

# **Food Safety Risk Profile for Primary Industries in South Australia**

Final Report

June 2002

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Sumner, J., 2002, *Food Safety Risk Profile for Primary Industries in South Australia*, Department of Primary Resources SA, Adelaide.

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**PRIMARY INDUSTRIES  
AND RESOURCES SA**

This food safety risk profile has been prepared for the Agriculture Food and Fisheries division, Primary Industries and Resources SA (PIRSA).

The PIRSA Agriculture, Food and Fisheries Division (AFF), works in partnership with primary industries, stakeholders and other national and state government departments toward "profitable, continuing returns for South Australia from international markets." The AFF Division develops and implements policies, legislation, regulatory frameworks and programs to promote an optimal business, natural and social environment within which primary industries can thrive.

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**Acknowledgments**

A number of staff of Primary Industries & Resources SA and Dairy Authority of South Australia supplied information and helped immeasurably by reviewing and improving draft reports.

The author wishes to acknowledge the contributions of:

Tony Brown, Chris Etherton, Kim Critchley, Paul Dowsett, Rob Esvelt, John Fennell, John Hannay, Dennis Heanes, John Kassebaum, Ken Lee, Michael McManus, Barrie Paynter, Elena Petrenas, Barry Philp, Andy Pointon, Jon Presser, Geoff Raven, Glenn Ronan, Steve Rice, Roger Tilmouth, John Weaver, Will Zacharin.



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# 1. Risk Management Priorities for PIRSA

Based on risk profiles, a number of recommendations are made as risk management priorities for PIRSA; full details of each recommendation appear within the respective section of the main text.

## 1.1. Risk management priorities for PIRSA's Meat Hygiene Program

### Recommendation 1:

PIRSA should increase the rigour surrounding validation of Critical Control Points (CCPs) for listeriocidal processes in all smallgoods operations.

*Note: PIRSA's contract auditors are familiar with process control and are capable of undertaking a review of each plant's CCPs.*

### Recommendation 2:

PIRSA should critically evaluate the relative effectiveness of Good Manufacturing Processes in controlling *L. monocytogenes* in smallgoods operations by reviewing microbiological testing data of meat processing.

### Recommendation 3:

PIRSA should evaluate the scientific evidence for spin chilling being a CCP.

*Note: The Codex definition requires that a CCP prevents, eliminates or reduces the hazard to an acceptable level and these criteria provide sufficient rigour for an assessment.*

### Recommendation 4:

PIRSA should engage DHS in a co-operative approach to managing risks of Gram-negative pathogens in raw and cooked poultry.

*Note: This co-operation should have measurable management indicators.*

### Recommendation 5:

PIRSA should undertake a comprehensive review of processes and regulatory arrangements in the smallgoods industry centred on:

(5a) Validation of all processes both for uncooked and cooked fermented sausages manufactured in the state.

*Note: This should be based on FSANZ recommendations surrounding, raw material quality, a process delivering a 3-log reduction in generic *E. coli* plus final product in which *E. coli* is not detected in a defined mass of product (0.1g or 1g).*

(5b) A review of processes and process control for spreadable sausages, such as Teewurst.

(5c) Resolve the anomaly where regulation of smallgoods is the responsibility of DHS yet the audit of plants and processes is the responsibility of PIRSA.

### **Recommendation 6:**

PIRSA should establish a task force to identify existing processes and controls surrounding primary hazards in livestock and poultry production. The task force should include stock feed within its remit.

### **Recommendation 7:**

PIRSA should establish a task force to survey egg production and processing in South Australia with a focus on prevalence of pathogens, particularly *Salmonella*. Depending on the outcome of the survey control measures should be developed to embrace a pathogen reduction program.

*Note: There are epidemiological linkages between pathogens in eggs and foodborne illness.*

## **1.2. Risk management priorities for the Dairy Authority of South Australia**

### **Recommendation 8:**

It is recommended that the Authority:

- (a) Undertakes a scientific assessment of the HACCP plans of suppliers of unpasteurised milk to ensure there is a validated Critical Control Point (CCP) to prevent contamination of milk by pathogens during milking.
- (b) Confirms that a CCP (if identified) is properly monitored.
- (c) Commission a statistical evaluation of the microbiological sampling plan for testing unpasteurised milk to ensure the program provides a high level of confidence that contaminated milk is not being drawn and offered for sale.

*Note: In making the assessment the Authority should take into account:*

- *Producer and consumer risks associated with the Operational Characteristics curve of the sampling plan.*
- *Difficulty in isolating Campylobacter from food samples*
- *Whether the sample size is adequate to detect pathogens given the attendant risk of failure*
- *That outbreaks of salmonellosis (1999) and campylobacteriosis (2000) from unpasteurised milk occurred while the sampling program was operated*

## **1.3. Risk management priorities for PIRSA - Horticulture**

### **Recommendation 9:**

PIRSA should survey the unpasteurised fruit juice industry in South Australia to identify companies manufacturing such products, the complete range of unpasteurised products and volumes consumed.

### **Recommendation 10:**

PIRSA review all HACCP plans of companies which manufacture unpasteurised fruit juice. If a Critical Control Point (CCP) is claimed for preventing, eliminating or reducing pathogens to an acceptable level, PIRSA should obtain a scientific validation to support the CCP.

### **Recommendation 11:**

Based on the outcome of recommendation 10 PIRSA should work with DHS to regulate the sale of unpasteurised fruit juice.

*Note: Unpasteurised fruit juice should be recognised under the new South Australian Food Act as a high risk food and therefore food safety programs and microbiological testing should be mandated, and a sampling plan formulated for testing unpasteurised fruit juice to ensure the program provides a high level of confidence that contaminated juice is not being offered for sale.*

### **Recommendation 12:**

PIRSA should maintain surveillance of the use of water and fertilisers by suppliers of salad products, with particular reference to use of reclaimed waters.

