2 The food supply

Australia is a major food exporting country and food exports are a major factor in the nation's economy. Ninety-five per cent of domestic food needs are satisfied by domestic production, but the economic importance of imports is much greater than their effect on the composition of food supply. Relative to exports, imports have a minor influence on the supply of food products also produced domestically, with the exception of fish and seafood[1] and some oilseed products.[2] Increasing domestic production of exotic and tropical fruits and vegetables that are normally imported is also tending to limit imports.[3]

The food and beverages processing industry is a key influence on the composition of food produced and the range of food choices available. The number of different food products available for purchase increased more than tenfold between 1938 and 1985,[4] primarily as a result of the increasing diversity of processed products. The food processing industry is looking increasingly to export markets and to the development of import-competitive operations.

Other influences on the domestic food supply are wastage, diversions from human consumption, and storage. Wastage occurs at all stages of the food supply chain. Post-harvest and post-abattoir wastage can result from damage or spoilage during transportation and from storage or deterioration when shelf life is exceeded. Non-food uses (that is, diversions from human consumption) include the production of industrial materials such as industrial alcohol and glues and the use of food products for pet and livestock food.

Available data on wastage and non-food uses of carcass meat, fruits and vegetables show that the proportions of food products lost are small: 0.2 per cent of meat and meat products, 1.1 per cent for fruits, and 5.4 per cent for vegetables.[5] The amount of wastage may be decreasing as a result of better storage, handling and transportation methods in the wholesale and retail areas and better storage methods in the home.[5] Few data are available on the effect of storage on the food supply but, taking end-of-year stock carryover volume as an estimate, the amounts would appear to be insignificant.

In the longer term, consumer demand also has an effect on the food supply, although measuring the extent of effect may be difficult. Considerable time (possibly years for some animal products) may elapse before primary producers are able to respond appropriately to changes in user demand (for example, by changing their breeding programs). Food imports can be highly responsive to demand, particularly when demand is price-elastic, although they are also influenced by other factors such as government policies and the trade policies of Australia's trading partners.[6] For example, Australia maintains strict quarantine controls to protect domestic producers from imported diseases such as foot and mouth disease.

2.1 Primary production

Potential information sources for monitoring

Mechanisms for reporting primary production tend to concentrate heavily on the financial aspects of such production: some modification may be required to increase the utility of the data for nutrition monitoring.

Table 2.1: ***Major food production information sources***

Organisation	Telephone
Australian Agricultural Economics Society	(067) 73 2915
Australian Apple and Pear Growers Association Inc.	(03) 689 3600
Australian Berryfruit Growers Federation	(002) 23 1494
Australian Bureau of Agricultural and Resource Economics	(06) 272 2000
Australian Bureau of Statistics	(06) 252 7911
Australian Chicken Growers Council	(02) 605 6464
Australian Citrus Growers Federation	(08) 212 4245
Australian Council of Egg Producers	(02) 588 5211
Australian Horticultural Corporation	(02) 357 7000
Australian Meat and Livestock Corporation	(02) 260 3111
Australian Oilseed Crushers Association	(02) 635 4307
Australian Sugar Milling Council	(07) 221 5633
Australian Wine and Brandy Corporation	(08) 365 1165
Department of Primary Industries and Energy	(06) 272 5212
Flour Millers Council of Australia	(03) 670 9079
Food and Beverage Importers Association	(03) 690 7600
National Farmers Federation	(06) 273 3855
Ricegrowers Association of Australia	(069) 53 0433
State agriculture departments	
Department of Agriculture (New South Wales)	(063) 91 3100
Department of Agriculture (Victoria)	(054) 30 4444
Department of Primary Industries (Queensland)	(07) 239 3000
Department of Agriculture (Western Australia)	(09) 368 3333
Department of Primary Industries (South Australia)	(08) 226 0222
Department of Primary Industry, Fisheries and Energy (Tasmania)	(002) 33 8011
Department of Primary Industry and Fisheries (Northern Territory)	(089) 89 2211

Information about commercial food production is collected by several agencies (see Table 2.1) and is most commonly reported as gross production and produce values. In some cases it may be possible to disaggregate the data to enable distinctions of nutritional relevance to be made between product types. Major sources of information on food production include industry groups, statutory marketing authorities, and State primary industries departments. At the national level there are the Australian Bureau of Statistics, the Australian Bureau of Agricultural and Resource Economics and a number of groups within the Department of Primary Industries and Energy. Many industry bodies are potential or actual sources of information. Information on key groups in rural industries, both private and public sector, is compiled by the

Department of Primary Industries and Energy and updated annually in its Rural Industry Directory. Both the Australian Bureau of Statistics and the Australian Bureau of Agricultural and Resource Economics publish regular series covering financial, labour, production and international trade matters. The former also publishes an annual compendium, *Yearbook Australia*, and the latter publishes occasional special-subject reports.

Industry components

Rural industries are classified as broadacre, dairy and horticultural.[7] Broadacre industries cover the following classes based on the Australian Standard Industrial Classification (ASIC):

- ASIC0181—cereal grain including oilseeds not elsewhere classified;
- ASIC0182—sheep – cereal grains;
- ASIC0183—meat cattle – cereal grains;
- ASIC0184—sheep – meat cattle;
- ASIC0185—sheep;
- ASIC0186—meat cattle.

In addition, there is overlap with ASIC0187—milk cattle.[8]

The broadacre industries are obviously important in terms of land use. In 1991–92 they comprised 77 818 establishments, with an average farm area of 57.7 square kilometres, and there were 14 167 dairy industry farms, with an average area of 1.7 square kilometres.[7] Table 2.2 shows the estimated area breakdown for these industries.

Table 2.2: ***Area distribution of rural industries, 1991–92***

Industry	Estimated number of farms	Average farm area (km^2)	Total farm area ('000 km^2)
Broadacre			
Wheat and other crops	7 135	12.2	87
Mixed livestock – crops	22 193	15.0	333
Sheep	18 038	58.7	1059
Beef	20 153	131.3	2645
Sheep–beef	10 299	35.2	362
All broadacre	**77 818**	**57.7**	**4486**
Dairy	14 167	1.7	25
Horticulture	na	na	na

na Not available

Source: Australian Bureau of Agricultural and Resource Economics[7]

The economic importance of primary food production means that economic events will ultimately affect the implementation of nutrition policy. For example, at February 1993 an estimated 400 000 people were engaged in food agriculture and fishing; more than half were producing cereal grains, sheep, cattle and pigs, 13 per cent were involved in horticulture, 5 per cent were involved in fishing, and 2 per cent were in the poultry

industry.[9] This workforce includes up to 20 000 unpaid family helpers,[10] which could be indicative of financial difficulty in the farm sector. This and the many uncertainties of rural life have adverse health effects[11,12] that may be relevant to food and nutrition monitoring.

The vagaries of primary food production are illustrated by production values. In 1989–90 the industry was valued at more than $16 thousand million[13] and in 1990–91 at $12 thousand million, the decrease being caused by lower world commodity prices. Exports in 1990–91 were valued at about $7 thousand million, or 58 per cent of production.[10]

One other factor that plays a part in shaping food production is the role of non-commercial producers. The major contributions come from fruit, nut and vegetable growing, poultry and eggs, beer and wine, and recreational fishing. As part of its 1992 population survey, the Australian Bureau of Statistics surveyed home production; the results are expected to be available in 1994.[14]

The meat industry

Total meat production from livestock exceeds domestic requirements and a large proportion—about 38 per cent—is exported. The proportion entering the domestic supply varies according to the type of meat; Table 2.3 shows the divisions for 1982–90. Veal, lamb, pigmeat and poultry are produced primarily for the domestic market. Beef and mutton are the major export meats. About 50 per cent of meat offal production is also exported. Meat imports affect the food supply very little.[3]

Table 2.3: ***Meat supply, domestic and export, Australia, 1982–90 ('000 tonnes carcass wt)***

Meat	1982	1983	1984	1985	1986	1987	1988	1989	1990
Domestic									
Beef	696	598	617	596	616	599	645	640	623
Veal	46	45	33	33	35	32	30	26	27
Mutton	66	64	90	113	108	133	105	129	136
Lamb	257	251	254	277	255	243	249	264	258
Pig									
Pork	83	93	103	108	114	115	122	125	127
Bacon, ham	143	152	151	153	159	166	171	173	175
Poultry	295	300	314	363	368	391	404	414	430
Export									
Beef	887	719	565	647	764	866	860	837	838
Veal	11	7	6	6	7	7	8	7	7
Mutton	205	144	100	123	168	164	156	153	201
Lamb	34	33	30	43	51	54	47	40	42
Pig[(a)]	3	3	4	4	4	7	10	8	7
Poultry	3	1	1	1	3	3	1	2	2

(a) Breakdown of pork and bacon and ham not available

Source: Australian Meat and Livestock Corporation[6]

In 1990 total beef and veal production amounted to 1.5 million tonnes. Veal accounted for only 2 per cent of production, of which less than 20 per cent was for export. About

43 per cent of beef production is for the domestic market.[6] Possibly the most significant effect of fluctuations in the export market would be the diversion of beef with a higher fat content to the domestic market if export demand were to fall. (Export beef often has a higher fat content than beef produced for the domestic market reflecting export market preferences.)

The beef industry is made up of three groups, each with a different relationship to the domestic market. The pastoral industry, centred in the north of Australia, produces beef mainly for export to the United States market. Feedlot (grain-fed) production is an expanding industry, responding primarily to North Asian preferences for grain-fed beef. The southern beef industry produces a larger proportion of younger animals grazed on improved pastures and turned off for slaughter at 9–18 months for domestic consumption.[6,15]

There is a distinction in the sheepmeat industry between lamb and mutton. Lamb production (300 000 tonnes in 1990) is generally associated with improved pastures; about 85 per cent of lamb produced goes to the domestic market. Mutton production (337 000 tonnes in 1990) is a by-product of wool production (as are sheep for live export); this part of the industry is associated with the wheat–sheep zone. Availability is related to global demand for wool rather than domestic demand for mutton. More than half of Australia's mutton production is exported.[6]

About 97 per cent of pigmeat production goes to the domestic market;[16] production increased by 34 per cent to 309 000 tonnes between 1982 and 1990, with a greater increase in pork production than in bacon and ham production. Pork constituted 37 per cent of pigmeat production in 1982 and 44 per cent in 1990.[16] Pig-breeding and the pigmeat production system have changed in response to changing consumer preferences, although most pigmeat for the fresh pork market still requires some fat-trimming to satisfy consumer preferences.[17]

The introduction of Estimated Lean Meat Yield (ELMY), a value-based payment scheme for all meats, has the potential 'to improve the transmission of consumer preferences via price signals to producers'.[17] The ELMY system is now incorporated in the AUS•MEAT chiller assessment program (see Box 2.1).[18] A similar system for pigmeat is advocated in the United States, where Total Body Electrical Conductivity (TOBEC) scanning, ultrasound and optical fibre techniques are used to differentiate lean meat and fat.[19]

As with pigmeat, poultry and eggs are produced almost entirely for domestic consumption, with over 99 per cent of poultry going to the domestic market.[20] Between 1982 and 1990 poultry meat production rose 45 per cent, from 298 000 to 432 000 tonnes. Over 95 per cent of poultry for meat production is chicken; turkey is the next highest contributor at about 2.5 per cent.[20] Commercial egg production has remained fairly stable during the past decade at about 2300 million eggs per year, or two-and-a-half eggs per person per week.

Other kinds of meat are of limited nutritional significance at present, although health and other benefits may accrue from replacing traditional meats with the leaner kangaroo, deer and rabbit meats. An estimate of available venison in 1989 was 414 tonnes (60 per cent imported from New Zealand), or about 65 mg per person per day.[21] The goat meat industry is small, but exports reached 7000 tonnes in 1989–90.[22]

Game birds (such as pheasants, quail, partridge, pigeon and guinea fowl) and ducks and geese are of interest in that they are sold primarily to the restaurant and catering trade, with only 5–10 per cent of the 7500-tonne annual production being bought for household consumption.[23]

Box 2.1: AUS•MEAT

AUS•MEAT is the Authority for Uniform Specification of Meat and Livestock. It is accountable through its board to the Australian Meat and Livestock Corporation. AUS•MEAT board members represent the following organisations:

- *Australian Meat and Livestock Corporation*
- *Australian Meat Exporters Federal Council*
- *Meat and Allied Trades Federation of Australia*
- *Cattle Council of Australia*
- *Sheepmeat Council of Australia*
- *Australian Pork Corporation*
- *Australian Supermarket Institute*
- *Australian Standing Committee on Agriculture.*

Established in 1987, AUS•MEAT is responsible for developing a national system of livestock, carcass and meat-cut descriptions to cover beef, sheep, pork, goat and buffalo.[24] *There is an AUS•MEAT descriptive language, there are technical assessment manuals, and there is an accreditation scheme for abattoirs (based on use of standard descriptions as well as quality assurance). All export abattoirs must be accredited; at 30 April 1990, 80 per cent of cattle, 72 per cent of sheep, 59 per cent of pigs, and 100 per cent of goats were processed through accredited abattoirs.*

AUS•MEAT monitors and provides training for accredited establishments and offers feedback to producers and processors. Chiller assessment, for example, uses an extended production description that provides standardised data from the slaughter floor onwards. Data collection covers standard carcass weight, sex and dentition; marbling, meat colour and fat colour; meat texture and firmness; eye muscle area and rib fat (subcutaneous fat); and an estimated lean meat yield (ELMY).[18] *Major supermarket chains and other large domestic meat buyers use AUS•MEAT language to specify requirements.*[17]

It should be noted that at present AUS•MEAT has a limited impact on the domestic supply, where accreditation is not mandatory. The potential is excellent, but implementation of the scheme is slow and use of the AUS•MEAT language is not extensive.

The dairy industry

Milk production has increased slowly since 1980–81, from a post-war low of 5243 million litres[2] to 6731 million litres in 1991–92[25]—this is an increase of 28 per cent, although per capita availability has changed very little. The increase was sustained despite a 10 per cent decrease in dairy cattle numbers during that period: milk yields (per cow) increased 43 per cent.[2,25] From a nutrition perspective, information about any related changes in the fat and calcium content of milk would be pertinent.

About 26 per cent of milk produced enters the food supply as liquid milk (which includes flavoured, UHT and low-fat milks); the balance is used in manufacturing, the main products being cheese, butter and milk powders.[26] The market milk volume of 1 763 000 litres in 1991–92 translates to an availability of around 300 mL (containing approximately 350 mg of calcium) per person per day.[27,28]

The international trade in fresh milk products is negligible but exports of processed products are significant. In 1991–92, 44 per cent of butter production, 51 per cent of milk powders, and 26 per cent of other products (except cheese) were exported. Cheese exports amounted to 66 100 tonnes, or 33 per cent of production, but 25 000 tonnes of cheese imports in that year were equivalent to 20 per cent of net domestic supply.[2]

Over the last decade the variety of liquid milk products has expanded to include a range of fat content from skim milk to whole milk, a range of flavoured products, and products with an increased calcium content. Recently, lactose-modified milks have also entered the market.[26,29]

The fishing industry

Australian fisheries and aquaculture production for 1991–92 amounted to 220 510 tonnes, with an estimated gross value of $1158 million.[1] This estimate excludes inland commercial fisheries and an unknown but relatively small quantity of squid, octopus and cuttlefish from Western Australia. Fish and seafood form a commodity group for which imports have a significant influence on supply.*

The major seafood catches in 1991–92 were prawns, rock lobster, and scallops. Nearly 70 per cent of the rock lobster catch was exported, while imports were negligible; in contrast, 49 per cent of the prawn catch was exported, but imports constituted 45 per cent of domestic supply. Exports of processed seafood amounted to 3400 tonnes in 1991–92 compared with 27 000 tonnes of imports.[1] Table 2.4 demonstrates the market structure in this industry. Australia exports high-value product and imports low-value product. For example, seafood exports were valued at about $23 per kg and imports at about $7 per kg.

The fishing industry collects quantitative information, in many cases to the species level, so there is potential to obtain accurate estimates of nutrient contributions. At present, however, the type of information reported differs from State to State. For example, the Tasmanian Department of Sea Fisheries reports only shark separately from other fish; the Tasmanian 'other fish' category, however, represents 19 per cent of the total Australian catch.[1] Accepting this limitation in the reported data, the major identified fish groups caught are orange roughy (14 per cent), tuna (9 per cent), pilchards (8 per cent) and shark (5 per cent). Molluscs and crustaceans are also reported by type, so the same potential for estimating nutrients exists for all fisheries production. At the same time, nutrient composition data are available for only some of the many Australian fish and seafood species and this also limits the ability to make nutrient estimates.[30]

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* 'Seafood' describes invertebrate food species: crustaceans (for example, prawn, lobster, crab, yabby) and molluscs (for example, squid, cuttlefish, octopus and shellfish—scallop, oyster, abalone). 'Fish' are vertebrates, generally with fins, scales and tails. Sharks and related fish (skates and rays) are exceptional in that they have cartilaginous skeletons and do not have scales (sharkskin has been used as an alternative to sandpaper).