### **Recommendation 13:**

PIRSA should identify each supplier of salad items and assess whether their processes have CCPs which prevent, eliminate or reduce pathogens to an acceptable level.

### **Recommendation 14:**

PIRSA (both horticulture and grains sections) should undertake a comprehensive review of processes in the South Australian sprouting industry centred on:

- (14a) *Identifying all key process parameters which impact on pathogen growth.*
- (14b) Using a predictive microbiology exercise to assess pathogen multiplication.
- (14c) Undertaking a survey of pathogens in seed stock used for sprouting.

### **Recommendation 15:**

Based on the outcome of recommendation 14 PIRSA should consider regulating the sprouting industry based on the ability of companies to demonstrate control of pathogen growth.

## **1.4. Risk management priorities for PIRSA – Apiary Industry**

### **Recommendation 16:**

Because spores of *Clostridium botulinum* are present in honey and have been linked with Sudden Infant Death Syndrome, PIRSA should ascertain whether in South Australia parents are actively informed not to feed honey to children in their first year.

### **Recommendation 17:**

PIRSA should consider whether to proactively supply South Australian apiarists and processors with food safety information and HACCP plans.

*Note: The B-Qual approach is clearly at an early stage of development and operators may be unable to prepare a HACCP plan without considerable (and costly) assistance for HACCP practitioners.*

## **1.5. Risk management priorities for PIRSA - Seafood/Aquaculture**

### **Recommendation 18:**

PIRSA should monitor processes and CCPs of smoked seafoods and assess their scientific validity for control of *Listeria monocytogenes*.

### **Recommendation 19:**

PIRSA should consider regulating the adventitious gathering and sale of:

- Pipsis from the Goolwa/Coorong area;
- Scallops along the SA coast;
- Shellfish gathered from Port River.

*Note: There is the need to bring these areas into the SA Shellfish Quality Assurance Program (SASQAP).*

## **1.6. Risk management priorities for PIRSA – Grains**

### **Recommendation 20:**

PIRSA should maintain surveillance of microbial and chemical hazards associated with grain products.

*Note: This recommendation reflects the absence of epidemiological evidence linking grain products with foodborne disease in the Australian community.*

## 2. Background to Risk Analysis and Terms of Reference

### 2.1. Introduction

Risks from microbiological and chemical hazards are of serious concern to human health. Risk Analysis is a process which is used to enhance protection of public health. It has three parts:

- Risk Assessment
- Risk Management
- Risk Communication

Risk Assessment is the science component of risk analysis used to establish standards, guidelines and other recommendations for food safety to enhance consumer protection. The present work is concerned with Risk Profiling, which is defined by the Codex Committee on Food Hygiene, as a description of a food safety problem and its context developed for the purpose of identifying those elements of a hazard, or risk which are relevant to risk management decisions.

The terms of reference are:

1. To provide a risk profile of SA primary industry sectors including:
  - Meat
  - Livestock and poultry
  - Seafood/aquaculture
  - Horticulture
  - Dairy
  - Grains
  - Honey
2. For each sector the outcome will be:
  - A broad brush risk profile which leads to prioritisation of risk
  - Some in-depth assessment of risk within that sector which reflects factors such as SA regional or manufacturing differences
  - Some preliminary risk mitigation strategies

In 1999 the Codex Alimentarius Commission (CAC) set out general principles for microbiological risk assessment. Since the present project will also consider non-microbiological hazards, these principles have been amended from the Codex Principles for Microbial Risk Assessment (Codex, 1999) by omitting “Microbiological” where appropriate. The principles state that:

1. Risk Assessment should be soundly based upon science.
2. There should be a functional separation between Risk Assessment and Risk Management.
3. Risk Assessment should be conducted according to a structured approach that includes Hazard Identification, Hazard Characterization, Exposure Assessment, and Risk Characterization.

4. A Risk Assessment should clearly state the purpose of the exercise, including the form of Risk Estimate that will be the output.
5. The conduct of a Risk Assessment should be transparent.
6. Any constraints that impact on the Risk Assessment such as cost, resources or time, should be identified and their possible consequences described.
7. The Risk Estimate should contain a description of uncertainty and where the uncertainty arose during the Risk Assessment process.
8. Data should be such that uncertainty in the Risk Estimate can be determined; data and data collection systems should, as far as possible, be of sufficient quality and precision that uncertainty in the Risk Estimate is minimized.
9. A Microbiological Risk Assessment should explicitly consider the dynamics of microbiological growth, survival, and death in foods and the complexity of the interaction (including sequelae) between human and agent following consumption as well as the potential for further spread.
10. Wherever possible, Risk Estimates should be reassessed over time by comparison with independent human illness data.
11. A Risk Assessment may need re-evaluation, as new relevant information becomes available.

The present risk profiling exercise conforms with the Principles 1-6 and 9-11 (above) to a large degree but does not determine uncertainty.

## **2.2. Methodology used in the present study**

The present study involves several areas with PIRSA, and also the Dairy Authority of South Australia (DASA). It has been progressed in several stages:

Stage 1: Identification of key food safety issues with staff in each area.

Stage 2: Research of hazards and exposure – gathering of data

Stage 3: Submission of draft risk profiles submitted to personnel in each area

Stage 4: Submission of final draft risk profiles

## **2.3. Statement of purpose**

Each area has the same purpose to provide:

- A broad-brush assessment of risks associated with hazards (chemical and microbiological) consumed with a range of products.
- Alternatives for mitigating the risks associated with selected hazard:products pairs.

## **2.4. Risk estimates**

Where data were available a Risk Ranking was provided based on the output from a spreadsheet tool (Risk Ranger). Risk Ranking covers a range of 0-100 where the lower value represents risk associated with one case of illness from the hazard:product pair in the earth's population over the course of 100 years. The upper risk ranking represents every member of the earth's population being exposed to a lethal dose during one day. Risk Ranger also predicts the number of annual illnesses resulting from a hazard:product pair. Full details of Risk Ranger are in Ross, T. and J. Sumner (2002) A simple, spreadsheet-based, food safety risk assessment tool. *International Journal of Food Microbiology* 77:39-53, which is appended as a PDF file.

Risk Ranger has proved a robust, versatile tool and has been used for predicting risk in a range of food industries including a risk profile of the seafood industry (see Sumner, J. and T. Ross 2002. A semi-quantitative seafood safety risk assessment. *International Journal of Food Microbiology* 77:54-59).

## **2.5. Risk Profiling**

This phase of the work followed the same progression used in Risk Assessment: Hazard Identification, Hazard Characterisation, Exposure Assessment, and Risk Characterisation. Hazards identification was carried out by:

- Linkage with confirmed foodborne illness using statistics published either nationally in Communicable Diseases Intelligence (CDI) or in South Australian Department of Human Services (DHS) statistics.
- International foodborne disease outbreaks.
- Recalls monitored by FSANZ.

By this method a list of hazards reasonably expected to occur in a particular food category were identified. Some attention was also given to perceived hazards e.g. agricultural chemicals which, while they have never been associated with illness, are regarded by some consumers as hazardous.

Hazard characterisation was undertaken by gathering information on:

- Behaviour of the hazard (particularly microbial hazards) through the agri-process-retail-home preparation continuum.
- Intake of the hazard likely to cause illness within the population of illness (dose-response).

Exposure Assessment for microbiological agents was based on the potential extent of food contamination by a particular agent or its toxins, and on dietary information. Where available, data on prevalence and concentration of hazards were used. Where data were not available assumptions were made and identified as such. A typical serving size was calculated from nutritional surveys or from consumption data for consumers in South Australia.

Risk Characterization integrates Hazard Identification, Hazard Characterization, and Exposure Assessment to obtain a Risk Ranking and an estimate of the likelihood and annual illness in the specific population. Risk ranking does not include a description of the uncertainties associated with these estimates. A list of definitions from the Codex is included in Appendix A.



### 3. Risk Profiles of Livestock, Poultry, Stockfeed, Eggs, Meat and Meat Products in South Australia

#### 3.1. Production of meat and meat products in SA

The farm gate value of livestock produced for slaughter in South Australia in 2000-01 was \$656.2 million. This comprised \$289.5m for cattle, \$154.8 million for sheep (\$46.4m for mutton and \$108.4m for lamb), \$146.4m for pigs, \$60.6m for chicken, \$2.1m for goats, \$0.8m for deer and \$2m for kangaroos (Table 1).

The wholesale value of meat processed in South Australia during 2000-01 was \$821m. This comprised \$288.9m for beef, \$231.6m for sheep meats (\$50.5m for mutton and \$181.1m for lamb), \$165.3m for chicken meat, \$125.9m for pig meat, \$3.1m for goat meat, \$0.8m for venison and \$6m for kangaroo meat (Table 1). In 2000-0101, South Australian abattoirs and other meat wholesalers exported \$299.7m overseas and \$68.5m interstate (Table 1).

The meat market chain from farm gate to retail is valued at \$1.8 billion, which comprises 22% of state food revenue per annum. Meat and meat processing industries are the second largest in terms of value to the South Australian food and beverage industry (excluding wine).

Table1: Value of meat and meat exports – South Australia, 2000-01

	Production numbers	Farmgate value (\$m)	Slaughter numbers	Processed meat value (wholesale \$ m)	Value exported (fob \$m)	Value interstate (\$m)
Beef	517,228	289.5	375,188	288.9	63.4	0.0
Sheep	2,633,563	46.4	1,531,956	50.6	44.9	5.6
Lamb	2,710,502	108.4	3,017,129	181.0	167.5	17.2
Chicken	38,02,339	60.6	38,010,000	165.3	1.4	22.4
Pig meat	845,337	146.4	472,685	125.9	4.1	22.7
Goat	79,449	2.1	61,591	3.1	1.9	0.0
Deer	8,665	0.8	1,846	0.3	0.4	0.6
Kangaroo	168,000	2.0	168,000	6.0	1.0	0.0
Other					15.1	
TOTAL		656.2		821.1	299.7	68.5

In Table 2 are presented livestock and slaughter volumes (tonnes) for South Australia in 2000-01.

Table 2: South Australian livestock and slaughter volumes, 2000-01 (t, carcase weight)

Category	Processed in SA abattoirs (t)			Exported (t)		Imported (t)
	Total	Domestic	Export	Overseas	Interstate	
Beef	82,000	37,000	45,000	38,000	-	10,000
Pig meat	32,000	17,000	15,000	1,500	6,000	4,000
Lamb Meat	60,000	13,000	47,000	38,000	4,000	-
Mutton	33,000	5,000	28,000	24,000	2,500	-
Chicken Meat	55,000	NA*	NA*	1,500	7,500	
Total	262,000	72,000	135,000	103,000	20,000	14,000

In Table 3 are presented consumption volumes (tonnes) of red meat, chicken and meat products in South Australia.

Table 3: Consumption of meat and meat products in SA

Category	Consumption source (t)			Total
	Domestic abattoirs	Export abattoirs	Interstate/overseas	
Beef	37,000	7,000	10,000	54,000
Pig meat	17,000	7,500	4,000	28,500
Lamb	13,000	5,000	-	18,000
Mutton	5,000	1,500	-	6,500
Chicken	46,000			46,000
Total	118,000	21,000	14,000	153,000

### 3.2. Production of eggs in SA

In 2000-01, the poultry industry in South Australia produced almost 170 million eggs with a farm gate value of \$14.6 million and a retail value of \$26.2 million. Around 70 million eggs were exported interstate with a value of \$12.7 million. The final value to the South Australian economy from eggs was \$46 million.