Table 2.4: ***Fish and seafood production, imports and exports, 1990–91 and 1991–92***

	1990–91			1991–92		
	Quantity ('000 t)	Gross value ($m)	Mean value ($/kg)	Quantity ('000 t)	Gross value ($m)	Mean value ($/kg)
Production						
Fish	157	326	2.08	140	378	2.70
Seafood	80	724	9.09	81	781	9.64
Total	236	1050	4.45	221	1158	5.25
Imports						
Fish						
Fresh, chilled, frozen	39	115	2.93	44	135	3.06
Processed	29	137	4.85	33	155	4.72
Seafood	25	193	7.63	25	178	7.00
Total	93	445	4.78	102	469	4.57
Exports						
Fish						
Fresh, chilled, frozen	17	93	5.58	13	83	6.52
Processed	2	12	5.75	2	18	7.17
Seafood	28	613	22.13	31	726	23.58
Total	46	718	15.46	45	826	18.37

Note: Numbers may not add exactly due to rounding

Source: Derived from Australian Bureau of Agricultural and Resource Economics[1]

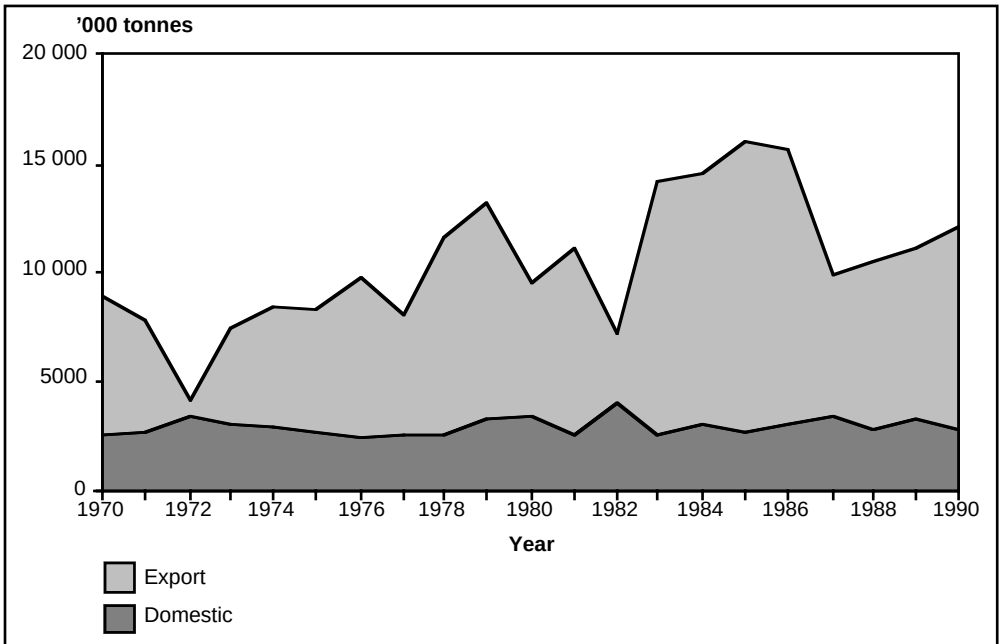
In terms of harvesting from wild fisheries, the Australian fishing industry, like the fishing industries of other developed countries, is a sophisticated hunter–gatherer operation. Consequently, the composition of the catch is responsive to many factors other than consumer demand. One such factor is the depletion of stocks, which sometimes leads to the imposition of quotas. As an example, the orange roughy catch decreased by over 50 per cent between 1989–90 and 1991–92,[1] partly because of depletion and partly because of quota restrictions. This industry is one part of the food supply where the non-commercial component is significant, possibly accounting for as much as 30 per cent of available fish.[31]

The Australian Fish Marketing Authority, which is responsible for Commonwealth fishing areas, has quotas for 16 species; the main difficulty lies in identification, even though the Authority provides guides to identification. Further difficulties may arise over how the catch is recorded, how it is identified at the market, and under what name it is sold, because there is no legislation in force in Australia on the use of common names for fish.[31]

The increasing interest in aquaculture and mariculture has the potential to improve the ability of demand to modify supply. Aquaculture contributed 6 per cent of production in 1989–90[1] and 21 per cent of value.[32] The major producing states are New South Wales and Tasmania, together accounting for over 80 per cent of production.[1]

The broadacre cropping industry

Wheat is both the major Australian broadacre crop and the major export commodity. The 1991–92 wheat crop was 10.7 million tonnes, of which 7.6 million tonnes (71 per cent) were exported.[2] This was a relatively poor year (see Box 2.2). Generally, domestic supply is influenced very little by any but very large fluctuations in export sales, as illustrated in Figure 2.1.



Source: Australian Wheat Board[33]

Figure 2.1: ***Australian wheat production, domestic and export markets, 1970–90***

Wheat for domestic use in 1991–92 amounted to 3.4 million tonnes, of which about half was used for livestock feeding. Of the 1.8 million tonnes processed through flour milling, 1.4 million tonnes became wheat flour. The remaining 0.4 million tonnes became the by-products bran and pollard, which are used almost exclusively by the stock industry as pellets, although a small amount is sold as bran for human consumption. About 75 000 tonnes of flour were exported, and 25 per cent of the remainder was used in starch and gluten manufacture. The remainder—about 1 million tonnes—was used for domestic human consumption. The approximate apparent consumption of wheat products based on industry figures is 150 g per person per day, which is 15–20 per cent less than the equivalent Australian Bureau of Statistics estimate.[34]

Rice production in 1991–92 was 1.1 million tonnes, about 30 per cent higher than the average for the previous decade.[2] Annual exports during the 1980s amounted to about 0.4 million tonnes. Domestic supply figures for 1990–91 and 1991–92 were distorted by stock movements in and out of storage;[2] the average available supply during the 1980s was 113 000 tonnes, or 19 g per person per day.

Significant amounts of other grain crops are diverted to fodder and seed use. The domestic supply of barley was about 40 g per person per day; for oats it was 6.5 g per person per day and for maize 14 g per person per day.[2] However, most of the barley for food use goes to malt production and maize to corn syrup and corn starch production. Over 70 per cent of sugar production is exported; 840 000 tonnes enter the domestic supply, amounting to about 132 g per person per day.[2]

Box 2.2: Rain and the wheat crop, 1992–93

Australia is the world's fourth-largest wheat exporter and the wheat industry makes a substantial contribution to the income and livelihood of hundreds of rural communities. It also has a significant impact on the nation's economic welfare through its effect on export earnings and the current account balance. Any factor that may have a negative impact on the wheat crop is naturally viewed with concern. One such factor is unseasonal or excessive rain.

Some farmers will remember the Christmas of 1992 as the time when the best-looking harvest became one of the worst. Heavy rain swept through the southern States, causing widespread crop damage. Crops were flattened or waterlogged, harvests were delayed, and grain shot or sprang. The damage was worst in Victoria and South Australia; northern New South Wales and Queensland were relatively unaffected.

By New Year's Day it was estimated that weather damage could claim nearly half of the expected 14-million-tonne bumper crop. Downgrading of a sizeable proportion of the crop—some to stock feed grade—was predicted, as were significant decreases in crop values. This was especially frustrating for the farmers, who saw prices for good-quality grain rise as the rain continued to fall. Many had hoped that a good crop could restore the ailing grain industry, help to pay off longstanding farm debts, and give Australia's balance of payments a boost. Instead, growers were estimated to be facing a loss of an average $30 000 each.

By late January the picture had improved. The downgrading of the crop was less than expected. There was some reduction in protein content but much of the crop was still of a millable grade. The Australian Wheat Board estimated production at 15.3 million tonnes, a significant increase over mid-year predictions.

Nevertheless, Australian Wheat Board Managing Director John Lawrenson stated, 'About 5 million tonnes of that production has been weather damaged. In effect, that's a $250 to $300 million lost opportunity for Australian wheat farmers this year. I'd estimate that, of the total production, between 12.5 and 13 million tonnes will be delivered to the Australian Wheat Board pools this year and that will give us an export potential of between 11.5 and 12 million tonnes'.[35]

The weather damage had a limited effect on the domestic market. The Wheat Board announced plans to import quantities of specialist durum wheat for pasta manufacture, since the wet harvest in South Australia meant there was no chance of harvesting significant tonnages of quality grain. Overall, however, because the Australian domestic demand takes up only 20 per cent of total available wheat, there was little effect on the domestic supply (see also Figure 2.1).

Estimates of the domestic supply of other crops such as grain legumes and oilseeds are less certain. The uncertainty arises from lack of information about diversion for stock feed of produce that could be available directly for human use. By-product use by the stock food industry varies in response to variations in supply and price, with substitutions of alternatives to give least-cost formulations. Production of grain legumes, excluding lupins, totalled 770 000 tonnes in 1991–92, about half being exported.[2] Data on the oilseed industry is reported variously as oilseed production, oil, and meals and flour. Australia imported 22 700 tonnes of safflower oil, 29 100 tonnes of soy oil, and small quantities of other oils, as well as about 112 000 tonnes of oils of crops not grown domestically in 1991–92. Approximately 11 300 tonnes of soy meal and 18 600 tonnes of other meals and flours were imported (probably for stock feed) and 6400 tonnes of meal exported. Domestic production of soybeans in 1991–92 totalled 50 500 tonnes and imports 61 600 tonnes. Half of the 24 000-tonne safflower crop and half the 90 000-tonne sunflower crop were exported. The other major seed export was 158 000 tonnes of cottonseed, or 20 per cent of the crop.[2] Estimates of edible oils available for consumption are difficult to make at this point on the food supply chain.

Horticulture industries

The food-producing horticulture industries include the fruit, vegetable and nut industries and the honey industry. A 1993 Industry Commission review of horticulture concluded that the industry was efficient, competitive and increasing its export share.[36] A major factor in this, it said, had been the establishment of the Australian Horticultural Corporation, whose first responsibility was to increase the export of horticultural products. Other Corporation functions include improving product quality and industry efficiency, promoting domestic and export consumption, and improving interstate marketing within Australia. At 1 January 1993 the participating industries were the apple, pear, nashi, citrus, dried vine fruit, chestnut, avocado, macadamia and honey industries (and the non-food nursery industry).[37] The Australian Horticultural Corporation collates and publishes production figures annually; some data come directly from the participating industries and are not otherwise accessible.

In terms of volume, the major fruit industries in Australia are the citrus, pome, banana and pineapple industries; other significant industries are stonefruit, melon, table grape, avocado, berry, kiwi fruit and mango.[38] The number of tropical fruits available is increasing. Stone and pome fruits are more widely grown, but production is greater in southern Australia. The major vegetables grown in Australia are potatoes, tomatoes, onions, carrots, brassicas, and peas and beans. Table 2.5 summarises fruit and vegetable production, and trade. These values are for fresh fruit and vegetables and the fresh fruit equivalent weight of fruit juices. It should be noted that the Industry Commission's figures vary in some particulars from those compiled by the Australian Bureau of Statistics. Some variation arises from differences in the particular 12 month period used. Large differences in the imports of citrus fruit, potato and tomato products are due to the focus of the Industry Commission on horticultural production: thus about 270,000 tonnes of imported processed products are not included.

Citrus fruits, particularly oranges, are the most important of the fruits in nutrient terms because of their contribution to the vitamin C and folate content of the food supply.

They provide approximately 37 per cent of the vitamin C supply. The citrus crop is valued at $200–250 million annually. About 35 per cent of the citrus crop is sold directly as fresh fruit on the domestic market, with 57 per cent going to processing.[39] Citrus availability is influenced by exports (around 8 per cent of the crop) and imports, of which orange juice concentrates constitute about 90 per cent.[39]

Table 2.5: ***Fruit and vegetable production and trade for the fresh food market, 1 April 1990– 31 March 1991 ('000 tonnes) and comparison with processing use.***

Product	Production[(a)]	Fresh exports	Fresh imports	Prop. processed (1989–90) (%)
Oranges	453	48	2	60
Lemons, limes	32	1	1	55
Mandarines	40	4	–	15
Grapefruit, other	26	0.2	0.4	65
All citrus	**552**	**53**	**4**	**56**
Apples	289	26	–	38
Pears[(b)]	160	26	0.1	55
All pomefruit	**448**	**52**	**0.1**	**44**
Peaches and nectarines	70	0.7	2.4	58
Plums, prunes	20	2.3	–	61
Apricots	25	0.2	0.7	84
Cherries	5	0.2	0.2	13
All stonefruit	**120**	**3**	**3**	**48[(c)]**
Bananas	165	–	–	2
Berries	6	0.4	6	na
Pineapples	126	0.9	0.1	78
Avocados	12	0.2	1.7	–
Mangoes	12	0.8	0.4	13
Other fruit	12	5	12	na
All other fruit (excl. grapes)	**333**	**7**	**20**	na
Wine grapes	487	–	–	100
Drying grapes	317	–	–	100
Fresh grapes	47	9	–	na
All grapes	**851**	**9**	**–**	**99**
All fruit (incl. grapes)	**2304**	**124**	**27**	na
Potatoes	1136	15	–	na
Tomatoes	364	2	–	na
Mushrooms	24	–	0.3	na
Onions	222	60	1	na
Carrots	152	20	–	na
Lettuce	98	2	–	na
Other vegetables	545	27	6	na
All vegetables	**2542**	**127**	**7**	**50**
All fruit and vegetables	**4846**	**251**	**34**	**na**

Note: Figures may not add exactly due to rounding
na Not available
– Zero
(a) Production volumes are for the year ending 31 March
(b) Production includes nashi. Trade includes quinces
(c) Proportion processed is for apricots, cherries and peaches only

Source: Industry Commission 1993[36]

The annual value of apple and pear production is close to $300 million; exports of fresh apples constitute 10 per cent of production and exports of pears 20 per cent.[2] The Goulburn Valley region in Victoria produces 80 per cent of the pear crop. Grapes are grown for three primary markets: table (fresh) grapes, drying, and winemaking. Total grape production (fresh weight) in 1991–92 was 1 058 000 tonnes—605 000 tonnes for winemaking, 399 000 tonnes for drying, and 54 000 tonnes for table use.[40] Dried vine fruits are energy dense but in 1990–91 domestic supplies contributed less than 1 per cent of the per capita availability of energy.[41,42] The major influence of grapes on the food supply comes from alcoholic beverage production, with the available wine supply at around 50 mL per person per day, providing almost 6 mL per person per day of ethanol.[42]

The banana crop is sold almost entirely as fresh fruit on the domestic market; the 1990–91 domestic supply was about 36 g per person per day based on Australian Bureau of Statistics data. The Industry Commission figure is considerably less—27 g but the cause of the discrepancy is not apparent. Another major tropical crop, pineapples, goes primarily to canning and juicing.

Commercial peanut production in 1990–91 totalled 20 300 tonnes, of which 1700 tonnes were exported. Imports amounted to 27 000 tonnes. Total 1990–91 tree nut production was 18 300 tonnes and 7400 tonnes were exported.[27] The main crops were almonds and macadamias.[36] Imports constitute most of the Australian tree nut supply—56 200 tonnes were imported in 1990–91, or about 75 per cent of the available domestic supply.[27]

Of the vegetables, carrots are extremely important in nutrient terms. Australian production, usually around 140 000–150 000 tonnes per year,[43] provides a per capita supply of 2000–2400 μg per day of β-carotene (equivalent to 330–400 μg per day of retinol equivalents and 12–17 per cent of the total vitamin A supply).[41,43] Brassica vegetables as a group (broccoli, Brussels sprouts, cabbage and cauliflower, for example) make a significant nutrient contribution; production in Australia was nearly 200 000 tonnes in 1989, equivalent to a per capita supply of 32 g per day.[36] Brassicas also have a number of non-nutrient, biologically active constituents, some of which may have a preventive role in the development of cancers, particularly colorectal cancers.[44–50]

Potato production in Australia, at over 1 million tonnes in 1990–91, represents a per capita supply of 160 g per day (and over 20 per cent of vitamin C supply). Tomato production is over 300 000 tonnes per year, 80 per cent of the crop being processed;[36] tomatoes contribute around 9 per cent of the vitamin C supply.[36,41,43]

Honey production in Australia between 1989 and 1991 declined by about 10 per cent as a result of adverse growing conditions but was over 20 000 tonnes in 1991.[37,51,52]

2.2 The food processing industry

> In Mrs Beaton's time most women spent their lives working for hours each day in the kitchen … Much of the work that used to be done by hand in the Victorian kitchen is now done by machines … in the food processing plant or factory.[53]

What is food processing and what is it for?

In a modern industrial society, in which consumers have little direct involvement with the production of food, many of the tasks formerly done in the home are now delegated to the food processing industry. Advances in science and technology have expanded the variety of techniques available and there has been an extension of the role of industry, culminating in such products as ready-to-eat breakfast cereals, chilled and frozen complete meals, and take-away foods.

The food processing industry is more precisely the secondary food industry. It is frequently referred to as the 'food industry'—as distinct from 'primary industry'—and comprises all 'food and beverages processing industries'. In this report, the term 'food industry' is used to mean the secondary, or manufacturing, industry and to include beverages within 'foods'. The tertiary, or retail, food sector is considered in Chapter 3.

Food processing implies the use of technology but the boundaries are imprecise and the following broad groups of techniques of increasing complexity are all included:

- preliminary operations such as cleaning, sorting, grading and packaging of produce;
- processes such as peeling, cutting and dicing or preparation and chilling or freezing of meat carcasses. Some forms of packaging are more than preliminary (for example, packing in a modified atmosphere or with a preservative added);
- more complex processing used for operations such as the milling of grains and sugar refining and for preservation activities such as pasteurising milk, canning of fruit and the preparation of frozen vegetables;
- highly sophisticated techniques used to produce, for example, extruded snack products, fish fingers, ready-to-eat breakfast cereals, biscuits, beer, bread, cheese, pasta and confectionery. These foods are sometimes described as 'highly processed'.

Although the Australian food industry does not use the term 'highly processed', it is used extensively by government to describe the kinds of food products preferred for export. This usage is inappropriate for food products because 'highly processed' is often equated with 'high value added'. The two are not necessarily related.

Many food processing techniques originate from a need for preservation. Without preservation, at 20°C the storage life of meat, fish and leafy vegetables is no more than two days, and the limit is about three weeks for some root vegetables.[54] Drying, brining and adding sugar all make water unavailable to micro-organisms and restrict growth, as does the exclusion of oxygen (for some), the addition of preservative chemicals, and chilling or freezing. Irradiation (presently not approved for use in Australia) and a number of forms of heating preserve by killing micro-organisms present in food. Preservation can prolong storage life, but not indefinitely: protein denaturation has been reported to occur in skim milk powder stored for three years under liquid nitrogen.[55]

Fermentation is controlled microbial degradation that produces a preservative by-product of microbial metabolism; for example, ethanol or acids. Packaging is a process designed to prolong the preserving technique by preventing contamination or excluding oxygen. Other traditional food processing methods are separation (fractionation) of produce and reconstitution of products from food components. Examples are the milling of flour and extrusion technology.

A food and nutrition monitoring strategy will need to consider operational and technological changes that have the potential to affect the food and nutrient supply. Several useful reviews deal with the relationship between food processing and nutrition, including a very detailed review by Bender,[55] which looks at the recent history of food processing, and more succinct accounts by Truswell and Brand[53] and Jones.[54]

Since 1938, as a result of technological advances, the range and variety of products available has increased from about 1000 to between 9000 and 15 000.[56] The positive attributes of food processing can be summarised thus:

- reducing waste and hence cost and allowing large-scale efficient production;
- improving food safety by treating food to eradicate pathogens and de-activate natural toxins;
- extending the availability of foods beyond the natural growing season and extending the usable life of food products;
- widening the geographical availability of foods;
- reducing time spent on food preparation in the home—convenience;
- improving the aesthetic qualities of food—appearance, flavour and appeal, palatability, variety.[53,57]

One of the issues in food processing is the effect on nutrient content. Processing of cereal grains, for example, removes unwanted components and improves digestibility. Losses may be due to the process itself (such as loss of outer cereal layers in producing refined flours), or as a side-effect (for example, the destruction of heat-labile or oxygen-sensitive vitamins such as thiamin, conjugated folates or vitamin C).[53,55,57] An important determinant of nutritional or other quality reduction is length of exposure to high temperatures; high temperature short time (HTST) and ultra-high temperature (UHT) techniques, for example, may affect nutrients less than conventional canning processes. HTST processing for milk is 15 seconds at 72°C and rapid cooling to 5°C; this gives sterilisation equivalent to that achieved by the older pasteurisation method of 60°C for 30 minutes plus slow cooling. UHT processing (a few seconds at 137°C) has little effect on nutritional quality but causes a flavour change.[58]

Although food processing generally tends to reduce absolute levels of heat-labile or easily oxidised nutrients, the Canned Food Information Service[59] has shown that canning can preserve some nutrients beyond the normal shelf life of fresh equivalents.