### 3.3. Hazard identification

#### 3.3.1. Meat and Chicken Products

Outbreaks associated with meat and chicken products in South Australia (Table 4) and Australia (Table 5) indicate that salmonellosis was by far the most common meat borne disease; *L. monocytogenes* and pathogenic *E. coli* also caused illness. Detail regarding these outbreaks is included in Appendix 1. The foods implicated, both national and in SA, are similar, mainly cooked meat and poultry, together with uncooked fermented meats.

Thus, in South Australia over the last decade, there have been over 500 cases of food-borne illness involving meat and poultry that were of sufficient severity to require medical treatment, and 2 deaths.

Table 4: Meat-associated outbreaks in South Australia 1990-2001

Year	Product	Pathogen	Cases	Deaths
1991	Salami	<i>S. Anatum</i>	>120	
1994	Pork sausage	<i>S. Enteritidis</i>	14	
1995	Salami	<i>E. coli</i> O111	ca 150, 22 (HUS)	1
1996	Diced chicken	<i>L. monocytogenes</i>	5	1
1996	Meat rolls	<i>Salmonella Typhimurium</i> PT 135	71	
1998	Spatchcock	<i>S. Typhimurium</i> RDNC A045	38	
2000	Chinese food from single restaurant	<i>S. Typhimurium</i> RDNC	6	
2000	Asian food from single restaurant	<i>S. Typhimurium</i> phage type 44	11	
2001	Chicken	<i>S. Typhimurium</i> phage type 126	93	

Table 5: Meat-associated outbreaks in other Australian states 1990-2000

Year	State	Product	Pathogen	Cases	Deaths
1990	WA	Pâté, Pastrami (?)	<i>L. monocytogenes</i>	11	6 (stillbirths)
1992	WA	Salami	<i>S. Typhimurium</i>	>20	
1996	QLD	Not identified	<i>E. coli</i> O157	6	
1996	VIC	Cold roast meat	<i>C. perfringens</i>	33	
1997	VIC	Corned Silverside	<i>S. Muenchen</i>	24	2
1997	VIC	Pork Rolls	<i>S. Typhimurium</i> 1	>700	
1997	VIC	Unknown	<i>S. Typhimurium</i> 43	7	1 (?)
1997	VIC	Corned Silverside, Leg Ham and Virginia Ham	<i>S. Anatum</i>	25	
1997	VIC	Unknown	<i>S. Chester</i>	25	

Meat and poultry products involved in Australian recalls, some of which were South Australian products (Table 6) were predominantly cooked, cured meat and poultry, plus uncooked fermented meats.

Table 6: Meat and poultry products recalled during 1990-2001

Bacon	1
Cooked chicken	5
Cooked and cured meat	9
Fresh sausage	4
Fermented sausages	17
Minced meat	3
Slow cured meat	1
Pâté	1
Total	41

The causes of recall were microbiological in 25/41 (60%) of cases, foreign matter in 12/41 (30%) of cases with undercooking, labelling and tainting accounting for the remainder (Table 7).

Table 7: Causes of recall of meat and poultry products, 1990-2001

Microbiological		
	Generic <i>E. coli</i>	2
	EHEC	2
	<i>L. monocytogenes</i>	10
	<i>Salmonella</i>	5
	Microbiology	1
	Mould	1
	Precautionary	4
	Microbiological subtotal	25
Foreign matter		12
Labelling information		1
Undercooking		2
Chemical taint		1
	Total	41

### 3.3.2. Eggs

There are strong epidemiological links between *Salmonella* in eggs and salmonellosis both internationally, nationally within Australia and within South Australia. Globally, *S. Enteritidis*, particularly Page Type 4, has become a major, in some countries *the* major, cause of salmonellosis. In Australia this serovar is relatively rare, being associated with overseas travel, mainly to Bali.

Crerar *et al.* (1996) cited three outbreaks from eggs in the period 1980-95, two salmonelloses and one described as “Unknown”. Since 1995 there have been several other outbreaks (Table 8), the first two of which are South Australian.

According to the FSANZ database, there have been no recalls in which eggs or egg-based products were confirmed as the cause.

Table 8: Salmonellosis attributed to eggs in Australia 1996-2001

Year	Product	Pathogen	Cases
2001	Raw eggs	<i>S. Typhimurium</i> PT 135	18
2001	Desserts	<i>S. Typhimurium</i> PT 135a	11
2001	Duck eggs	<i>S. Typhimurium</i> PT 9	6
2002	Dessert	<i>Salmonella Typhimurium</i> PT 135	53

In Victoria in 2000 there were 74 isolations of *Salmonella* from egg products, all from a processing facility in that state, isolated as part of the daily sampling regime. It is not known whether all samples were from egg product (yolk, white or whole egg) prior to pasteurisation. The data are useful only to indicate firstly, that *Salmonella* is found in raw egg products and secondly, to identify the serovars (Table 9).

Table 9: *Salmonella* serovars isolated from egg products in Victoria (2000)

Organism	Isolations in 2000
<i>S. Typhimurium</i> PT 135	15
<i>S. Cerro</i>	12
<i>S. Virchow</i> PT 34	9
<i>S. Ohio</i>	8
<i>S. Singapore</i>	7
<i>S. Typhimurium</i> PT 9	5
Other	18
Total	74

According to data from IMVS, within South Australia, between 1998 and 2001 there were no isolation of *Salmonella* from 590 samples of eggs and egg products.

### 3.3.3. Livestock and poultry

Agriculture, Fisheries and Forestry Australia (AFFA) have identified hazards in two categories for livestock and poultry: primary and secondary and, within each category, there are chemical and biological and chemical hazards (Tables 10 and 11). In Table 10 are listed the broad chemical hazard categories which may be taken up by livestock and poultry from grassland and/or stockfeed.

Table 10: Primary chemical hazards in livestock and poultry

Livestock	Poultry
Agricultural and veterinary chemical residues	Agricultural and veterinary chemical residues
Environmental contaminants	Environmental contaminants
Cadmium and heavy metals	Arsenic, mercury and heavy metals

As evidenced from Table 11, livestock carry a wide range of micro-organisms in their intestines, glands and udders which are pathogenic either to the host or to humans. These pathogens may be transferred to carcasses during slaughter and dressing. Similarly, the intestines of poultry may be colonised by salmonellas, which are transferred to the carcass during slaughter and processing stages.

Table 11: Primary biological hazards in livestock and poultry

Livestock	Poultry
Gram-negative pathogens <i>Brucella</i> , <i>Salmonella</i> , pathogenic <i>Escherichia coli</i> , <i>Campylobacter jejuni</i> , <i>Yersinia enterocolitica</i> <i>Coxiella burnetii</i>	<i>Salmonella spp.</i> , <i>Campylobacter jejuni</i>
Gram-positive pathogens <i>Listeria monocytogenes</i> , <i>Staphylococcus aureus</i> , <i>Bacillus anthracis</i> , <i>Clostridium spp.</i> , <i>Mycobacterium bovis</i> , <i>Streptococcus spp.</i>	
Parasites <i>Cystocercus bovis</i> , <i>Cystocerca ovis</i> , <i>Onchocerca spp.</i> , <i>Taenia saginata</i> , <i>Toxoplasma gondii</i>	
Viruses	
Prions	

In the present context, the hazards are controlled both by preventive and corrective actions. Preventive actions include vaccination such as the Brucellosis and Tuberculosis Eradication Campaign (BTEC) aimed at eradicating brucellosis and tuberculosis from all Australian cattle. Corrective actions include culling of carrier stock or of slaughtering diseased animals separately at the abattoir to prevent spread to healthy stock. Further corrective action is undertaken by on-line inspection of mammals to excise diseased tissues and organs and/or to exclude diseased animals.

In the case of poultry, preventive actions seem less well developed as evidenced by the recent outbreak of salmonellosis from *S. Typhimurium* PT 126 associated with diseased poults entering the state for on-growing. Clearly the processing regime in this case did not contain a Critical Control Point for preventing Gram-negative pathogens from contaminating final products.

### 3.3.4. Stockfeeds

Formulated feeds contaminated with *Salmonella* have been responsible for large-scale outbreaks of salmonellosis. A case in point is the spread in 1969 of *S. Agona* from fishmeal produced in Peru. Prior to this time *S. Agona* had been isolated only rarely in cases of salmonellosis. In the early 1970s, however, the serovar became a public health problem in Europe, USA and eastern-European countries, rising in some countries to be the second-most isolated serovar, after *S. Typhimurium*. In many countries, a similar peak in salmonellosis from contaminated feed was seen in the late-1970s, from *S. Hadar*.

Since these pandemics, there have been great improvements in the hygiene of rendered products and a comparison of salmonellae isolated from stock feeds in Australia and salmonellosis shows little concurrence (Table 12). The data indicate that those serovars most commonly isolated (83.9%) from animal feeds were involved in only 7.1% of human cases of salmonellosis acquired in Australia. On some occasions, serovars in feeds were not isolated from animal products (meat, poultry and eggs) during 2000.

Taken together, the above data do not implicate serovars in animal feeds with those in human salmonellosis. Nonetheless, it would be prudent for PIRSA to make an assessment of stockfeeds used in South Australia – both locally-produced and imported. If reliable company data for pathogen contamination exist, PIRSA could use that source, rather than investing in survey data.

Table 12: Serovars isolated from animal feeds, meat/poultry/eggs and patients in Australia (2000)

Serovar	Number of isolations				
	Feeds	Meat	Poultry	Eggs	Humans (%)
<i>S. Orion</i>	116	+	+	+	3 (0.07)
<i>S. Zanzibar</i>	64	+	+	-	27 (0.59)
<i>S. Anatum</i>	55	+	-	+	67 (1.46)
<i>S. Senftenberg</i>	39	-	+	-	30 (0.65)
<i>S. Ohio</i>	34	+	+	+	11 (0.24)
<i>S. Schwarzengrund</i>	30	-	-	-	7 (0.15)
<i>S. Infantis</i>	29	+	+	-	97 (2.11)
<i>S. Tennessee</i>	28	-	-	+	32 (0.70)
<i>S. Cerro</i>	25	-	-	+	5 (0.11)
<i>S. Mbandaka</i>	20	-	+	+	27 (0.59)
<i>S. Agona</i>	19	+	+	-	65 (1.41)
<i>S. Kiambu</i>	17	-	-	+	28 (0.61)
	476 (83.9%)				399 (7.1)

### 3.4. Risk profiling of meat and poultry products

#### 3.4.1. Microbial hazards

From the hazard identification phase (Section 3.3) was established the products most likely to cause disease, together with the microbial agents. Accordingly, risk profiles were generated for a number of hazard:product pairings, for which a summary is presented in table 13.

Table 13: Summary of risk rankings for pathogens in meat products

Hazard	Product	Risk ranking*
<i>L. monocytogenes</i>	Cooked, cured ham	45
	Sliced vacuum packed meat	51
	Pâté	39
Pathogenic <i>E. coli</i>	Controlled UCFM process	0
	Partially controlled UCFM process	54
<i>Salmonella</i>	Cooked processed chicken	55
<i>Campylobacter</i>	Cooked processed chicken	66

\* Every change in Risk Ranking of 6 units is equivalent to a 10-fold change in risk

Detailed risk rankings for *L. monocytogenes* in smallgoods are presented in Table 14, of *Salmonella* and *Campylobacter* in cooked chicken (Table 15) and of pathogenic *E. coli* in uncooked fermented meats (Table 16).