Research and development

The Industries Assistance Commission inquiry into the food industry in the late 1980s concluded that the Australian food industry had a low level of investment in research and development. Over 90 per cent of companies recorded no expenditure on research and development in 1986–87. Imports accounted for most of the improved technology

used and uptake of Australian research and development was more rapid outside Australia than within, suggesting the existence of structural and regulatory impediments to research and development in Australia.[60]

From this low base, expenditure on research and development in the Australian food industry has responded to initiatives such as the 150 per cent tax concession, a range of grants focused on industry-identified opportunities, and the establishment of State food research institutes and the Cooperative Research Centre for Food Industry Innovation.[61] Increased research and development activity reflects industry's awareness of the need to meet the requirements for capturing export market share, particularly in Asia (see also Chapter 1). Total human resource research and development effort by business enterprises increased from 1.49 per cent of total employment in 1988–89 to 1.67 per cent in 1990–91; total food, beverages and tobacco effort was below the average at 1.07 per cent. Nevertheless, total expenditure devoted to research and development was over $85 million in 1990–91.[62]

Consumer interest often moves ahead of science and, in responding to market signals, the food industry has produced a very large number of product modifications and additions. This responsiveness is a valuable attribute of the industry, although the introduction of new product formulations may move ahead of demonstrations that a modification is beneficial (or otherwise) in terms of health. Currently, there are processed food products available that, compared with their standard counterparts, have lower salt, reduced fat, reduced alcohol and increased fibre—all modifications consistent with recommendations for appropriate dietary change.[57]

An example of the food research capacity to respond is the work of the CSIRO Division of Plant Industry,[63] which has developed a modified linseed (Linola™) producing an edible, highly polyunsaturated oil, the crop being harvested at a time of year when other edible oilseed crops are out of season. Other examples are provided by the New Zealand Institute of Crop and Food Research, which has worked with the food industry to develop oat and barley strains with higher levels of the soluble fibre β-glucan, widely reported to exert a significant serum-cholesterol-lowering effect. Further research involves the development of orange-coloured wheat and barley containing β-carotene.[64]

Other research efforts include gene manipulation techniques aimed at increasing the disease resistance of potatoes or controlling the ripening process for kiwifruit and tomatoes,[64] and cost-effective process improvements such as advanced enzyme immobilisation techniques for large-scale continuous production lines.[65] A number of new processing techniques are being investigated because they use lower temperatures and thus retain sensory and nutritional quality. These include ultrasound, high-intensity electrical fields, and ultra-high-pressure technology.[58] Australian research has also been directed to modifying dairy products by substitution of milk fat with mono-unsaturated oils.[66,67]

Packaging is one of the basic tools of the food industry and advances have been instrumental in extending the shelf life and quality of food products.[68] Among current developments are environmentally safe packaging and an edible food container based on potato.[65] There is also research into high-performance, ultra-thin edible films that can be used to separate wet and dry components or differently coloured components in composite packs or to locate preservatives at the surface of foods.[58]

'Functional foods' are also attracting attention in Australia because of the Japanese interest in them and their export potential (see Section 2.5).

The Australian food industry

The food industry is the largest manufacturing industry in Australia, accounting for more than 20 per cent of manufacturing turnover.[69] Labour force estimates for February 1993 showed 184 600 people employed in food and beverage manufacturing—2.4 per cent of the total Australian workforce. Ninety per cent of employment in all the food industries was in New South Wales, Victoria and Queensland. Tasmania, however, had the highest proportion of food industry workers in food manufacturing, at 28.7 per cent.[9]

The focus in the past decade has been on increasing exports of processed foods. Major reviews of the role of the food processing industry, by the Prime Minister's Science Council in 1991[70] and the Industries Assistance Commission in 1989,[60] were undertaken with a view to improving export performance. The establishment of the National Food Authority in 1991—following the Industries Assistance Commission's 1989 recommendations to streamline the food regulatory review process—has changed the nature of the regulatory framework within which the food processing industry operates.

The Australian Bureau of Statistics collects manufacturing production data, which it publishes monthly and quarterly. Tobacco is grouped with food and beverages, but the tobacco industry is small relative to the food industry (0.2 per cent of establishments and 2.5 per cent of turnover in 1987–88)[71] and can be discounted for the purpose of monitoring trends in the food and beverage industries. The bread, cake and biscuit manufacturers accounted for 43 per cent of establishments and 9 per cent of turnover; this contrasts with the meat industry, which generated 26 per cent of the sector's turnover from 16 per cent of establishments.

Key players in the food industry

The food industry is highly concentrated: in 1992, 60 per cent of the market was shared by only 20 companies.[69] In some segments of the industry one or two firms may have over 90 per cent of the market for a product group. The Industries Assistance Commission identified four product segments in which the market share of the leading firm was over 70 per cent.[60] Nevertheless, there were over 3900 food or beverage processing establishments in 1991,[72] and firms engaged in packaging, recruiting, marketing and distribution expand that number. The *Foodweek* yearbook for 1993[73] lists over 350 companies engaged in manufacturing, importing and distributing processed foods. This includes 18 firms dealing solely with alcoholic beverages, 26 dealing solely with confectionery, and 28 dealing solely with dairy foods (other firms may also deal in these products as part of a wider range). In addition, *Foodweek*[73] lists 18 suppliers of packaging materials and there are many others. The Department of Industry, Technology and Regional Development surveyed the food industry in 1991 and found five firms with an Australian turnover greater than $1000 million and a further 10 firms with turnover greater than $500 million.[72]

There are two key umbrella bodies for the food industry: the Food Industry Council of Australia (FICA) and the Council of Australian Food Technology Associations (CAFTA). As well as its advocacy role for the industry as a whole, the Food Industry

Council of Australia initiated the establishment of the Australian Food Foundation in 1990. Broadly, the Foundation's objectives are to develop credibility for information about food provided by the industry and to promote and disseminate such information. Additionally, in common with the position taken by the Government in its National Food and Nutrition Policy,[74] the Foundation seeks to encourage cooperation between the food industry, consumers, and the health sector.[75]

The Council of Australian Food Technology Associations is the organisation best placed to consider and advise the food industry on matters relating to the science and technology of food processing and has a major role in examining food standards issues. Its history and development have been linked with food standards and food legislation since Federation.[76] The establishment of the National Food Authority has augmented the role of peak bodies such as CAFTA and FICA in the rapid assimilation of information and preparation of written submissions to the Authority.[77,78]

The National Food Authority is responsible for review and development of the Food Standards Code, which is now the basis for food regulation in all States. It has a key role because most of the food regulations concern food processing. The National Food Standards Council, to which the National Food Authority makes its recommendations, makes decisions on those recommendations and is the key body in food regulation. Table 2.6 lists influential national private and semi-government food processing industry bodies.

Other key groups are the trade unions associated with the industry and consumer organisations, of which the peak body is the Australian Federation of Consumer Organisations. A number of Commonwealth and State government bodies are actively involved in providing support and information to the industry, among them the Agri-food Branch of the Department of Industry, Technology and Regional Development and the International Food Institute of Queensland, a body within the Queensland Department of Primary Industries. Several CSIRO divisions are active in food research—Plant Industry, Dairy Research, Food Science and Technology, and Human Nutrition.

Processed foods and beverages on the domestic market

Processed products form the bulk of the food supply offered for sale in Australia. The food processing industry does not operate independently of the primary and tertiary food operators, and Australia is following the trend to vertical integration that has characterised other developed markets, although the Industries Assistance Commission noted in 1989 that, 'in the main, packaging, transport, wholesaling and retailing are carried out by highly specialised enterprises'.[60] The Industries Assistance Commission also noted that industry concentration probably occurred because of the opportunities for economies of scale. Vertical integration carries with it the prospect of improving communication between consumer and primary source.

Responding to consumer demand

In a review of current food trends, Mitchell suggests that the microwave oven represents 'probably the most significant technological advance' in domestic food preparation and that it has arrived in a period when less time is spent on food preparation and the demand for convenient, quick-to-prepare meals is growing.[64] The food industry has responded with the development of a wide range of convenience

products, although not necessarily assigning the same primacy to the microwave oven as did Mitchell.

The proliferation of low-fat dairy products is the industry's response to increasing consumer concern about high-fat products, particularly those high in saturated fatty acids. The successful market penetration of 'mono-unsaturated' margarines (see Section 2.4) has been followed by the release of a low-saturated-fat cheese based on canola oil, with '80% less cholesterol than regular cheddar. Just 3% saturated fat'.[66] Australian Co-operative Foods has developed a 'full-cream' milk low in saturates by substituting mono-unsaturated oils for milk fat.[67]

Table 2.6: ***Private and semi-government Australian food industry bodies***

Organisation	Description
Food Industry Council of Australia	Council of major industry associations; peak industry body
Council of Australian Food Technology Associations Inc.	Peak professional body; advisor and advocate on food standards and regulations; publishes the journal *Food Australia* (formerly *Food Technology in Australia*)
Australian Food Brokers Association	Association of Australian and New Zealand food wholesalers
Australian Food Foundation	Provides information; advocacy and liaison
Australian United Fresh Fruit and Vegetable Association Ltd	Industry umbrella association
Australasian Soft Drink Association Ltd	Represents bottlers and distributors; advocate to governments and consumer groups
Canned Food Information Service Inc.	Provides information to public, dietitians and governments on behalf of the industry
Confectionary Manufacturers of Australia Ltd	Trade association
Food and Beverage Importers Association	Advocate to governments and advisor on food regulations to importers
Grocery Manufacturers of Australia Ltd	Represents the industry to governments, the media and the public
Australian Ice Cream Association	Industry association
Australian Dairy Corporation	Statutory corporation; promotes the industry, provides information to the public, health professionals and the media
Australian Meat and Livestock Corporation	Statutory corporation; promotes the industry, provides information to the public and the media; in conjunction with the Meat Research Corporation, commissions research
CSIRO (various divisions) Food Science and Technology Human Nutrition Dairy Research Plant Industry Meat Research	Statutory body; research and development

Communication with consumers

The usual stance taken by the food industry is that it responds to, rather than influences, consumer demand. Ian Gittus, chairperson of FICA, has stated that the industry follows, assists and accelerates trends but does not inspire them,[79] but this view is not universal.[80,81] Food industry expenditure on advertising and evidence of its effectiveness suggest that the boundary between inducing and accelerating trends may be indeterminate. A major market research organisation 'Brand Scan' promotion in 1992 indicated that promotion of one brand (nature of the product unknown) had a profound, though possibly short-term, effect on product category sales volume; that is, it created additional sales that were not accounted for by 'pantry stocking' or brand substitution, although attracting customers from competitors may have been a factor.[82]

The food industry has a vital role because, together with retailers, it largely determines the range of products available to the consumer. The food industry will act to meet (or predict) consumers' changing preferences. If these be based on nutritional criteria, then the industry has changed and will continue to change product characteristics to meet those preferences. Increased interest on the part of food companies in the nutritional aspects of processing and promotion has arisen from extensive and sophisticated market research to produce foods that better match consumer requirements; for example, more wholemeal and wholegrain products, and reduced-fat, reduced-sugar, reduced-salt and low-energy-density items.[80,83]

One noteworthy change in the food supply in the past decade has been the increasing proportion of food prepared and often eaten away from home.[84] A significant proportion of food production is now directed to the food service industry, and a large number of products are prepared to be marketed as foods or meals requiring minimum preparation by the consumer.[73] Such products include bulk and special processed items for food services, supplies for on-site take-away food outlets and pre-prepared packaged whole meals mainly for the food service industry. More information is needed about the scale of this trend.

2.3 The available food supply*

The most important source of data on the food supply is the Australian Bureau of Statistics series *Apparent consumption of foodstuffs and nutrients, Australia* (catalogue number 4306.0), which has been published regularly since 1936–37. The series deals with the supply and use of foodstuffs and with the level of nutrients in the food supply. The food industry also provides data, and in some cases industry figures are the basis of the Australian Bureau of Statistics collection (for example, dairy product information is supplied to Bureau by the Australian Dairy Corporation). Box 2.3 provides details of Bureau publications related to the *Apparent consumption* series.

The *Apparent consumption* series

The *Apparent consumption* series provides a national inventory of food production and contains details of imports, exports, wastage, non-food use and stock carryovers.[85]

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* This section contains material adapted (with permission) from the *Apparent consumption* series.

Historical data are provided as averages for three-year periods, starting with the period ending 1938–39. It is important to note that per capita consumption represents only the average amount of food available across the population as a whole.[86] Apparent consumption data are food supply measures and, since there are few restrictions on the movement of food across internal political boundaries in Australia, they cannot provide information on a State basis. Nor can they be disaggregated to give information about the food intakes of individuals, households or population subgroups, because consumption is not measured directly. In general, the apparent consumption statistics are for financial years. If, however, there is a marked seasonal pattern in the production or marketing of specific crops, the statistics refer to crop years. For example, statistics relating to commercial production of citrus fruit are for the year ending 31 March. A final consideration is that discontinuities in methodology limit to some extent the accuracy of trends estimates, but such estimates can nevertheless be made.

Box 2.3: Australian Bureau of Statistics publications related to the *Apparent consumption* series

The following Australian Bureau of Statistics publications provide more detail on various aspects of the food supply (catalogue number appears in parentheses):

- Summary of crops, Australia, 1990–91 *(7330.0)*
- Livestock and livestock products, Australia, 1990–91 *(7221.0)*
- Manufacturing commodities, principal articles produced, Australia, 1986–87 *(8303.0)*
- Foreign trade, Australia: merchandise exports, detailed commodity tables, 1991–92 *(5436.0)*
- Foreign trade, Australia: merchandise imports, detailed commodity tables, 1991–92 *(5437.0)*
- Manufacturing production, Australia: food, drink, tobacco, stock and poultry food *(8359.0)—issued monthly*
- Sales of Australian wine and brandy by winemakers *(8504.0)—issued monthly*
- National Health Survey: health risk factors, 1989–90 *(4380.0)*
- National Health Survey: alcohol consumption, 1989–90 *(4381.0).*

The Bureau has more detailed agricultural statistics on magnetic tape, microfiche and floppy disk. Agstats *on floppy disk offers an even wider range of data, aggregated at smaller geographic areas than those generally available in printed publications.*

Current publications produced by the Australian Bureau of Statistics are listed in the Catalogue of publications and products, Australia *(1101.0).*

The apparent consumption data can be used for international comparisons. FAO[86] provides country-by-country food balance sheets derived from calculations of food available for consumption or 'apparent consumption' comparable with the Bureau derivation, which is as follows:[27]

apparent consumption = [commercial production + estimated home production + imports + opening stocks] minus [exports + use for processed food + non-food use + wastage + closing stocks]

The result of the equation is so labelled because it is food otherwise unaccounted for that may reasonably be assumed to have been available for human consumption and so 'apparently' consumed.[87] Since this food has effectively 'disappeared' from the supply, data of this kind are also referred to as 'disappearance data'. A new system for classifying imports and exports, the Australian Harmonised Commodity Classification, was introduced on 1 January 1987 and may have some impact on the data from 1987–88 onwards when compared with data for previous years because some classifications now differ.

National supply of foods

The accuracy of apparent consumption as a measure of actual consumption is limited by the quality of data for factors in the general equation. Quantities actually measured are broadly the quantities available for consumption at a particular level in the process of distribution—ex-market, ex-store or ex-factory, depending on the method of marketing or processing, or both. It is assumed that in most cases the foodstuffs will find their way to individual consumers with a minimum time lag. The figures are therefore a fairly accurate representation of apparent consumption, as defined, in the year to which they relate.

An important qualification is that statistics on available production are confined mainly to commercial production. The home production estimate has been based on information collected during the 1944 household survey,[88] but will be revised in 1994 from the home production survey conducted in 1993.

Statistics for stocks refer to in-store stocks (that is, those held by marketing authorities) and factory stocks. With minor exceptions, no details are available for wholesalers', retailers' or householders' stocks. For perishable commodities this is of little importance since the very nature of these commodities precludes the accumulation of stocks. This is not the case, however, with non-perishable foodstuffs, and estimates derived for apparent consumption of such foodstuffs for individual years may not state the position accurately, particularly in the case of canned foodstuffs that have a long shelf life.

Production statistics are derived from sources such as the Australian Bureau of Statistics' annual agricultural census and other annual or monthly collections for the year in question. The apparent consumption equation is not used if the information is incomplete or a better measure is available. In the 1990–91 *Apparent consumption* edition, for example, the equation is not used for milk, some milk products, cheese, rice, bread, butter, eggs, beer, wine, spirits and dried fruits.

In many cases, allowance is not made for wastage of foodstuffs between purchase and intake and little adjustment can be made for food preparation practices. The importance of this is difficult to estimate, but in some seasons gluts result in considerable wastage of perishable foodstuffs. The effect of ignoring wastage is ultimately to overstate the apparent consumption. In recent years, however, it is likely that there has been less wastage of foodstuffs than previously: more efficient methods of distribution and storage, including refrigerated transport, air freight and household refrigeration, make this so.

Per capita supply

Apparent consumption data are expressed as total product amount per year and as the per capita supply either per year or per day. Per capita consumption is derived by dividing apparent consumption by the mean resident population for that year (mean population figures are derived from Australian Bureau of Statistics demographic statistics—catalogue number 3101.0).[27]

Changes in the composition of the population have a bearing on trends in the patterns of apparent (and actual) consumption. The most significant change since 1945, which has almost certainly had some effect on the consumption pattern, is the increasing proportion of the population born overseas and resident for only a comparatively short period in Australia; for example, the proportion of the population born overseas was 9.8 per cent in 1947 and 22.7 per cent in 1991. [89]

Another important factor is the age distribution of the population. For example, while per capita consumption of infants' and invalids' food is calculated on the basis of mean Australian population for the year concerned, these commodities are consumed by a relatively small proportion of people. The effective per capita consumption by these consumers would therefore be considerably higher than the figures show. The overall ageing of the population will also have an effect on patterns of consumption.

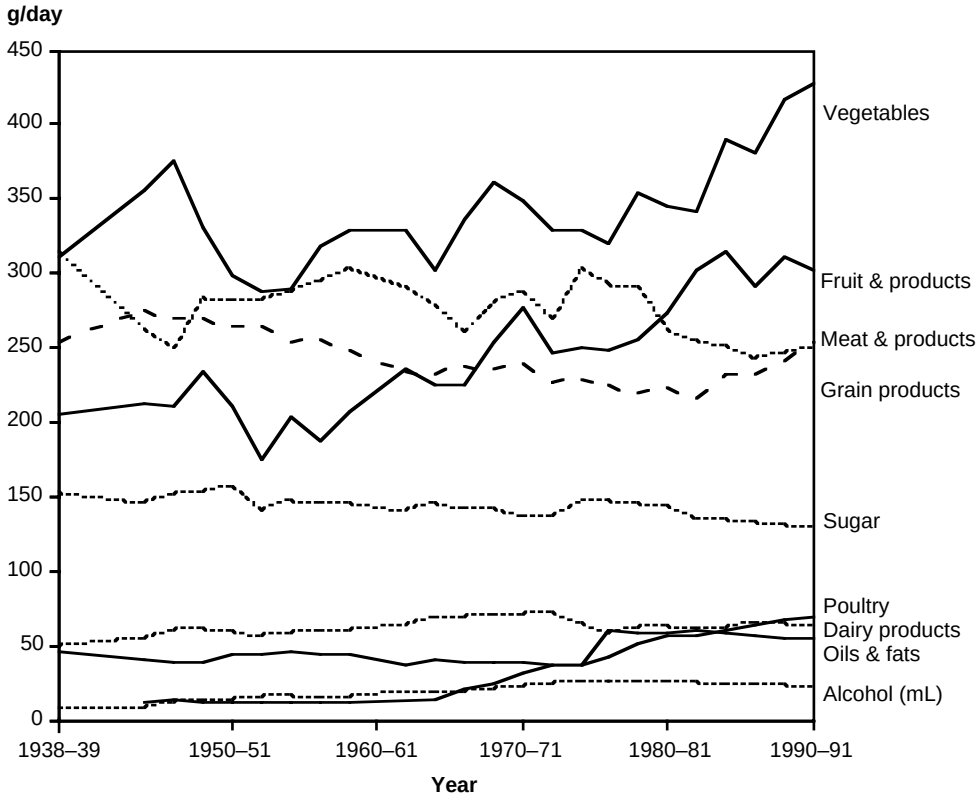
The convention in the *Apparent consumption* series is to present food data as 'per year', and to present nutrient data as 'per day'. Where possible, in this document data are expressed on a per-person-per-day basis unless otherwise indicated. This is consistent with the usual expression of nutrition reference standards and other data and, because it allows for comparison on a common basis, it is the most useful presentation for monitoring purposes.

Disappearance statistics have provided the only long-term estimates of what the Australian population consumes. For this reason the *Apparent consumption* series has been the quantitative basis for assessing and applying strategies towards better nutrition for Australians. It was the basis for the first Dietary Guidelines for Australians.[90] The Dietary Guidelines were revised in 1992[91] but were still based in part on food supply data, as were the some of the targets for nutrition goals put forward as part of the process of developing the national health goals and targets recommendations published in 1992[92](see Appendix D).

The commodity groups used in reporting apparent consumption depend in part on the purposes of the collections from which the data originate (see Box 2.3). They do not always correspond with groupings that describe dietary characteristics. Where possible, in this document the food group subdivisions used are those used for the 1983 National Dietary Survey of Adults[93] and the Australian food composition data.[94–100]

Trends in the food supply

Despite some limitations on the validity of comparisons made with figures of earlier years, the *Apparent consumption* series is the primary source for data on the foodstuffs and nutrients available for consumption and the only source of information about trends in consumption over the last 50 years, during which time there have been significant changes in the food supply and in the Australian diet. Jamrozik et al.[101] collected oral diet histories from nine elderly women that showed distinct changes in food use between the subjects, their parents, and their children. Changes in consumer demand and technological developments in food processing have contributed to these changes.[27] Figure 2.2 shows trends in apparent consumption between 1938–39 and 1990–91.



Source: Australian Institute of Health and Welfare, derived from Australian Bureau of Statistics, Cat. no. 4306.0

Figure 2.2: ***Apparent per capita consumption of selected foodstuffs, 1938–39 to 1990–91***

Apparent consumption of foodstuffs*

Apparent consumption levels for some commodity groups (such as alcoholic beverages, sugars and dairy products) have varied very little in the last 50 years, but

the trends that are evident for broad commodity groups may mask important changes within groups. Sugar is an example: the proportions available as sugar or from manufactured foods have changed while, overall, the available supply has not. One notable trend is the long-term decline in the meat supply, particularly in the last decade, with apparent substitution by poultry. For current monitoring purposes, however, recent trends are of more relevance. Table 2.7 shows apparent per capita consumption data from 1985–86 to 1990–91, expressed in terms of grams per day.

Table 2.7: ***Apparent per capita consumption of selected foodstuffs, 1985–86 to 1990–91 (g per day, except where stated)***

Selected foodstuffs	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91
Grain products	232	232	242	241	246	253
Vegetables[a]	373	381	412	416	443	428
Fruit & fruit products[a]	293	292	289	311	308	302
Meat & meat products[b]	233	224	229	228	233	231
Poultry	63.0	64.4	67.7	67.7	67.4	69.6
Seafood	20.5	20.8	21.6	23.8	24.1	26.0
Eggs & egg products (number per year)	140	138	135	128	125	126
Nuts	14.8	15.6	14.8	15.6	16.7	15.9
Dairy products[c]	62.5	64.7	65.5	64.9	64.7	63.6
Market milk (fluid whole) (mL per day)	281	282	278	276	276	277
Oils & fats[d]	57.3	56.4	55.9	55.3	54.2	54.2
Sugars[e]	137	134	130	132	133	129
Beverages (mL per day)						
Aerated and carbonated waters	218	222	240	256	262	265
Alcoholic	376	362	360	362	356	346

(a) Fresh equivalent weight
(b) Carcass equivalent weight. Cured carcass weight of bacon and ham is included as fresh equivalent weight of pigmeat
(c) Converted to milk solids, fat and non-fat. Includes market milk
(d) Fat content. Includes an estimate for vegetable oils and other fats
(e) Includes sugar content of syrups and glucose

Source: Australian Bureau of Statistics[27]

Grain products

Consumption of grain products increased steadily between 1985–86 and 1990–91, from 232 to 253 g per person per day. Consumption in 1990–91 was composed of flour (203 g per person per day), manufactured breakfast foods (33 g per person per day) and table rice (16 g per person per day). The amount of wheat products determined by the Australian Bureau of Statistics is perhaps 20 per cent greater than the Flour Millers

* This section contains material adapted (with permission) from the Australian Bureau of Statistics publication *Apparent consumption of foodstuffs and nutrients Australia*, 1990–91.[27]

Council figure of around 150 g per person per day (see also Section 2.1).[34] The reasons for the difference need to be investigated but the Australian Bureau of Statistics estimate is used here for trend analysis. There was a 36 per cent increase in breakfast cereal availability from 1985–86 to 1990–91, and a per capita increase of 154 per cent since 1936–39, from 13 to 33 g per day. Consumption of table rice has also shown steady gains, increasing 62 per cent from the 1985–86 figure of 10 g per person per day.

Flour consumption appears to have stabilised in the 1980s, after declining since the 1940s. It showed a marginal per capita increase from 197 g per day in 1985–86 to 203 g per day in 1990–91. Bread consumption statistics are derived from the annual manufacturing census. The manufacturing census was not conducted in 1985–86, and commodity data were not collected in 1987–88 and 1988–89. The 1989–90 bread statistics were collected as part of the manufacturing census but are not yet available.

Table 2.8: ***Trends in flour use, flour for bread-making, flour for pasta, and table rice, 1985–86 to 1990–91***

Data source / item	1985–86	1986–87	1987–88	1988–89	1989–90	1990–91
Bread Research Institute						
Total milled flour ('000 tonnes)	1144	1208	1265	1280	1336	1311
Human consumption ('000 tonnes)	869	935	959	971	993	968
per cent of total milled	*76.0*	*77.4*	*75.8*	*75.9*	*74.3*	*73.8*
Amount available (g/capita/day)	148	158	157	159	160	154
per cent change	na	*+6.7*	*–0.6*	*+1.3*	*+0.6*	*–3.8*
To bread bakers ('000 tonnes)	523	541	563	596	595	596
per cent of human consumption	*60.2*	*57.9*	*58.7*	*61.3*	*59.9*	*61.6*
Amount available (g/capita/day)	89	90	92	98	96	95
per cent change	na	*+1.1*	*+2.2*	*+6.5*	*–2.0*	*–1.0*
To pasta manufacturers ('000 tonnes)	38	41	44	40	53	46
per cent of human consumption	*4.4*	*4.4*	*4.6*	*4.1*	*5.3*	*4.8*
Amount available (g/capita/day)	6.6	6.9	7.4	6.5	8.6	7.3
per cent change	na	*+4.5*	*+7.2*	*–12.1*	*+32.3*	*–15.1*
Apparent consumption						
Total flour ('000 tonnes)	1138	1159	1208	1206	1248	1276
Table rice (g/capita/day)	10.1	10.1	13.4	14.8	15.9	16.4
per cent change	na	–	*+32.6*	*+10.4*	*+7.4*	*+3.1*
All grain products (g/capita/day)	231	231	242	241	246	253
per cent change	na	–	*+4.7*	*–0.4*	*+2.1*	*+2.8*

– Zero
na Not applicable

Sources: Bread Research Institute 1993 (unpublished data); Australian Bureau of Statistics[27]

The most recent available figures are for 1986–87, when apparent per capita consumption was 122 g per day.[27] The Bread Research Institute collects data from its members about the uses of the national flour mix,[102] and from this, information about the destination of products made from flour can be estimated (see Section 2.1). Table 2.8 shows data for the period 1985–86 to 1990–91.

There is consistency between the industry data and the Australian Bureau of Statistics data; the data available from the industry show changes in usage. There has in recent years been concern that bread consumption may be declining, but the availability of bread-making flour increased during the late 1980s and the small decrease in 1989–90 and 1990–91 was less for bread-making flour than for (wheat) flour per se. Wheat production was unusually low at that time (see Section 2.1).

Trends in the supply of bread-making flour are of particular interest because on 1 January 1991 it became mandatory to add thiamin. The future supply of flour for bread-making must be monitored to determine if the thiamin strategy is effective (see Box 2.4).

Vegetables

Statistics for vegetable consumption are shown in terms of fresh or fresh equivalent; that is, the statistics in effect relate to the pre-processing stage. For example, statistics for the apparent consumption of tomatoes include fresh tomatoes consumed plus the fresh equivalent of tomatoes consumed as tomato products (canned tomatoes, tomato juice, and so on). Stocks, imports and exports of processed tomatoes are converted to fresh equivalent for this purpose. Similarly, potatoes are available as dried potatoes, frozen potatoes, potato crisps, potato chips, and potato scallops and cakes. Separate data on processed vegetables (product weight) and fresh vegetables are no longer published. The available data are unevenly partitioned and need to be revised to take into account recent trends. For example, while data were collected on several processed forms of tomatoes, no breakdown is available for forms of potato. The same applies to corn, which has a growing market as corn chips and pre-prepared taco shells.

The long-term trend in the vegetable supply has seen availability increase by one-third between 1956–59 and 1988–89. The per capita availability of tomatoes doubled in that time, largely because of the increased availability of tomatoes in the southern States during winter. Between 1985–86 and 1989–90 potato consumption increased by almost 20 per cent, tomato consumption increased by 40 per cent, and consumption of leafy and green vegetables by 14 per cent. Per capita consumption of vegetables decreased marginally to 428 g per day in 1990–91, after regular increases in the previous four years. By far the largest single vegetable amount in 1990–91 was potatoes (174 g per person per day); this was followed by tomatoes (71 g per person per day). Leafy and green vegetables (66 g per person per day), other root and bulb vegetables (58 g per person per day), and all other vegetables (60 g per person per day) comprised the remainder.[27]

Fruit and fruit products

Statistics for fruit consumption are shown in terms of fresh or fresh equivalent and relate to the pre-processing stage. Stocks, imports and exports are converted to fresh equivalent for this purpose. Data are also shown for some fruit in terms of product weight. As with vegetables there is a need to consider further partitioning of fruit data, and to review, for example, factors used by the Australian Bureau of Statistics to adjust the refined sugars group to allow for the added sugar component of exported and imported canned and juiced fruit. Marketplace changes in syrup use, particularly the move to lighter canning syrups and use of juice, and pie-pack fruits similarly require greater differentiation in the information collected.

Since 1936–39 per capita consumption of fruit has increased by about 40 per cent, primarily because of the increase in consumption of citrus fruit (including juice). Citrus fruit represents almost one-third of the total fruit consumed. The total apparent consumption of fruit has been falling since 1988–89 but is still 3 per cent higher than in 1983–84.[27]

Fresh fruit, including fruit for fruit juice, constituted the bulk of the 302 g per person per day apparent consumption of fruit and fruit products in 1990–91, with citrus fruits (99 g per person per day) dominating. The other fresh fruits totalled 143 g per person per day. The remainder (59 g per person per day fresh fruit equivalent) was available as jams, conserves, and dried and processed fruit.[27]

Meat and meat products (including poultry)

The *Apparent consumption* series treats meat and meat products separately from poultry. The methodology for calculating meat consumption has been revised from 1975–76 and shows meat consumption in terms of fresh carcass weight equivalent. Statistics for canned meat are not available and no allowance is made for home production. Carcass weight is defined as ex-abattoir (that is, bone-in). Because of the diverse cutting practices of butchers and the difficulty in clearly defining 'retail weight of meat', it is considered impractical to derive a factor for the purpose of expressing estimated meat consumption in terms of retail weight. Estimates of retail weight as a percentage of carcass weight range from 72 per cent for beef, 83 per cent for veal, 80 to 85 per cent for lamb, and 82 per cent for pork. The carcass meat figures include fats remaining in the carcass after slaughtering and which may or may not be subsequently removed for boiling down, and so on, before retailing. These are not the factors used to determine retail level edible weight for nutrient computation; factors used exclude fat wastage at the retail level.

'Pigmeat' represents the available carcass weight of all forms of pigmeat, including carcasses that are cured for bacon and ham production. A factor of approximately 1.33 must be applied to cured carcass weight to convert it to fresh carcass weight.

Poultry data are given in terms of dressed weight; that is, as sold in butcher shops. An allowance is made for home production.

Apparent consumption of meat and meat products was a record low 217 g per person per day in 1991–92; the total including poultry was 288 g per person per day. There was an 8.6 per cent fall in apparent consumption of beef and veal between 1990–91 (111 g per person per day) and 1991–92 (102 g per person per day); there were also falls in apparent consumption of sheepmeat and offal.[27] Apparent consumption of pigmeat and poultry continued a long-term gradual upward trend, to 51 g per person per day for pigmeat and 71 g per person per day for poultry by 1991–92.[85]

Fish and seafood

Statistics for apparent consumption of fish and seafood are expressed differently from those for meat. Fresh and frozen fish and seafood product statistics are expressed in terms of edible weight. Canned weights are treated as total edible content and it is assumed that the products are not canned in oil. Although this leads to an underestimation of the amount of oil in the food supply it is not a significant amount either for total added oils or for wastage figures.

An allowance of 10 per cent of commercial production is made for the non-commercial catch of fish. This almost certainly underestimates the contribution of recreational fishing.[103] No allowance is made for non-commercial catches of crustaceans or molluscs.

Since 1936–39, seafood consumption has increased by over 90 per cent and by 27 per cent in the past five years.[27] In those five years consumption of fresh and frozen Australian fish rose by nearly 73 per cent. Almost half the 26 g per person per day of seafood available in 1990–91 (44 per cent) was imported; 31 per cent was canned, bottled or otherwise processed.[27]

Eggs and egg products

Before 1982–83, data on apparent consumption of eggs were based on egg boards' records of output from areas under their control plus estimates of production in uncontrolled areas (that is, where there is no statutory egg marketing authority) and by 'backyard' poultry keepers based on information obtained from other sources.[14] Because of the inadequacy of such data, apparent consumption figures from 1982–83 to 1987–88 cover commercial disposals by State egg boards and some information for uncontrolled areas, particularly North Queensland and the Northern Territory. No allowance is made for home production. For these reasons, apparent consumption data for eggs before and after 1982–83 cannot be compared. Estimates from 1990–91 are now obtained from Agricultural Census data.

Apparent consumption of eggs and egg products, at 126 eggs per person per year in 1990–91, represents a 10 per cent fall from 140 per year in 1985–86.

Nuts

Per capita apparent consumption of peanuts declined by about half between 1948–49 and 1978–79 and (measured as in-shell equivalent weight) has fluctuated irregularly between 4 and 6 g per day since; it was 5.5 g per day in 1989–90 and 5.2 g per day in 1990–91. Apparent consumption of other nuts increased to a peak of 16 g per person per day in 1968–69, declining to 8 g per person per day by 1978–79 and increasing to 10 g per person per day by 1989–90 and 11 g per person per day by 1990–91. No allowance is made for home production of nuts in the *Apparent consumption* series.

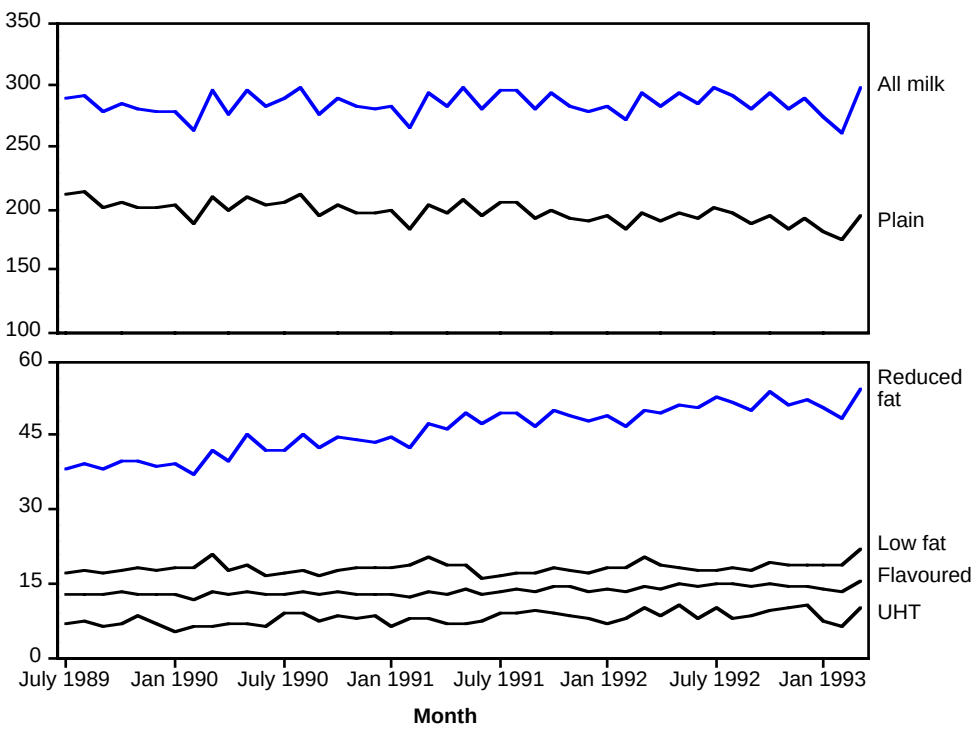
Dairy products

Data on apparent consumption of dairy products are given by weight. Butter is excluded; it is listed with oils and fats. There is no allowance for home production.