Rankings ranged from 39 (*L. monocytogenes* in pâté) to 66 for *Campylobacter* in chicken cooked in processing plants. A measure of the relative severity of the illness is that pâté consumption is predicted to result in one listeriosis every decade while there could be as many as 6000 campylobacterioses per annum and pathogenic *E. coli* may cause 46 illnesses/annum in young or aged people if the process is not controlled.

Table 14: Risk ranking of consumption of cooked, cured smallgoods containing *L. monocytogenes*

Risk criteria	Whole hams	Sliced, vacuum packed meat	Pâté
<b>Dose and severity</b>			
Hazard severity	Moderate	Moderate	Moderate
Susceptibility	General – all population	General – all population	General – all population
<b>Probability of exposure</b>			
Frequency of consumption	Monthly	Monthly	Few times
Proportion consuming	Most (75%)	Most (75%)	Some (25%)
Size of population	South Australian (1.5 million)	South Australian (1.5 million)	South Australian (1.5 million)
<b>Probability of contamination</b>			
Probability of raw meat contaminated	2% contaminated	2% contaminated	2% contaminated
Effect of processing	Reliably eliminates	Reliably eliminates	Reliably eliminates
Possibility of recontamination	Minor (1%)	10%	Minor (1%)
Post-process control	Well controlled – cold chain	Well controlled – cold chain	Well controlled – cold chain
Increase to infective dose	100,000x	100,000x	100,000x
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard	Not effective in reducing hazard
Predicted illnesses per annum in selected population	1	14	0.1
Risk ranking (0-100)	45	51	39

Raw meat contamination of 2% based on data from MLA baseline survey (1995)

Recontamination levels based on estimates in MLA risk assessment of *L. monocytogenes* in smallgoods (in preparation, University of Tasmania)

Higher levels in sliced products reflect increased surface area and handling

Increase to infective dose based on FAO/WHO risk assessment (FAO paper 71, 2000), which suggests a probability response, around  $10^7$  organisms.

Table 15: Risk ranking of consumption of chicken cooked in processing plants containing *Salmonella* or *Campylobacter*

Risk criteria	<i>Salmonella</i> in cooked chicken	<i>Campylobacter</i> in cooked chicken
<b>Dose and severity</b>		
Hazard severity	Moderate	Moderate
Susceptibility	General – all population	General – all population
<b>Probability of exposure</b>		
Frequency of consumption	Weekly	Weekly
Proportion consuming	Most (75%)	Most (75%)
Size of population	South Australian (1.5 million)	South Australian (1.5 million)
<b>Probability of contamination</b>		
Probability of raw meat contaminated	25% contaminated	50% contaminated
Effect of processing	Eliminates 99%	Eliminates 99%
Possibility of recontamination	Minor (1%)	1%
Post-process control	Well controlled – cold chain	Well controlled – cold chain
Increase to infective dose	10,000x	100x
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard
Predicted illnesses per annum in selected population	60	6000
Risk ranking (0-100)	55	66

Prevalence of *Salmonella* for poultry is based on personal communication from Jeff Fairbrother (2002). It should be noted that the majority of salmonellas in raw poultry are *S. Sofia* which has low virulence and was responsible in 2001 for 17 cases of salmonellosis in Australia.

Prevalence of *Campylobacter* in poultry based on data for NSW product presented to Meat Standards Committee by Stuart King (2000).

Recontamination figures are estimates only.

Data used in increase to infective dose are based on 100g consumption of product with a low concentration (1-10 organisms/g). Infective doses for non-vulnerable consumers are around 105/g for *Salmonella* and 103/g for *Campylobacter* (see “Foodborne micro-organisms of public health significance, 1997, AIFST, Sydney).

Table 16: Risk ranking of consumption of uncooked fermented meat containing pathogenic *E. coli*

Risk criteria	Reliable process	Unreliable process
<b>Dose and severity</b>		
Hazard severity	Moderate	Moderate
Susceptibility	Children and aged	Children and aged
<b>Probability of exposure</b>		
Frequency of consumption	Monthly	Monthly
Proportion consuming	Some (25%)	Some (25%)
Size of population	South Australian (1.5 million)	South Australian (1.5 million)
<b>Probability of contamination</b>		
Probability of raw meat contaminated	0.1% contaminated	0.1% contaminated
Effect of processing	Reliably eliminates (100%)	Eliminates 99%
Possibility of recontamination	None	None
Post-process control	Well controlled	Well controlled
Increase to infective dose	Zero	Zero
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard
Predicted illnesses p.a. in selected population	0	46
Risk ranking (0-100)	0	54

Risk tool automatically selects a proportion of the South Australian population which is vulnerable.

Consumption data are assumptions.

Contamination level (0.1%) is based on MLA baseline study (1994), which was 0.38%, reduced to take into account lower microbial levels established by the second baseline study (1998).

In the reliable process, maturation temperature and time give a 3-log reduction; in the unreliable process maturation is not completely effective

Increase to infective dose is based on low levels of *E. coli* O111 established in Garibaldi mettwurst (1995).

### 3.5. Risk context for PIRSA

Based on the Risk Rankings established in section 3.5, it is clear that risk is concentrated in one sector of the SA meat industry – the smallgoods sector. It is obvious that meat consumed as cuts, roasts, chops, steaks etc receives a cooking step which is biocidal for all microbial hazards other than spore-formers. Providing it is eaten soon after cooking meat will be a very low risk product. In the catering sector *Clostridium perfringens* will continue to present a problem which is not part of the PIRSA responsibility.

#### 3.5.1. *L. monocytogenes* in cured and cooked meats

Risk rankings vary from 39 (pâté), via 45 for whole hams to 51 for sliced vacuum-packed meats. Each operation claims a cooking step which delivers a 5-log reduction in *L. monocytogenes* as a CCP. Thus post-cooking, products should be *Listeria*-free. The cooking temperature and time are relatively straightforward to validate and verify (see Guidelines for Smallgoods Manufacture, MLA, 2002).

By contrast, recontamination of processed meats by *L. monocytogenes* is extremely difficult to control, especially in sliced processed meats. In the state's small plants which manufacture cooked, cured products, meat is usually sliced to order, which minimises the likelihood of an infective dose. By contrast, in vacuum packed sliced meats sold via supermarkets the likelihood of elevated levels of *L. monocytogenes* is increased by the long shelf-life required by supermarkets.

*Recommendation 1: PIRSA should increase the rigour surrounding validation of Critical Control Points (CCPs) for listeriocidal processes in the HACCP plans of the state's smallgoods plants. PIRSA's contract auditors are familiar with process control and are capable of undertaking a review of each plant's CCPs.*

Recommendation 2: PIRSA should critically evaluate microbiological testing data contained in a review of meat processing in the state to assess the relative effectiveness of Good Manufacturing Processes for control of *L. monocytogenes* of smallgoods operations.

#### 3.5.2. Gram-negative pathogens in cooked chicken

Risk Rankings for *Salmonella* and *Campylobacter* in chicken which is cooked and further processed by smallgoods plants are 55 and 66, respectively with a predicted annual illness of 6000 associated with the latter organism. From the industry perspective some argue that there is no CCP in the slaughter and dressing process for preventing either *Salmonella* or *Campylobacter* contamination of raw poultry. Others may cite chilling and/or chlorination as a CCP.

*Recommendation 3: PIRSA should evaluate the scientific evidence for spin chilling being a CCP. The Codex definition requires that a CCP prevents, eliminates or reduces the hazard to an acceptable level and these criteria provide sufficient rigour for an assessment.*

It is generally believed that the vast majority of salmonellosis and campylobacteriosis occur by recontamination of cooked products in the home and food service sectors. Thus responsibility for illness from Gram-negative pathogens is shared by PIRSA (in the processing and transport sectors) and DHS (in the home and food service sectors).

*Recommendation 4: PIRSA should engage DHS in a co-operative approach to managing risks of Gram-negative pathogens in raw and cooked poultry. This co-operation should have measurable management indicators.*

### **3.5.3. Gram-negative pathogens in uncooked fermented meats**

Uncooked fermented meats from SA manufacturers have been associated with numerous recalls and food poisoning incidents from Gram-negative pathogens (*Salmonella* and pathogenic *E. coli*).

*Recommendation 5: PIRSA should undertake a comprehensive review of processes in the smallgoods industry centred on:*

- (5a) Validation of all processes both for uncooked and cooked fermented sausages manufactured in the state. This should be based on FSANZ recommendations surrounding, raw material quality, a process delivering a 3-log reduction in generic *E. coli* plus final product in which *E. coli* is not detected in a defined mass of product (0.1g or 1g).*
- (5b) A review of processes for spreadable sausages such as Teewurst.*
- (5c) Resolve the anomaly where regulation of smallgoods is the responsibility of DHS yet the audit of plants and processes is the responsibility of PIRSA.*

The consequences of not reviewing and controlling processes may be seen from Table 16 where an effective process delivers a Risk Ranking of 0, compared with one which delivers a 99% effective process (RR = 54) with predicted associated illness among infants and the aged of 14 per annum.

### **3.5.4. Primary hazards in livestock and poultry**

At present, PIRSA does not address, in a pre-emptive manner, disease characteristics of livestock and poultry, both locally produced and imported. Neither are contaminants in stockfeed routinely investigated.

*Recommendation 6:*

*PIRSA should establish a task force to identify existing processes and controls surrounding primary hazards in livestock and poultry production. The task force should include stockfeed within its remit.*

### **3.5.5. Egg production and processing**

There are epidemiological linkages between pathogens in eggs and foodborne illness to which PIRSA should respond.

*Recommendation 7:*

*PIRSA should establish a task force to survey egg production and processing in South Australia with a focus on prevalence of pathogens, particularly *Salmonella*. Depending on the outcome of the survey control measures should be developed to embrace a pathogen reduction program.*

## **References**

Crerar, S., Dalton, C. Longbottom, H. and Kraa, E. (1996) Foodborne disease: current trends and future surveillance needs in Australia. *Medical Journal of Australia*, 165:672.

Appendix 1: Recalls of meat products recorded by FSANZ 1990-2001

States involved in recall	Product	Cause
<b>1990</b>		
WA	Pastrami	<i>L. monocytogenes</i>
<b>1993</b>		
SA	Pâté	Mould
<b>1994</b>		
SA	Mettwurst	<i>Salmonella</i>
<b>1995</b>		
SA	Garlic mettwurst	<i>E. coli</i> O111
National	Pepperoni	Precautionary
Tasmania	Salami	Precautionary
SA	Pizzas with pepperoni	Precautionary
National	Pizzas	Precautionary
Vic, NSW, SA, ACT	Salami	<i>Salmonella St. Paul</i>
WA	Mettwurst	<i>E. coli</i> O157
<b>1996</b>		
Vic	Diced, cooked chicken	<i>L. monocytogenes</i>
<b>1997</b>		
Vic, Tas, SA, Qld	Cooked meats	<i>S. Muenchen</i>
Vic, Tas, Qld	Cooked meats	<i>S. Anatum</i>
National	Liverwurst, Kabana	<i>S. Adelaide</i>
NSW, ACT	Fresh sausage	Metal
Vic	Fresh sausage	Metal and glass
Tasmania	Ham	Plastic
Qld, NSW	Kabanas	Metal and plastic
WA	Minced meat	Metal
Qld, NSW	Fresh sausage	Metal
WA	Sliced silverside	<i>L. monocytogenes</i>
WA	Bacon	Metal
<b>1998</b>		
National (except WA)	Liverwurst	Undercooked
SA, Qld, Vic	Chicken nuggets	Labelling
<b>1999</b>		
WA	Teewurst	<i>E. coli</i>
WA	Salami	<i>E. coli</i>
WA	Polony	<i>L. monocytogenes</i>