Overall steady post-war consumption of dairy products has disguised important changes within this category. Apparent per capita consumption of cheese has increased markedly since 1968–69, from 10 g per day to 24 g per day in 1990–91.[27] In the same period the annual per capita market milk supply dropped from 351 mL per day to 277 mL per day. Skim milk availability in 1990–91 was 4.7 g per person per day, up from 3.8 g in 1989–90 and 3.6 g in 1988–89.[27,85] Apparent consumption of other milks such as condensed, concentrated, evaporated and powdered milks accounted for another 15 g per person per day, or 18 g per person per day if infant and invalid foods are included.[27]

Milk market data are supplied to the Australian Bureau of Statistics by the Australian Dairy Corporation. These data show that the milk market has diversified and that

many new product formulations were established in the food supply by 1989. The market penetration of reduced-fat milks is notable (see Figure 2.3). This diversity is not yet evident in the apparent consumption figures. One reason is that some data are aggregated to protect commercial confidentiality. In addition, it is only in the last three years that the Australian Dairy Corporation has had consistency in reporting between States, allowing for product delineation.[104] The Australian Dairy Corporation has, for example, compositional data for whole milk, UHT milk, skim milk, 2 modified liquid milks, 6 varieties of flavoured milk, 5 kinds of cultured milk, 4 canned milks, 5 powders, 11 yoghurts, 10 creams, 10 ice-creams, and 10 kinds of butter.[27] This is in contrast to the apparent consumption data, which report skim milk and market milk (all other), 3 canned milk categories, 2 powdered milk categories, and butter as a single entity.



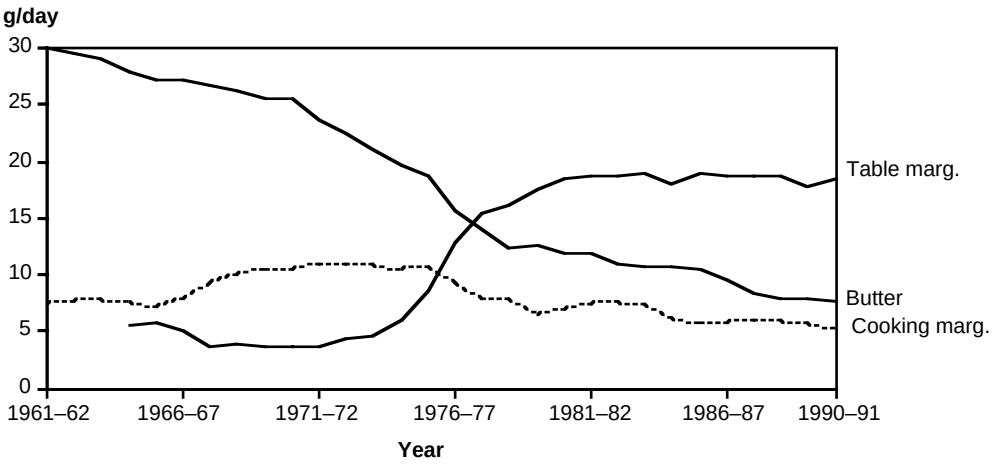
Source: Australian Dairy Corporation (unpublished data)

Figure 2.3: ***Market milk sales, by type, July 1989 to March 1993***

Oils and fats

The distinction between 'fats' and 'edible oils' is physical. Both are composed primarily of mixtures of triglycerides (fatty acid esters of the tri-hydric alcohol glycerol. Edible oils are fats that are liquid at room or refrigerator temperatures. The chemical basis for the variable physical consistency of fats is that melting / freezing point increases with increasing carbon chain length and with decreasing unsaturation (number of double bonds in the carbon chain). Thus, fats from ruminant animals are high in long-chain saturated fatty acids (C16, C18, no double bonds) and are hard solids at ambient temperatures. Polyunsaturated margarines are softer and melt more easily than ruminant fats because they have more linoleic acid (C18, two double bonds); olive oil is liquid because it has a high proportion of oleic acid (C18, one double bond); coconut oil is liquid because it comprises mainly short-chain fatty acids, even though they are saturated (C12, C14, no double bonds).

As noted under meats, no allowance is made for fats consumed in association with carcass meat but animal fat used for shortening in catering and cooking and derived from fat removed in the abattoir, is included. The availability of other edible oils and cooking fats is an estimate only. Source limitations have always made information on these products difficult to update and cooking fats and oils, particularly commercial frying fats, are liable to substantial wastage. An estimate of 6 g per person per day (2 kg per year), based on the 1944 household consumption survey,[88] was used until 1980–81. A revised estimate of 27 g per person per day (10 kg per year) was applied in 1980–81.[27] Data from 1975–76 have been revised accordingly and although there appears to be increase of about 27 per cent in apparent consumption of oils and fats between 1968–69 and 1988–89, it arises principally from this revision.



Source: Australian Bureau of Statistics, Cat. no. 4306.0

Figure 2.4: ***Apparent per capita consumption of butter and margarine, 1961–62 to 1990–91***

Apparent consumption of butter and table margarine has declined slowly, from about 42 g per person per day in 1938–39 (when it was almost all butter) to around 27 g per person per day at the end of the 1980s.[27] Within the last 20 years, the proportion of butter to table margarine has fallen steadily: the table margarine supply exceeding that of butter by the mid-1970s (see Figure 2.4). The proportion of butter to margarine within the 'fat spread' category has changed from approximately 70:30 to 30:70 in the 40 or so years since butter rationing ceased in June 1950.[105,27]

Apparent consumption of table margarine has been relatively steady since the late 1970s, at 16–18 g per person per day. Apparent consumption of 'other margarines' declined slowly to about 5 g per person per day by 1990–91. Consequently, 'total oils and fats' (including the constant 27 g per person per day oil allowance) have shown a small decrease of 5 per cent between 1985–86 and 1991–92. Most of this decrease is accounted for by the fall in butter consumption, from 10 g per person per day in 1985–86 to 8 g per person per day in 1991–92. In the corresponding period apparent consumption of margarine fell by only 1 g per person per day. These trends are part of a longer term trend that has seen an 8 per cent fall in the total per capita oil and fat supply since 1976–79, including a 45 per cent fall for butter, and a small increase for margarine.

Sugar (refined sugars)

The name for this grouping should be 'refined sugars'. 'Sugar' in normal usage is synonymous with sucrose, but this commodity group includes sugar cane products, honey and other sugar syrups and products. Conversely, the group does not include sugars normally present in foods such as fruit and milk.

Sugar consumption represents apparent consumption in terms of disposals of sugar by refineries and the sugar content of disposals of sugar products by manufacturers. In general, stocks are not taken into account. Until 1980–81, however, sugar used in the brewing industry was being counted twice—as sugar in manufactured foods and as alcohol in beer. When the effect of the double count was removed in 1980–81 there was a resulting apparent decrease in the energy contribution of the sugar supply in the form of 'sugar'. Recalculated data for all years from 1975–76 are used for current editions of the *Apparent consumption* series.

In the past 50 years total consumption of sugars has remained relatively constant, but with a marked shift from home use of refined cane sugar to sugar consumed in manufactured foods. Apparent consumption of total sugars fell 5.4 per cent in the five years to 1990–91. Changes in consumption of various sugar products were, however, not consistent.

Consumption of cane sugar fell 7 per cent, from 123 g to 115 g per person per day; consumption of other sugars (syrups and glucose) increased by 7 per cent, from 11.2 to 12.1 g per person per day; and honey consumption fluctuated between 2.2 and 2.5 g per person per day. About one-third of the decrease in cane sugar consumption has been linked to the decreased demand for sugar by the brewing industry.[27] It should also be noted that approximately 70 per cent (90 g per day) of the 129 g per day apparent per capita consumption of sugars in 1990–91 was in manufactured foods. The remainder was consumed as refined sugar (25 g per person per day), the sugar content of syrups and glucose (12 g per person per day), and honey (2.5 g per person per day).

Beverages

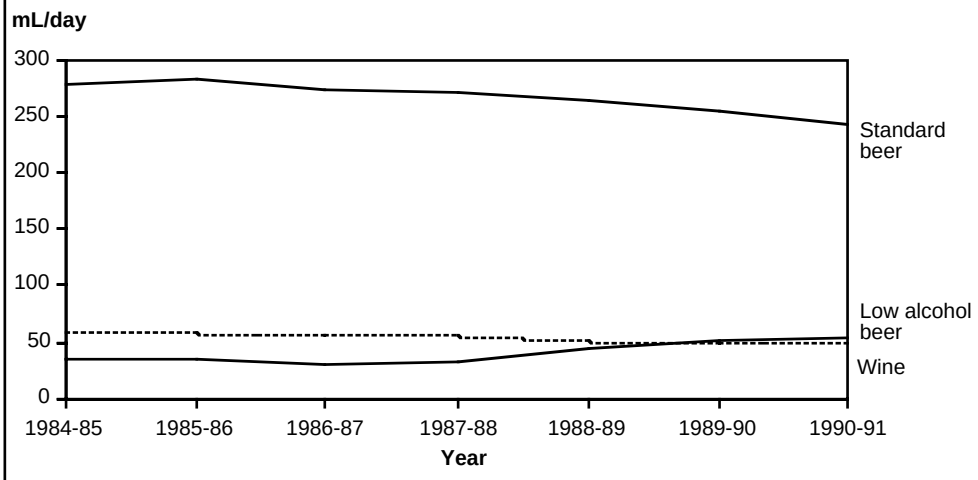
There has been a continuous long-term shift from tea to coffee consumption. Tea consumption fell from 8.5 g per person per day in 1936–39 to 2.7 g per person per day in 1990–91, whereas coffee consumption rose from 0.8 to 5.8 g per person per day in the same period. Consumption of aerated and carbonated waters continued to increase, from 130 mL per person per day in 1968–69 to 265 mL per person per day in 1990–91 (sugar content is included in the sugars group).

The increased market share of 'low alcohol' beers and wines led to a revision in the methodology for calculating litres of alcohol; from 1984–85 apparent alcohol consumption data show the apparent decrease resulting from the separation of beers into standard and low-alcohol types.

The per capita apparent consumption of all types of beer increased from 146 mL per day in 1938–39 to 365 mL per day in 1978–79. There followed a rapid decline to around 300 mL per day by the mid-1980s and since then there has been a further fall to 297 mL per day in 1990–91 and 279 mL per day in 1991–92, a decrease of 6 per cent.

This overall decrease is exacerbated in nutrient terms because there has been an accompanying increase in the low-alcohol beer supply. Low-alcohol beer consumption has increased from 31 mL per person per day in 1986–87 to 61 mL per person per day in 1991–92. This was at the expense of standard beers: apparent per capita consumption of standard beers decreased from 282 mL per day in 1985–86 to 243 mL per day in 1990–91. The proportion (by volume) of low-alcohol to other beers changed from 10:90 in 1986–87 to 22:78 by 1991–92.

Between 1938–39 and 1985–86 apparent consumption of wines increased over 700 per cent, from 7 to 59 mL per person per day. Since then there has been a decline of 17 per cent to 49 mL per person per day in 1990–91 and a 4 per cent recovery to 51 mL per person per day in 1991–92 (see Figure 2.5).



Sources: Australian Bureau of Statistics;[27] Australian Institute of Health and Welfare (unpublished data)

Figure 2.5: ***Apparent per capita consumption of alcoholic beverages, 1984–85 to 1991–92***

2.4 Nutrient composition of the food supply

Estimation of the apparent consumption of nutrients*

Nutrient levels are calculated from the *Apparent consumption* series food data. Nutrients estimated are the macronutrients (protein, fat, carbohydrate and alcohol) and energy, vitamin A, vitamin C, thiamin, riboflavin and niacin, and calcium and iron. Nutrients not estimated but for which there are Recommended Dietary Intakes (RDIs) are sodium, potassium, magnesium, zinc, selenium, phosphorus, iodine, folate, vitamin B-6, vitamin B-12, vitamin D and vitamin E.

The food composition data on which calculations of nutrient supply are made have changed over the years—in response to a changing food supply and also as more information has become available from the food analytical program, which was begun early in the 1980s.[106] The program has been managed by the National Food Authority since the Authority commenced operations in August 1991.[107] Data from the program are compiled in the Australian Nutrient Data Bank which was set up to 'act as an official and central store of information on the composition of foods ...'[108] and published as *Composition of foods, Australia*.[94–100] These data have been used for estimating nutrient levels since 1987–88 and, in addition, data from 1983–84 onwards were recalculated to improve the validity of comparisons with new data.

With the exception of tree nuts, revised nutrient composition data were applied to all food groups in the 1990–91 edition of the *Apparent consumption* series.[27] Revised data on

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* This section contains material adapted (with permission) from the Australian Bureau of Statistics publication *Apparent consumption of foodstuffs and nutrients, Australia*.[27]

tree nuts are not expected to differ significantly from existing data. A more detailed level of data on alcoholic beverages has also been used from the 1987–88 edition and for most food groups from 1988–89.

The biggest impact of the change in calculation bases has been on the meat and poultry data. For meat, a significant proportion of this has been due to the change to factors used to estimate 'raw edible weight of available retail meat' from carcass equivalent weight. The increase in available vitamin A has been a result of the revised data on the level of this nutrient in offal.

With the exception of foods such as cheese, powdered and canned milks, dried fruit, all fish and alcoholic beverages, all nutrient determinations are based on fresh equivalent edible weight, with an allowance for natural wastage from skins, seeds, bones, and so on. Apart from ready-to-eat breakfast foods, no allowance is made for the addition of vitamins and supplements (for example, vitamin tablets, supplements and fortification) in the nutrient supply data.

Effects of processing on the nutrient content of foods

In 1988 the Canned Food Information Service commissioned analyses of comparable fresh and canned products at the South Australian branch of the Australian Government Analytical Laboratory.[59] Table 2.9 shows selected results.

Thiamin content is reduced by processing, as expected, but significant levels of vitamin C are preserved. Riboflavin was detected in fresh corn kernels (0.06 mg per 100 g cooked) but was destroyed by processing. A similar pattern emerged from tests of mixed dishes. The homemade dishes were higher in most nutrients, but markedly so only for fibre, thiamin, vitamin C and vitamin A. Nevertheless, the canned products retained a significant proportion of nutrients. Sodium-to-potassium levels were found to be high in canned products compared with home-cooked meals, although the addition of salt at the table would reduce the difference. Low-salt versions of many canned foods have become available and this, too, would redress the balance.

In the *Apparent consumption* series, allowance has been made for losses in total food available for consumption due to processing. Nutrients are adjusted by determining the difference between fresh weight equivalent and canned weight. Adjusted amounts are given, as well as the direct calculation, to account for losses of vitamins in cooking and for the additional niacin synthesised endogenously from protein (see Table 2.10).

Some foods, particularly fruit and vegetables, lose some of their nutritive value when cooked or stored. Estimates of possible loss of vitamin C and thiamin in cooking are given in Table 2.10. Losses of other nutrients in cooking do occur but to a lesser extent. Losses incurred through storage have not been estimated.

Table 2.9: ***Effect of processing on nutrients in selected products***

Product	kJ per 100g	Fibre (g/100g)	Iron (mg/100g)	Zinc (mg/100g)	Na/K ratio	Thiamin (mg/100g)	Vitamin C (mg)	β-carotene (μg)
Tomato								
Canned, heated 1 min.	83	1.4	0.6	0.2	0.5	nd	14.6	340
Fresh, cooked	79	1.4	0.3	0.1	0.3	nd	10.0	445
Pineapple								
Canned in syrup, heated 1 min.	400	1.6	0.4	tr	<0.1	0.17	8.0	8
Canned in juice, heated 1 min.	248	1.6	0.4	tr	<0.1	0.07	6.0	15
Fresh, cooked	200	1.7	0.3	tr	<0.1	0.06	9.4	26
Corn kernels								
Canned, heated 1 min.	401	3.1	0.5	0.4	3.2	nd	nd	6
Frozen, cooked	381	2.6	0.5	0.5	0.6	0.07	3.6	5
Fresh, cooked	399	4.8	0.6	0.7	0.4	0.15	3.2	6
Peaches								
Canned in juice, heated 1 min.	231	1.9	0.5	0.2	<0.1	nd	5.0	111
Fresh, cooked	188	1.8	0.2	0.1	<0.1	nd	5.0	32
Pears								
Canned in juice, heated 1 min.	176	2.8	0.4	0.2	<0.1	nd	tr	nd
Fresh, cooked	238	3.3	0.2	0.1	<0.1	nd	3.0	nd
Orange juice								
Canned	148	0.2	0.3	tr	<0.1	0.05	50.0	26
Fresh	139	0.2	0.1	tr	<0.1	0.06	35.0	66

Note: 'nd' denotes 'not detectable'; 'tr' denotes 'trace'; Na/K ratio is the ratio by weight of sodium to potassium in the food

Source: Canned Food Information Service Inc.[59]

Table 2.10: ***Adjustments to the availability of specific vitamins[(a)] (mg per person per day)***

	Calculated amount			Amount available		
Year	Vitamin C	Thiamin	Niacin	Vitamin C	Thiamin	Niacin equiv.
1985–86	134	1.65	22.7	99	1.40	39.6
1986–87	135	1.66	22.8	100	1.41	39.7
1987–88	136	1.72	23.7	98	1.46	41.2
1988–89	142	1.73	23.7	105	1.47	41.1
1989–90	141	1.75	24.3	102	1.49	42.0
1990–91	140	1.78	24.9	102	1.52	42.6

(a) Losses in cooking have been estimated for vitamin C and thiamin only; the adjusted niacin value includes an allowance for endogenous synthesis from tryptophan.

Source: Australian Bureau of Statistics[27]

Conversion of apparent consumption food groups to nutrients

Appendix B provides nutrient data for 1990–91, disaggregated to the lowest available level.

Grain products

Flour is currently treated as plain white flour for nutrient calculations, and the nutrient content is from the Australian Nutrient Data Bank. Ideally, flour would be partitioned into white and wholemeal and there would be a means of adjusting the data applied for thiamin content of flour to allow for the requirement since 1 January 1991 to fortify bread-making flour with thiamin. The data for bread are, in nutrient terms, a subcomponent of flour and so are not used to calculate nutrients.

Breakfast foods are divided into rolled oats and pre-prepared breakfast cereal. Nutrient data allow for added nutrients only in the case of the latter. The nutrient data are based on Australian data for common forms of pre-prepared breakfast cereals.

Rice is treated as white rice for want of further information.

Fruit and fruit products

Data are recorded as total fresh equivalent weight (that is, fruit available fresh or as juice), processed product weight, and fresh equivalent of processed product weight. The last is necessary for properly determining nutrients available and for any discussion of uses of fruits. Note that the nutrient data for processed fruit ignore the added sugars component which is accounted for elsewhere. Dried fruits and jam fruits are calculated separately. An adjustment of weights to ‘edible portion’ is made before the calculation is made.

Greater differentiation of fruit products would be useful for nutrient calculations. For example, other data suggest that juicing is a major use of fresh fruit. This affects nutrients both positively (vitamin C, because of legislative requirements for minimum levels) and negatively (for example, dietary fibre) and these cannot be accounted for.

Vegetables

As with fruit and fruit products, data for vegetables are recorded as total fresh equivalent weight, processed product weight and fresh equivalent of processed product weight. The last is necessary for proper determination of nutrients. There is insufficient information about product types to allow precise determination of nutrients in processed foods.

Meat and meat products (including poultry)

For the meat and meat products (including poultry) food group nutrients are given for the edible retail-level raw component for each kilogram of carcass meat. That is, adjustment is made for losses in butchering to provide the retail cuts (including sausage trimmings) and losses related to inedible components of retail cuts. Such losses include fat trimmings that may end up in cooking fats and non-food uses. Offal is also excluded by this process but is included separately as 'offal and meat not otherwise included'. This is mainly offal, and a weighted composite of offal meats is used for calculating nutrients.

The nutrients therefore apply to the edible portion of retail cuts across the carcass. It should be noted that retail purchases of meat may be for non-human consumption and that there may be wastage of edible meat in the home (for example, fat trimmings) or elsewhere along the food chain. There are no nutrient data for mutton since there is little of this meat available or identified as such on the fresh retail market in Australia and nutrient data for lamb are used.

Poultry is approximately 90 per cent chicken and is usually interpreted as chicken. The nutrient data are not weighted and are based on chicken. Adjustment to 'edible portion' is made before the calculation to nutrients.

Fish and seafood

Fish and seafood calculations are made from a composite of major fish and seafood nutrient data, separately for Australian fish and seafood (Australian nutrient data) and imported fish and seafood (United Kingdom nutrient data). Only 'edible portion' data are collected.

Dairy products

The nutrient data for sweetened dairy products exclude the added sugars component since this is included in the refined sugars group. There are no separate data on many dairy products (such as yoghurt) and the nutrients must be assumed to be included in the general milk data (liquid, powdered forms, and so on). Cream is not listed as a separate item but its nutrients are included in the determination of nutrients available.

Infants' and invalids' foods includes milk-based drinks and foods specifically produced for these purposes; they are treated as infant formula.

Oils and fats

For appropriate interpretation of fat intake, the spreads are about 85 per cent fat by product weight and the cooking fats and oils virtually 100 per cent. The food totals are given as product weight.

Sugar (refined sugars)

In determining the contribution of refined sugars to nutrients, the sugars used in the brewing industry are excluded. Soft drinks are covered within this grouping. The term 'soft drink' refers to all carbonated beverages, nutritive or not, but excludes mineral-water-based products.

Beverages

Only the data on alcoholic beverages are used for nutrient determinations. Alcohol (ethanol) is not reported directly in the publication but can be determined by difference

through macronutrient contribution to energy. As noted, soft drinks are included in the sugar (refined sugars) grouping.

Tea and coffee are important for food behaviour and other consumption issues but, with the exception of niacin in coffee (which is present in considerable excess) and caffeine, other constituents have not been a major nutritional issue.

Estimating the nutritional adequacy of the food supply

Nutrient estimates can be compared with the recommended dietary intakes to assess the nutritional adequacy of the food supply. As noted, the RDIs were established by the NHMRC and are 'the levels of intakes of essential nutrients considered ... to meet the known nutritional needs of almost all persons'.[109] This applies to all nutrients, with the exception that the energy RDIs are estimates of average requirements. It should be noted that actual food intakes can be limited by dietary practices as well as by the adequacy or otherwise of the food supply.

Arguably the most appropriate use for the RDIs is to estimate the nutritional quality of the food supply relative to the needs of the population.[110] For this estimation, weighted population RDIs must be obtained based on the age and sex profile of the population. The proportion of the population in each age and sex category is applied to the relevant RDI for that group and a cumulative total derived for each nutrient. This is the weighted population RDI for that nutrient, against which the per capita nutrient level available in the food supply (adjusted for vitamin C, thiamin and niacin) is assessed.

Revisions to the RDIs are incorporated in these calculations. They took place in 1977–78 and most recently from 1982 to 1991. The 'lowered' excess for some nutrients relative to earlier years is explained mainly by changes in the RDIs.

Calcium, because of a marked increase in RDIs, has been one of the nutrients most affected, now being only marginally in excess of the estimated RDIs for the population. The combined effect of reduced available energy and iron for consumption and an increase in the energy and iron RDIs has been to nearly halve the energy and iron available in excess of the RDIs. A reduction in the protein RDI has markedly increased the excess. Revisions to food composition data have also affected comparisons.

Nutritional quality of the food supply

The nutritional quality of food with respect to a particular nutrient depends on the nutrient density relative to energy density. This can be assessed by calculating the nutrient density score, a measure based on RDIs.[111,112] A nutrient density score is derived as follows:

$$\text{nutrient density score} = \frac{\text{available nutrient as \% of weighted RDI for the nutrient}}{\text{available energy as \% of weighted RDI for energy}}$$

A nutrient density score equal to or greater than 1 indicates a nutritional quality equal to or better than the recommended level; that is, the food item examined is a net contributor of the nutrient rather than a net consumer. Although this indicator is

generally applied to nutrient intake data, it can be calculated for the food supply and provides an insight into the supply's overall nutritional quality. Table 2.11 shows the nutrient density scores for calcium, iron, thiamin, riboflavin and vitamin A (as retinol equivalents) for selected years. Of the other nutrients estimated for the food supply, vitamin C, niacin and protein have all had nutrient density scores greater than 2 for at least the last decade. No RDIs are set for fat and carbohydrate.

Nutrient density scores tend to underestimate the quality of the food supply because nutrient RDIs, by definition, exceed average requirements while the energy RDI is set to approximate average requirements. It is important to stress that RDIs do not represent nutrient requirements and the nutrient density scores cannot be related to the needs of an individual. In assessing the Australian food supply, however, it is calcium that has the most limited supply; thiamin, iron and, in some circumstances, vitamin A are also limited. [113]

Table 2.11: ***Nutrient density scores for selected nutrients in the food supply, selected years***

Nutrient	1983	1985	1988	1990–91
Calcium	0.72	0.76	0.78	0.74
Iron	1.01	0.97	1.00	1.03
Retinol equivalents				
Including meat offals	2.10	2.56	2.67	3.01
Not including meat offals	1.03	1.14	1.16	1.12
Riboflavin	1.24	1.23	1.28	1.31
Thiamin	1.13	1.17	1.20	1.21

Source: Australian Institute of Health and Welfare, derived from Australian Bureau of Statistics[27]

Food security

'Food security is defined in its most basic form as access by all people at all times to the food needed for a healthy life.'[114] The nutrient composition of the food supply has a bearing on food security and, although this is not usually seen as an issue in Australia, it is the real starting point for any food and nutrition monitoring strategy. The energy content of the Australian food supply has never been lower than 12.9 MJ per person per day (1985–86) and that value exceeded the weighted mean RDI by 37 per cent (note that for energy, the RDI is the *average requirement*). The protein supply exceeds the RDI by more than 100 per cent.

Table 2.12 shows a list of nutrients compared with their weighted RDIs for 1990–91. The RDIs are age and sex specific. The RDIs used to assess apparent consumption data are the weighted mean RDIs based on the age–sex composition of the appropriate population.

As may be inferred from Australia's food production levels and excess of food exports over imports, the mean per capita energy supply has exceeded the weighted RDI since comparisons began in 1954 and was almost certainly in excess of requirements since the inception of the *Apparent consumption* series. Note that total energy includes the contribution of alcohol and of organic acids and other nutritive carbohydrate components of fruits and vegetables.[27] Of the nutrients shown in Table 2.12, the notable exceptions were thiamin and calcium, which were below the RDIs from when data

became available in 1954 until 1960. Calcium availability for 1990–91 was only 4 per cent in excess of the RDI, whereas vitamin C supplies were 200 per cent in excess and retinol equivalents even more (if meat offals are included).

Table 2.12: ***Estimated nutrients available for consumption (adjusted), recommended dietary intakes and nutrient density scores, 1990–91 (per person per day)***

Nutrient	Unit	Amount	RDI	Nutrient density score
Protein	g	102.7	45.8	1.59
Fat (all sources)	g	118.6	na	na
Carbohydrate	g	385.4	na	na
Alcohol	mL	22.0	na	na
Energy value	kJ	13 081	9283	na
Calcium	mg	873	838	0.74
Iron	mg	13.3	9.2	1.03
Retinol equivalent				
With meat offals	µg	2901	685	3.01
Without meat offals	µg	1079	685	1.12
Vitamin C	mg	102	34	2.13
Thiamin	mg	1.52	0.89	1.21
Riboflavin	mg	2.51	1.36	1.31
Niacin equivalent	mg	42.6	15.2	2.05

na Not applicable

Sources: Australian Bureau of Statistics;[27] Australian Institute of Health and Welfare (unpublished data)

Thiamin availability was overestimated during the 1980s because a decline of 27 per cent in the thiamin content of bread between 1977 and 1987 was not taken into account in the estimations.[115] Nevertheless, if 27 per cent is deducted from the thiamin contribution of the entire grain product group, the thiamin supply would still be 40–60 per cent greater than the RDI.

The addition of thiamin to bread-making flour from 1 January 1991 can be predicted to increase total thiamin supply.[116] No information is yet available to assess this because the composition data for thiamin were last updated in August 1990. Although the apparent consumption (unadjusted) of thiamin rose from 0.80 mg per person per day in 1989–90 to 0.85 mg per person per day in 1990–91, this was due to an increase in the flour supply (see Box 2.4).

Box 2.4: Thiamin enrichment of bread-making flour

'Thiamin enrichment' means the addition of thiamin to a food for the purpose of preventing deficiency of thiamin in specific population groups or in the population in general.

There are many examples of thiamin-enrichment programs for staple foods such as flour, bread and rice but they have rarely been evaluated. Thiamin enrichment of flour is known to be safe and is permitted by law in most countries.

Australia has an excellent food supply but some people make poor food choices. The 1983 National Dietary Survey reported that on the day of survey 35 per cent of men and 25 per cent of women had thiamin intakes below the recommended dietary intake of 0.1 mg of thiamin per 1000 kJ.[111] *Thiamin deficiency of the brain (Wernicke's encephalopathy) in association with alcohol abuse*[117] *was considered to be present in about 500 cases each year.*[118,119]

After a 10-year national debate, mandatory thiamin enrichment of Australian bread-making flour began on 1 January 1991. Enrichment took the thiamin level in bread-making flour from 0.22 mg of thiamin per 1000 kJ (when flour was classed as a 'thiamin donor' food) to 0.42 mg of thiamin per 1000 kJ (6.4 mg of thiamin per kg of flour).

Before mandatory enrichment the estimated thiamin available per person in the national diet was 0.11 mg per 1000 kJ; this was not a sufficient safety margin over the recommended thiamin intake of 0.1 mg per 1000 kJ. Thiamin was considered to be the nutrient most likely to be deficient in the national diet until the enrichment of bread-making flour became mandatory.[120-122]

The estimated thiamin supply per person in the national diet is published yearly in the Australian Bureau of Statistics Apparent consumption of foodstuffs and nutrients *series (catalogue number 4306.0) and its annual review is required to quantify the future safety margin in the estimated supply. It may be possible in future dietary surveys to detect any change in the number of men and women who appear to have diets that supply less thiamin than is recommended.*

Food sources of macronutrients and energy

For many years cereal foods have been the largest source of energy (about one-quarter of the total supply); the proportion rose slightly throughout the 1980s, to 28 per cent in 1990–91. Table 2.13 shows, for 1990–91, the proportions of energy contributed by the major commodity groups and important contributor foods within these groups. The energy contributions of sucrose (13.2 per cent) and flour (22.9 per cent) are notable. The contribution of oils, at 7.8 per cent, must be considered with the proviso that the quantity of oil is an estimate, not a measurement.

Table 2.13: ***Foods contributing to energy supply, 1990–91 (per cent)***

Food	Contribution	Food	Contribution
Grain products		**Alcoholic beverages**	
Flour	22.9	Beers	3.2
Other grains	5.4	Other alcoholic beverages	1.9
All grains	28.3	All alcohol	5.1
Sugars		**Vegetables**	
Sucrose	13.2	Potatoes	3.0
Other sugars	1.8	Other vegetables	1.5
All sugars	15.0	All vegetables	4.5
Oils and fats		**Dairy and dairy products**	
Oils and cooking fats (allowance)	7.8	Whole milk	5.7
Table margarine	4.2	Cheese	3.1
Butter	1.7	Other dairy	2.2
Cooking margarine	1.2	All dairy	11.0
All oils and fats	14.9		
Meat and meat products		**Fruit and fruit products**	
Beef and veal	4.3	All fruit	3.7
Sheep	3.5		
Pig	3.1	**Other foods**	
Poultry	2.6	All other foods	3.5
Offal and other meat	0.6		
All meat	14.1		

Source: Australian Institute of Health and Welfare, derived from Australian Bureau of Statistics, Cat. no. 4306.0

Table 2.14: ***Nutrients contributing to energy supply, 1938–39 to 1990–91 per cent***

Year	Protein	Fat	Carbohydrates	Alcohol	Other nutrients[(a)]
1938–39	11.7	37.9	46.3	1.6	2.6
1948–49	11.6	33.2	50.0	2.4	2.8
1958–59	11.3	35.3	48.3	2.9	2.2
1968–69	12.3	33.0	47.1	3.4	4.4
1978–79	11.8	38.6	43.3	4.1	2.2
1983–84	12.8	33.9	46.4	4.5	2.5
1984–85	13.0	34.0	46.7	4.3	2.0
1985–86	12.9	34.5	46.2	4.4	2.1
1986–87	13.0	34.4	46.3	4.3	2.1
1987–88	13.2	34.1	46.5	4.2	2.1
1988–89	13.2	33.9	46.7	4.1	2.1
1989–90	13.2	33.7	47.0	4.0	2.1
1990–91	13.4	33.6	47.1	3.9	2.1

(a) mainly organic acids

Source: Australian Institute of Health and Welfare, derived from Australian Bureau of Statistics, Cat. no. 4306.0

An important factor is the derivation of energy from the macronutrient supply, and in particular the proportion of energy derived from fat. Table 2.14 shows the proportional contribution of macronutrients for 1938–39 to 1990–91. These are recalculated figures using revised factors[116] and are directly comparable. They show a slight decrease in the contributions of fat and alcohol and a corresponding increase for protein and carbohydrate since 1983–84.

Fats and fatty acids in the food supply

Apparent consumption data are limited in their ability to describe the nature of the fat supply because of the limitations of food composition data and because food items of different compositions are aggregated into groups. The report of the NHMRC Working Party on the Role of Polyunsaturated Fats in the Australian Diet provides an overview of trends in apparent consumption of fatty acids.[30] The report notes that estimations of the fatty acid compositions of foods before 1980 are by inference and that, for the fats and oils in particular, several assumptions must be made. The nature of the categories of margarines specifically has been further complicated because of rapid formulation changes[123] and changes in food regulations. Several new margarine formulations entered the market in 1993.[124]

Trends in margarine composition and consumption

Until 1963, when the first polyunsaturated margarine was introduced in Australia, table margarines were made from a mixture of tallow and vegetable fats (including coconut) and consisted predominantly of saturated fat. Until 1972 margarines for table use were subject to a quota system intended to protect the dairy industry and there were constraints on the composition and even the shape of the packages in which margarine could be sold, to distinguish it from butter. Food regulations required that 90 per cent of the fat content of cooking margarines be derived from animal fats; this persisted in some States until the early 1980s.

Table margarines made from animal fat were still a component of the food supply in 1983 but had virtually disappeared by 1985.[30] Information about recent trends in the market shares of various margarines indicates that tallow-based cooking margarines still held 2.1 per cent of the margarine market in 1992.[124] By 1983 table margarine availability was around 26.3 g per person per day, declining slightly to 23.8 g by 1989–90. By 1992 polyunsaturated margarines made up 73 per cent of the total margarine market.[124] In 1983, however, one-third of table margarines were still made from animal fat, while in 1989–90 all table margarine was made from vegetable fat (although some were less polyunsaturated than others).[30]

Product diversification since the 1980s has rendered the apparent consumption category ‘table margarine’ incapable of yielding information about fatty acids and other nutrients. This information is important because, apart from the oil allowance, table margarine is the biggest individual contributor to the fat supply, with the potential to alter the nature of the supply markedly. Among the significant formulation changes include the following:[124]

- Salt-reduced margarines were introduced in 1985. By 1991, 45 per cent of margarines sold were salt reduced.

- Reduced-fat spreads were introduced in 1989. By 1990 they had acquired 5.1 per cent of market share, but this proportion declined to 4.3 per cent in 1991 and to 2.1 per cent by 1992 as a result of poor consumer acceptance of the product.
- Mono-unsaturated margarines were introduced in 1990, shortly after canola oil entered the market. There has been a high rate of acceptance for this product, the market share of which was 10.4 per cent in 1992 and is expected to increase. Almost all mono-unsaturated margarines currently available have canola oil as their chief component (at least one product is based on olive oil).
- Since the introduction of mono-unsaturated margarine the market share of table margarine not labelled 'polyunsaturated' has halved, from 22 per cent to 11 per cent.

Trends in butter composition and consumption

Apparent consumption of butter has decreased steadily since the early 1950s (see Figure 2.4). It has been the major contributor to the decline in per capita fat spread consumption and has been replaced partially by table margarines. Apparent consumption of butter in 1991–92 was 7.1 g per person per day, a fall of 33 per cent since 1985.

Like margarine, butter is now marketed in several forms. In 1991 the Australian Dairy Corporation listed salted, reduced-salt and unsalted butters, ghee, dairy blends (the milk fat is blended with a vegetable oil), and reduced-fat dairy spread.[27] Reduced-fat spreads contain about 40 per cent fat, and this can be all milk fat or a blend of milk fat and vegetable oil. Current food standards require that butter contain at least 80 per cent milk fat, and dairy blends must have 50 per cent of fat content as milk fat. This means that the dairy industry is limited in its ability to alter the fatty acid profiles of its butter-type products. Industry sources report that the market shares of butter and margarine for the calendar year 1992 were 26.1 per cent and 73.9 per cent respectively.[104] These proportions are consistent with recent apparent consumption figures. Of the butter proportion of the market, dairy blends held about one-third (7.7 per cent of the total fat spread market). The total reduced-fat butter and margarine share in 1992 was 4.4 per cent and declining. This total included a mix of products from highly unsaturated to all milk fat.

Oils

As noted, the oil component of apparent consumption is an allowance included to account for probable supply: it is not an actual amount available for consumption. The allowance is 27 g per person per day. The aggregate fatty acid profile cannot be determined, and the assumed P:M:S ratio used in Table 2.15 is based on an estimate made for the 1985–86 vegetable oil supply.[30]

The P:M:S ratio is a description of the fatty acid profile of a food or foods, giving the proportion of polyunsaturated fatty acids (P), mono-unsaturated fatty acids (M) and saturated fatty acids (S) of the fat in the food. The P:M:S ratio is normally expressed with S=1; for example, the P:M:S ratio of safflower oil (a highly unsaturated product) is 8.6:1.6:1 and the P:M:S ratio of animal-based frying fat (highly saturated) is 0.1:0.9:1.

Estimating the fatty acid profile of the fats and oils supply

Rapid changes in product lines in the last three years have introduced more uncertainty in the use of apparent consumption data to estimate fatty acids in spreadable fats. There is an uncertainty inherent in the processing of margarines because proportions of source materials vary according to availability and market prices.

The fat content of butter is all milk fat and, with the exception of minor natural variations, is of known and consistent composition. The fat content of dairy blends is at least 50 per cent milk fat. As with margarines, the composition of the vegetable oil content varies according to the price and availability of the various oils.[30]

Fatty acid profiles are estimated for 1991–92 on the basis of market share information and best estimates of fatty acid ratios. Amounts from the apparent consumption data and estimates based on market share information are reasonably compatible, except for a tenfold discrepancy between the proportions of cooking margarine from the two sources. This may be explained in part because the industry market segment information is based on sales, not supply. The estimated fatty acids supply shown in Table 2.15 is based on the apparent consumption data for supply with the proportions of the table margarine component from the market information normalised to 100 per cent of apparent consumption.

Table 2.15: ***Estimated fatty acid supply of butter and margarine varieties, 1991–92***

			Fatty acids (g/day)		
Variety	**g/day**	**Fat (g/day)**	**P**	**M**	**S**
Butters					
Butter	4.7	3.8	0.45	0.90	2.37
Reduced-fat butter	0.4	0.2	0.03	0.04	0.12
Dairy blend	1.9	1.6	0.04	0.55	0.98
Reduced-fat dairy blend	0.2	0.1	0.01	0.03	0.05
All butters		**5.7**	**0.55**	**1.49**	**3.54**
Table margarines					
'Standard' margarine	2.1	1.7	0.66	0.56	0.45
Polyunsaturated margarine	13.2	10.6	4.90	3.37	2.12
Reduced-fat polyunsaturated margarine	0.4	0.2	0.09	0.06	0.04
Mono-unsaturated margarine	1.9	1.6	0.28	1.10	0.19
All table margarines		**14.1**	**5.93**	**5.08**	**2.80**
All butters and table margarines		**19.8**	**6.48**	**6.57**	**6.34**
Cooking margarine	5.2	4.2	0.34	1.86	1.92
All butters and margarines		**24.0**	**6.82**	**8.43**	**8.26**
Oils	**27.0**	**26.0**	**9.70**	**8.95**	**6.83**
Total		**50.0**	**16.52**	**17.38**	**15.09**

Note: Numbers may not add exactly due to rounding

Source: Australian Institute of Health and Welfare, derived from industry and Australian Dairy Corporation data

It is apparent from Table 2.15 that the estimate for oil is an important determinant of the fatty acid profile of the food supply: oil represents around 20 per cent of the total fat supply, as reported. It has a strong influence on the fatty acid profile of fats and oils, and the estimate of its composition is very approximate. Given the difficulties in identifying agricultural and imported components of the domestic oil supply, an enhancement of the apparent consumption data and fatty acid profiles, although desirable, may be very difficult to implement without assistance from manufacturers.

Sources and trends in ethanol consumption

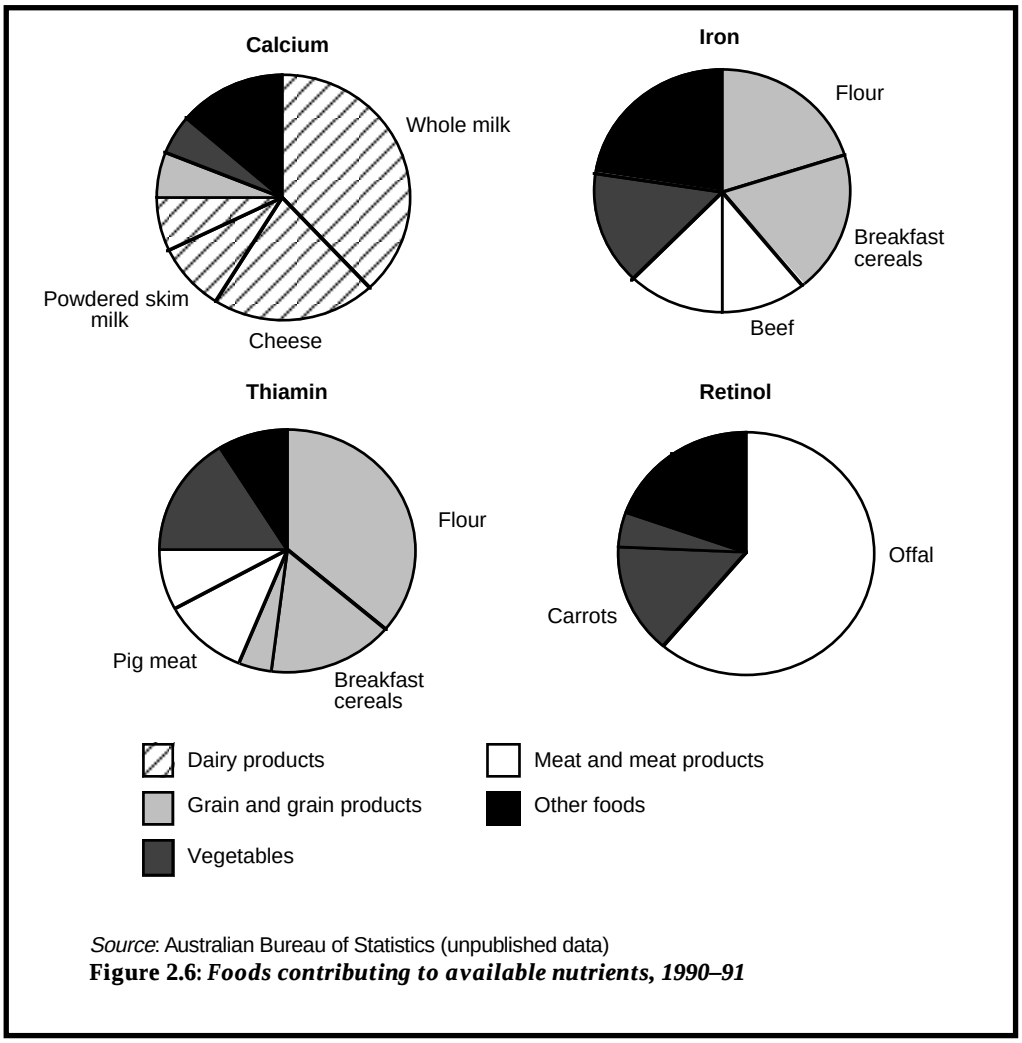
The ethanol supply increased from a pre-war 9.3 mL per person per day to 14.3 mL per person per day by 1948–49. It continued to increase to a peak of 26.3 mL per person per day in the late 1970s but then slowly declined to 21.1 mL per person per day by 1991–92. Between 1984–85 (when low-alcohol and standard beers were first differentiated) and 1991–92 the ethanol contribution of low-alcohol beers increased from 0.8 to 1.8 mL per person per day. At the same time, however, the ethanol contribution of standard beer fell from 13.4 to 11.4 mL per person per day. The decrease in alcohol available from beers can be attributed in part to the decrease in the quantity of beer: from 333 mL per person per day in 1984–85 to 279 mL per person per day in 1991–92.

The decrease in apparent consumption of all beers and the steady increase in apparent consumption of low-alcohol beer suggest that, while the beer supply is declining, there is also substitution of other beers by low-alcohol beer. If the substitution effect is assumed to be 100 per cent, then the benefit in reduced ethanol supply is substantial. The difference between actual ethanol availability from beer and the calculated ethanol level if all beer were 4.8 per cent alcohol by volume was 9 per cent by 1991–92. The increasing difference between actual and hypothetical ethanol levels from 1984–85 to 1991–92 suggests that substitution of standard beers by low-alcohol beer has a greater effect than the decrease in total apparent per capita consumption of beer.

Another factor influencing the ethanol supply is the reduction in average alcohol content of wines, from a peak of 17 per cent by volume in the late 1950s to around 13 per cent in 1980 and steady at 11.6 per cent since 1983–84. The decrease in ethanol from wine in the 1980s was due to a decreasing supply. Apparent consumption of ethanol from spirits averaged 3.3 mL per person per day throughout the 1980s and until 1991–92.

Food sources of micronutrients

Although the nutrient characteristics of the food supply examined so far show that the supply can provide adequately for the population, the distribution of nutrients within the food supply must also be considered. A limited range of sources may mean an increased likelihood of inadequate intakes for part of the population because food acquisition is selective. Figure 2.6 shows the food source distributions of selected nutrients in the food supply. The outstanding example is vitamin A, because of the importance of meat offals as a source but their low acceptability as a food.[94,125–127] Almost 80 per cent of the vitamin A supply comes essentially from two food items: liver and carrots. The calcium supply is heavily dependent on the dairy group of foods, which account for three-quarters of the supply. It is noteworthy that there are nutrients that warrant concern from a nutrition standpoint (such as zinc and folate) that have not so far been estimated for the *Apparent consumption* series. This is a deficiency in knowledge of the food supply that can, and should, be remedied.



Source: Australian Bureau of Statistics (unpublished data)

Figure 2.6: ***Foods contributing to available nutrients, 1990–91***

2.5 'Functional foods' and active non-nutrients

Functional (designer) foods

As in many other countries, there is much interest in Australia in a newly emerging group of foods, generally referred to as 'functional foods' but also known variously as 'nutraceuticals', 'designer foods', 'medical foods', 'genetically engineered foods', 'probiotic foods', or even 'foodaceuticals'. The characteristics of products in this category are that they look like conventional foods and are eaten as part of a normal diet but are modified to provide a (hypothetical) health benefit. It is claimed that they protect against diseases such as infections, hypertension, diabetes, cancer, osteoporosis and heart disease (for example, by regulating body functions). To be permitted in

Australia, however, the benefit would need to be substantiated scientifically. A number of definitions have been proposed for such foods:

- foods with a specific function, such as reducing fat intake;
- processed foods supplemented with cancer-preventing phytochemicals;
- foods modified or genetically engineered to prevent chronic lifestyle-related diseases;
- foods produced by mixing foods to give a standardised phytochemical content;
- substances derived from foods that provide medical or health benefits;
- physiologically functional foods designed and processed to protect body functions;
- natural or augmented foods that are epidemiologically associated with disease prevention or have been shown to be beneficial in animal bio-assays;[128]
- foods prepared by fortifying available fruit and vegetable products with phytochemicals that are 'unique in structure, class pattern or metabolism'.[129]

Are they food?

Some existing foods are considered to have 'functional' properties. For example, fermented dairy products such as yoghurt have been described as functional foods because of their probiotic activity; that is, the growth-promoting effect of one micro-organism on another.

The frequent claim for functional foods is that they have associations with health beyond any recognised nutritional properties. Scientific evidence is as yet insufficient for the development of definitive, specific food standards. In Australia, the National Food Authority (NFA) has had the topic of functional foods under review since May 1992. (In October 1993 the Authority held an international workshop on functional foods. Proceedings of this event have been published and distributed by the NFA. A gazette notice seeking public comment on the development of an appropriate regulatory framework for functional foods was published in May 1994). Many representatives of the Australian food industry and a number of medical researchers are suggesting to the Authority that they anticipate the imminent development of food products that will be able to substantiate a functional impact upon a disease or abnormal physiological condition. The food industry is keen for the NFA to develop a regulatory regime which would permit the use of health claims, and provide industry with a secure framework within which to commit resources to product development and research.

The topic is currently in a conceptual state of development and many issues need to be resolved to assist in the formulation of any proposed regulatory framework. These issues include establishing a definition of functional foods, distinguishing functional foods from therapeutic goods, the use of health claims and their substantiation and addressing the public health and safety concerns being expressed by consumer organisations.

Central to the debate regarding the use or otherwise of health claims is whether functional foods will actually represent a departure from the conventional assessment of the relationship between food and health. They may represent a technological 'breakthrough' from the past and thus be able to justify claims beyond currently

permitted nutrition messages to those more accurately described as 'medical' claims. The issue of substantiation will be of paramount importance in this process.

In most countries, including Australia, the concept of functional foods remains under review and it is expected that it will take several years for the regulatory issues that it raises to be fully resolved. The greatest challenge to regulators is the current hypothetical status of these proposed food products. It is difficult to anticipate possible future developments.

Physiologically active non-nutrient food components

Food components may have physiological activity that does not depend on nutrient attributes. Many such substances have no role as nutrients. Wahlqvist has reviewed the implications of these components for the food supply and the food industry (see Table 2.16).[130] For example, flavonoids, coumestans and lignans (occurring in plants) have weak oestrogenic activity[130] and may affect the state of the menopause, bone, the macrovasculature, proneness to breast cancer, and body fat distribution.[131] Wilcox et al. found that foods containing phyto-oestrogens contributed about 10 per cent of energy intake in a small sample of post-menopausal women.[131] Food components may be altered during processing and the resultant compounds may have biological activity. Examples of this kind of change are the roasting of coffee beans and the Maillard, or browning, reaction.[130]

Two common beverages—coffee and tea—are major sources for adults of the most common physiologically active non-nutrients: caffeine and other methylxanthines. Both beverages also contain other non-nutrient constituents that may also have physiological activity. The other sources of caffeine in the food supply are cola-type soft drinks and chocolate. Caffeine is a central nervous system stimulant and has been used as an ingredient in many over-the-counter pharmaceutical preparations. It occurs in a range of tropical plants, and early human cultures obtained the stimulatory effect by chewing the leaves of such plants. It is also a diuretic, although too weak for therapeutic use, and tends to increase cardiac output.

Most physiologically active food components come from plants. Strictly, many substances that are similar to or considered to be components of 'dietary fibre' are at least partially digestible or have by-products from the action of gut flora that are digestible and so are not 'non-nutrients'. Such substances as gums or mucilages and resistant starches can have a profound effect on food digestion and absorption, on the micro-ecology of the gut, and on metabolic processes.

Long-chain n-3 polyunsaturated fatty acids in fish and, at a broader level, other fatty acids have important metabolic effects.[30] Apart from the recognised relationships between macronutrients and health, there may be other more specific beneficial effects of diet. One example is a possible protective effect of milk-based protein against gastro-intestinal tumours; extensive research is being conducted into concentrating specific components of cows' milk and incorporating them in foods to increase the anti-infection properties of the foods. Processes have been developed to extract immunoglobulins and lactoferrin from milk or its components such as whey, to provide a potential source of immune factors for addition to foods such as infant formula.

Table 2.16: ***Physiologically active substances found in food***

Defined chemically	Defined physiologically
Ajoene / allicin	Opioids or exorphins
Caffeine	Other neuro-endocrine factors
Coumestans	Digestive enzyme inhibitors
Flavonoids	Glycaemia altering
Salicylates	Lipid lowering
Saponins	Satiating
L-dopa	Thermogenic
Capsaicins	Behaviour modifying
Lectins	
Trace elements	
Peptides	
Novel amino acids and fatty acids	
Peppermint oils	

Source: Wahlqvist[130]

Also naturally occurring are severe toxicants, primarily in plants (apricot kernels, for example, are highly toxic). Generally these do not form part of the diet but they may be ingested accidentally or sometimes as a herbal remedy or tonic.[132] Over 40 herbs are restricted under the Therapeutic Goods Act 1989, among them comfrey, sassafras and heliotrope. Potato is an example of a common food that may, under certain conditions, be poisonous—the alkaloid solanine is produced during 'greening'.

Probiotics

There may be potential for beneficial uses of micro-organisms in the realm of probiotics. An example is current research being undertaken by the CSIRO Dairy Research Laboratory on incorporating *Lactobacillus acidophilus* and bifidobacteria in dairy foods, where they may have a role in the treatment of peptic ulcer.[133,134] The proliferation of *Helicobacter pylori*, a causative agent in peptic ulcer disease, is inhibited by lactobacilli used in yoghurt production and by other micro-organisms that are suited to milk as a carrier medium.[134]

More is being discovered about the actions of components of foods with potential for positively influencing health and it will be important to follow closely the research activities in the field.

References

1. Australian Bureau of Agricultural and Resource Economics. Australian fisheries statistics 1992. Canberra: ABARE (Project 33.006), 1992;1–36.
2. Australian Bureau of Agricultural and Resource Economics. Commodity Statistical Bulletin 1992. Canberra: ABARE (Project 53.013), 1992.
3. Harris S. Agricultural trade and trade policy. In: Williams DB ed. Agriculture in the Australian economy. Melbourne: Sydney University Press in association with Oxford University Press Australia, 1990.
4. Ruthven D. Future trends in food marketing. In: Proceedings of Australia's First Food Conference. Melbourne: RMIT, 1988.
5. McCauley G. In: Williams DB ed. Agriculture in the Australian Economy. Melbourne: Sydney University Press in association with Oxford University Press Australia, 1990.
6. Australian Meat and Livestock Corporation. Meat industry. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;119–135.
7. Australian Bureau of Agricultural and Resource Economics. Survey results. Selected physical and financial estimates. In: Farm surveys report 1993. Financial performance of Australian farms 1990–91 to 1992–93. Canberra: ABARE (Project 20.005), 1993;76–83.
8. Australian Bureau of Agricultural and Resource Economics. ABARE farm surveys. In: Farm surveys report 1993. Financial performance of Australian farms 1990–91 to 1992–93. Canberra: ABARE (Project 20.005), 1993;1–7.
9. Australian Bureau of Statistics. Labour force estimates—February 1993. Canberra: ABS (Cat. no. 6202.0), 1993.
10. Cribb J. Agriculture in the Australian economy. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;11–118.
11. Humphreys JS, Weinand HS. Health status and health care in rural Australia: a case study. Comm Health Stud 1989;13:258–275.
12. National Rural Health Strategy. National Rural Health Conference. A fair go for rural health. National Rural Health Strategy. Discussion paper 1991;1–61.
13. Australian Bureau of Statistics. Agriculture. In: Yearbook Australia 1992. Canberra: ABS (Cat. no. 1301.0), 1992; 75th ed,413–441.
14. Australian Bureau of Statistics. Pers. comm. 1993.
15. Clark J, Lembit M, Warr S. A regional model of Australian beef supply. Canberra: ABARE (Research report 92.8), 1992;1–65.
16. Australian Pork Corporation. Pig industry. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;171–178.
17. Davidson A, Ferguson D. ELMY: a new value-based pig payment system. Paper presented to the Australian Pig Advisory Committee, 8 November, 1990.
18. AUS•MEAT. Chiller assessment. A pictorial guide. Sydney: AUS•MEAT, 1993;1–37.

19. Akridge J, Forrest J, Judge M. Pricing model would base hog price on carcass value. Feedstuffs 1990; 62(22):1,25–26,33.

20. Australian Chicken Meat Federation. Poultry meat industry. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;179–188.

21. Deer Farmers Federation of Australia. Deer industry. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;207–210.

22. Goat Industry Council of Australia. Goat industry. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;194–200.

23. Millington J. Game bird industry. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;189–193.

24. AUS•MEAT. AUS•MEAT report 1986–1990. Sydney: AUS•MEAT, 1990;1–28.

25. Australian Bureau of Statistics. Livestock products, Australia, February 1993. Canberra: ABS (Cat. no. 7215.0), 1993;1–11.

26. Australian Dairy Corporation. Dairy industry. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;161–170.

27. Australian Bureau of Statistics. Apparent consumption of foodstuffs and nutrients Australia, 1990–91. Canberra: ABS (Cat. no. 4306.0), 1993.

28. English R, Lewis J. Nutritional values of Australian foods. Canberra: AGPS, 1991;28–33.

29. Dairy Foods Advisory Bureau. Proximate composition of Australian dairy foods. Melbourne: Australian Dairy Corporation (publ. D25), 1991.

30. National Health and Medical Research Council. The role of polyunsaturated fats in the Australian diet. Report of the NHMRC Working Party. Canberra: AGPS, 1992;1–81.

31. Australian Fish Marketing Authority. Pers. comm. 1993.

32. Treadwell R, McKelvie L. Future challenges for aquaculture. National Agricultural and Resources Outlook Conference, Canberra, 29–31 January, 1991. Fisheries Symposiums 1991; 2. Aquaculture: 33–44.

33. Australian Wheat Board. Wheat industry. In: Cribb J. ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;269–285.

34. Lee AW (Flour Millers Council of Australia). Pers comm. 1993.

35. Lawrenson J. Australian Wheat Board Grain Statement, 2 February, 1993.

36. Industry Commission. Horticulture. Report no. 29, 18 February 1993. Canberra: AGPS, 1993;1–416.

37. Bennett R (Australian Horticultural Corporation). Pers. comm. 1993.

38. Australian Horticultural Corporation. Australian horticultural statistical handbook. March 1993. Sydney: Australian Horticultural Corporation, 1993.

39. Australian Citrus Industry Council. Citrus industry. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;388–393.

40. Strachan S, Kelly J. Grapes: the challenge ahead. Paper presented at the National Agricultural and Resources Outlook Conference, Canberra, 2–4 February, 1993. Canberra: ABARE, 1993;329–334.

41. Australian Dried Fruits Association. Dried vine fruit. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;398–403.

42. Australian Bureau of Statistics. Apparent consumption of foodstuffs and nutrients, Australia, 1990–91. Canberra: ABS (Cat. no. 4306.0) 1993;15–19.

43. Cribb J. Vegetables. In: Cribb J ed. Australian agriculture. A publication of the National Farmers Federation. 3rd ed. 1991–1992. Camberwell, Vic: Morescope Pty Ltd, 1991;413–418.

44. Prochaska HJ, Santamaria AB, Talalay P. Rapid detection of inducers of enzymes that protect against carcinogens. Proc Natl Acad Sci USA 1992; 89(6):2394–2398.

45. Levin B. Nutrition and colorectal cancer. Cancer 1992; 70(6 Suppl.):1723–1726.

46. Vargas PA, Alberts D. Primary prevention of colorectal cancer through dietary modification. Cancer 1992; 70(5 Suppl.):1229–1235.

47. Greenwald P. Colon cancer overview. Cancer 1992; 70(5 Suppl.):1206–1215.

48. Wattenberg LW. Inhibition of carcinogenesis by minor anutrient constituents of the diet. Proc Nutr Soc 1990; 49(2):173–183.

49. Zhang Y, Talaly P, Cho CG, Posner GH. A major inducer of anticarcinogenic protective enzymes from broccoli: isolation and elucidation of structure. Proc Natl Acad Sci USA 1992; 89(6):2399–2406.

50. Bradfield CA, Bjeldanes LF. Modification of carcinogen metabolism by indolylic autolysis products of *Brassica oleraceae*. Adv Exp Med Biol 1991;289:153–163.

51. Australian Horticultural Corporation. Australian horticultural statistical handbook. March 1992. Sydney: Australian Horticultural Corporation, 1992.

52. Australian Bureau of Statistics. Livestock and livestock products, Australia, 1990–91. Canberra: ABS (Cat. no. 7221.0), 1992;1–18.

53. Truswell AS, Brand J. Processing food. BMJ 1985; 291:1186–1190.

54. Jones GP. Food processing. In: Wahlqvist M ed. Food & nutrition in Australia. 3rd ed. Melbourne: Thomas Nelson, 1988;89–98.

55. Bender AE. Nutritional changes in food processing. In: Thorne T ed. Developments in food preservation. Vol. 4. London: Elsevier Applied Science, 1986;1–33.

56. Heywood P, Lund-Adams M. The Australian food and nutrition system: a basis for policy formulation and analysis. Aust J Public Health 1991;15(4):258–270.

57. Wilson GM. The place of processed food in the modern diet. Food Technol Aust 1986;38:71–73.

58. Selman JD. New technologies for the food industry. Food Sci Technol Today 1992;6(4):205–209.

59. Canned Food Information Service Inc. Residual nutritional value survey. Results of commissioned food analyses, Australian Government Analytical Laboratories (SA), 1988–1993. Melbourne: CFIS Inc, 1993.

60. Industries Assistance Commission. Food processing and beverages industry. 15 December 1989 (Report no. 424). Canberra: AGPS, 1990.

61. Morgan W (Food Industry Council of Australia). Pers. comm. 1993.

62. Australian Bureau of Statistics. 1990–91 Research and experimental development, all-sector summary, Australia. Canberra: ABS (Cat. no. 8112.0), 1993;12–13.

63. CSIRO Division of Plant Industry. News release. CSIRO sows bright yellow seeds of success. 16 June, 1992.

64. Mitchell R. Nutrition policies and current food trends. Agricultural Science 1993; March:37–42.

65. Keating P. Novel immobilised enzymes. Food Aust 1990;42:16–17.

66. Meadow Lea product information: Gold'n Canola Mild. 1993.

67. Anon. Full-cream milk has no cholesterol, low in fat. Food Industry 1993; May: 41.

68. Goldblith SA. 50 years of progress in food science and technology: from art based on experience to technology based on science. Food Technol Aust 1989;43:88–104.

69. Food Products Section, Department of Industry, Technology and Commerce. The Australian processed food and beverages industries. Key characteristics and trends. Paper presented at the Processed Foods Industry Conference, Sydney, 7–8 March, 1991.

70. Prime Minister's Science Council, Office of the Chief Scientist. Food processing. Papers prepared for the fourth meeting of the Prime Minister's Science Council, 20 May 1991. Canberra: AGPS, 1991;1–35.

71. Commercial Economic Advisory Service of Australia. Grocery industry review. June 1992. St Leonards, NSW: Commercial Economic Advisory Service of Australia, 1992;30–200.

72. Agri-food Secretariat, Department of Industry, Technology and Regional Development. Unpublished data. 1993.

73. White M, ed. The Foodweek and Liquor Week 1993 industry yearbook and directory of suppliers. Crows Nest, NSW: Ian Huntley, 1993;2–243.

74. Commonwealth Department of Health, Housing and Community Services. Food and Nutrition Policy. Canberra: AGPS, 1992;1–32.

75. Gittus I. A credible approach to food information. Australian Food Foundation Newsletter 1991; Issue 1, September;1–2.

76. Townsend FR. Genesis and development of CAFTA. Food Aust 1992;44:75–77.

77. Mitchell WR. The States and the National Food Authority. Food Aust 1991;43:549–550.

78. Downer AH. CAFTA and the National Food Authority. Food Aust 1991;43:446–447.

79. Gittus I. Our attitudes to food industry perspective. Paper presented at Australia's Food Conference—towards the next century. RMIT, Melbourne. 1988.

80. Zadow D. New processes and food forms. Paper presented at Australia's Food Conference—towards the next century, RMIT, Melbourne. 1988.

81. Hicks N, Robbins J, Edwards J, Zweck W. Governments, the food industry and good nutrition. An Australian review. Review paper for the National Food and Nutrition Policy development commissioned by the Department of Health, Housing and Community Services. Canberra: Department of Health, Housing and Community Services, 1991;1–55.

82. Australian Supermarket Institute. 1992 Nielsen review of grocery trends. Scan Track case studies. North Ryde, NSW: Nielsen Marketing Research, 1992;1–24.

83. National Health and Medical Research Council. Implementing the Dietary Guidelines for Australians. Report of the Subcommittee on Nutrition Education. Canberra: AGPS, 1989;1–138.

84. Nutrition Taskforce. Better nutrition for Australians. In: Better Health Commission, Looking forward to better health. Vol. 2. The taskforces and working groups: reports to the Better Health Commission. Canberra: AGPS, 1986;69–190.

85. Australian Bureau of Statistics. Apparent consumption of selected foodstuffs, Australia, 1991–1992, preliminary. Canberra: ABS (Cat. no. 4306.0), 1992;1–4.

86. Food and Agricultural Organisation. FAO Food Balance Sheets, 1984–1986 average. Rome: FAO, 1991;1–384.

87. Kelly A, Becker W, Helsing E. Food balance sheets. WHO Reg Pub Eur Ser 1991;34:39–48.

88. Nutrition Committee of the National Health and Medical Research Council. The food consumption and dietary levels in 2730 Australian households in 1944. Canberra: Australian Institute of Anatomy (Spec. rep. ser. no. 1), 1945;1–84.

89. Australian Bureau of Statistics Demography. In: Year book Australia 1992. 75th ed. Canberra: ABS (Cat. no. 1301.0), 1992;147–181.

90. Anon. Dietary Guidelines for Australians. J Food Nutrition 1981; 38(3):111–119.

91. National Health and Medical Research Council. Dietary Guidelines for Australians. Canberra: AGPS, 1992;1–110.

92. Nutbeam D, Wise M, Bauman A, Harris E, Leeder S. Goals and targets for Australia's health in the year 2000 and beyond. Report prepared for the Commonwealth Department of Health, Housing and Community Services. Canberra: AGPS, 1993;1–269.

93. Commonwealth Department of Health. National Dietary Survey of Adults: 1983. No. 1. Foods consumed. Canberra: AGPS, 1986;1–124.

94. Cashel K, English R, Lewis J. Composition of foods, Australia, 1989. Vol. 1. Canberra: AGPS, 1989.

95. English R, Lewis J, Cashel K. Composition of foods, Australia, 1990. Vol. 2. Cereals and cereal products. Canberra: AGPS, 1990.

96. Lewis J, English R. Composition of foods, Australia, 1990. Vol. 3. Dairy products, eggs and fish. Canberra: AGPS, 1990.

97. English R, Lewis J. Composition of foods, Australia, 1990. Vol. 4. Fats and oils, processed meats, fruit and vegetables. Canberra: AGPS, 1990.

98. Lewis J, English R. Composition of foods, Australia, 1990. Vol. 5. Nuts and legumes, beverages, miscellaneous foods. Canberra: AGPS, 1990.

99. Lewis J, Holt R, English R. Composition of foods, Australia, 1992. Vol. 6. Infant foods, dairy foods update. Canberra: AGPS, 1993.

100. Lewis J, Dobson R, English R. Composition of foods, Australia. Vol. 7. Ethnic foods. Canberra: AGPS, 1993.

101. Jamrozik K, Jamieson R, Fitzgerald C. An oral history of changes in the Australian diet. Med J Aust 1992;157:759–761.

102. Bread Research Institute of Australia. Unpublished data on the national flour mix. 1993.

103. Department of Primary Industry. Unpublished data. 1979.

104. Australian Dairy Corporation. Unpublished data. 1993.

105. Carver SR. Report on food production and the consumption of foodstuffs and nutrients in Australia. No. 7, 1951–52. Canberra: Commonwealth Bureau of Census and Statistics, 1953.

106. Cashel K. The revision of Australian food composition data. In: English R, Lester IH (eds). Proceedings of the first OCEANIAFOODS Conference, Canberra, Australia, 12–15 May 1987. Canberra: AGPS, 1987;24–27.

107. National Food Authority. National Food Authority annual report 1991–1992. Canberra: AGPS, 1992;32.

108. Carmody J. Development of the Australian Nutrient Data Bank—computer aspects. In: English R, Lester IH eds. Proceedings of the first OCEANIAFOODS Conference, Canberra, Australia, 12–15 May 1987. Canberra: AGPS, 1987;51–61.

109. Truswell AS. Development of the current set of recommended dietary intakes for Australians. In: Truswell AS, with Dreosti IE, English RM, Rutishauser IHE, Palmer N eds. Recommended nutrient intakes: Australian papers. Sydney: Australian Professional Publications, 1990;9–12.

110. National Health and Medical Research Council. Report of the 108th session, Canberra, November 1989. Canberra: AGPS, 1990;19.

111. Department of Community Services and Health. National Dietary Survey of Adults: 1983. No. 2. Nutrient intakes. Canberra: AGPS, 1987;1–115.

112. Department of Community Services and Health. National Dietary Survey of Schoolchildren (aged 10–15 years): 1985. No. 2. Nutrient intakes. Canberra: AGPS, 1989;1–117.

113. Australian Institute of Health and Welfare. Unpublished data. 1993.

114. Food and Agriculture Organization of the United Nations & World Health Organization. International Conference on Nutrition. Final report of the conference, Rome, December 1992. Rome: FAO & WHO, 1992;1–55.

115. Wood B. Thiamin —update. In: Truswell AS, with Dreosti IE, English RM, Rutishauser IHE, Palmer N eds. Recommended nutrient intakes: Australian papers. Sydney: Australian Professional Publications, 1990;61.

116. Australian Bureau of Statistics. Apparent consumption of foodstuffs and nutrients Australia, 1987–88. Canberra: ABS (Cat. no. 4306.0), 1991.

117. Wood B, Currie J, Breen K. Wernicke's encephalopathy in a metropolitan hospital: a prospective study of incidence, characteristics and outcome. Med J Aust 1986;1:12–16.

118. Wodak A, Richmond R, Wilson A. Thiamin fortification and alcohol. Med J Aust 1990;152:97–99.

119. Gold J, Perdices M, Lardner K, et al. The Wernicke–Korsakoff Project—the final report. Sydney: School of Public Health and Tropical Medicine, University of Sydney, 1985.

120. National Health and Medical Research Council. Report of a committee appointed to review the nutritive significance of Australian bread. Canberra: AGPS (NHMRC spec. rep. ser. no. 9), 1959.

121. National Health and Medical Research Council. Summary report on the thiamin status of the Australian people. In: Report of the 83rd session. Canberra: AGPS, 1977; App. XIV.

122. Wood B. Thiamin status in Australia. Wld Rev Nutr Diet 1985;46:148–218.

123. Wills RBH, Myers PR, Greenfield H. Composition of Australian foods. 14. Margarines and cooking fats. Food Technol Aust 1982;34:240–244.

124. Meadow Lea Foods Ltd. Unpublished data. 1993.

125. Department of Community Services and Health. National Dietary Survey of Schoolchildren (aged 10–15 years): 1985. No. 1. Foods consumed. Canberra: AGPS, 1988;1–105.

126. Baghurst K, Crawford D, Record S, Worsley A, Baghurst P, Syrette J. The Victorian Nutrition Survey, 1985 and 1990. Part one: food intakes. Adelaide: CSIRO, 1993.

127. Baghurst K, Crawford D, Record S, Worsley A, Baghurst P, Syrette J. The Victorian Nutrition Survey Part 1—Food intakes by age, sex and area of residence. Adelaide: CSIRO Division of Human Nutrition, 1987.

128. Pszczola DE. Designer foods: an evolving concept. Food Technology 1993; March: 92.

129. Jenkins MLY. Research issues in evaluating 'functional foods'. Food Technology 1993; April:76–79.

130. Wahlqvist M. Non-nutrients in foods: implications for the food industry. Food Aust 1992;44 (12):558–560.

131. Wilcox G, Wahlqvist ML, Burger HG, Medley G. Oestrogenic effects of plant foods in post-menopausal women. BMJ 1990;301:905–906.

132. Gorey J, Wahlqvist ML, Boyce NW. Adverse reaction to a Chinese herbal remedy. Med J Aust 1992;157:484–486.

133. Hull RR, Conway PL, Evans AJ. Probiotic foods—a new opportunity. Food Aust 1992;44:112–113.

134. Foods to fight intestinal infections. DRL News. Newsletter of the CSIRO Dairy Research Laboratory 1993; February:52.