Vic	Sliced meat	Chemical odour
WA	Kransky	Plastic
WA	Salami	Microbiology
Qld	Steakettes	Metal
<b>2000</b>		
NSW, Qld, Vic	Cooked chicken meat	<i>L. monocytogenes</i>
NSW, Qld	Cooked chicken meat	<i>L. monocytogenes</i>
Vic	Fresh sausage	Metal
NT, SA	Minced meat	Plastic
Qld	Silverside	<i>L. monocytogenes</i>
<b>2001</b>		
WA, SA, NT, Vic	Silverside	<i>L. monocytogenes</i>
Qld, NSW, ACT, Vic, SA	Ham	<i>L. monocytogenes</i>
Vic	Chicken curry	Undercooked
Qld	Ham	<i>L. monocytogenes</i>
	Chicken nuggets	Plastic

### Commentary for some meatborne incidents

1990

September, Western Australia. An outbreak of listeriosis occurred among pregnant women at King Edward Memorial Hospital for Women. There were six still-births among eleven recognised cases. *Listeria monocytogenes* was isolated from cooked diced chicken and a number of processed meats. Pâté was implicated, and together with pastrami from the same manufacturer were withdrawn from sale.

1991

February, South Australia. Up to 104 victims, initially advised after a wedding party, Coincidental to that investigation, a number of cases were reported from the wider community. The investigations implicated salami as the source. *Salmonella* Anatum was isolated from faecal samples provided by victims, and was also found in samples of the salami. Samples obtained from the manufacturer's premises found several other serovars of *Salmonella* in various salamis.

1992

March, Western Australia. An unusually high level of reports of *S. Typhimurium* led to an investigation. Coincidentally, samples of salami implicated in another case had been submitted for analysis, and focussed attention on smallgoods. A microbiological survey of smallgoods was initiated, and further investigations of other cases focussed attention on a particular brand of smallgoods. Samples from a particular manufacturer were found to be positive and a recall instituted. The presence of *S. Typhimurium* in felino salami was

confirmed, and phage typing linked the strain (“RNDS (WA2)”) to the human cases. *Salmonella* Anatum was also found in one salami sample.

1994

October. South Australia – outbreak (14 cases) of *Salmonella* Enteritidis phage type 4, associated with consumption of fresh pork sausage.

1995

December ‘94/January 1995. Australia’s first documented case of HUS caused by *E.coli* O111. 23 children aged from 14 months to 14 years developed HUS from the consumption of contaminated mettwurst, including one death. Around 150 other people suffered gastroenteritis.

1996

March, Brisbane. An outbreak of bloody diarrhoea associated with *Escherichia coli* O157 infection in young children on the Gold Coast. This outbreak was the first involving the O157 serotype in Australia. Fifty-seven people were screened and *E. coli* O157 was isolated from six people, all of whom had consumed different food items from a delicatessen. No single food item was identified as the source of the infection. One of the food handlers was positive for *E. coli* O157. This person had prior contact with an animal that showed clinical signs of infection, but it is also possible that a contaminated food product entered the delicatessen and contaminated other food products during handling. Therefore, cross contamination within the delicatessen was a likely factor in the transmission of this disease.

June, Melbourne. An outbreak of diarrhoea affected at least 33 of 58 people who attended a luncheon. After investigation it was concluded that *Clostridium perfringens* intoxications probably caused the outbreak, the result of temperature abuse of a meat cooked the day before the luncheon

September, South Australia. Five cases of patients in an Adelaide hospital (one outpatient) were reported to have systemic (haematological) infections. All were immunocompromised. All had eaten chicken sandwiches from the hospital. The sandwiches contained diced chicken from a commercial supplier. Low counts of *L. monocytogenes* 01 were obtained from samples of the diced chicken, and the premises where the chicken was prepared. The strains were shown to be the same as the disease strain. One of the victims died.

December, South Australia. 71 confirmed cases of *Salmonella* Typhimurium PT 135 were firmly linked to the consumption of bread rolls with a meat filling distributed through local Asian grocery stores from a home-based manufacturer.

1997

Early months, Victoria. A series of salmonellosis outbreaks occurred involving cooked meat products:

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Lago Smallgoods	Corned Silverside	<i>S. Muenchen</i>	24 ill, 2 deaths
World Hot Bread Shop	Meat Rolls	<i>S. Typhimurium</i> 1	>700 ill, 21 requiring

				hospitalisation
Hop Ky Restaurant	Unknown	<i>S. Typhimurium</i>	43	7 ill, possibly 1 death
Fabbris Smallgoods	Corned Silverside  Leg Ham Virginia Ham	<i>S. Anatum</i>		25 ill
Safeway	Unknown	<i>S. Chester</i>		5 ill

1998

April, Adelaide. Salmonellosis amongst guests at a wedding feast was investigated. Of the 58 attendees interviewed 38 (66%) subsequently developed gastrointestinal symptoms. Stool cultures from 7 cases grew *Salmonella* Typhimurium RDNC A045. Food samples were culture-negative for *Salmonella* spp. A cohort study implicated spatchcock.

2000

January, Adelaide. Six cases of *Salmonella* Typhimurium RDNC ('Reacts Does Not Conform') A047 all of whom resided in the same geographical area (age range from one to 77 years (median age 38 years) were epidemiologically linked with the consumption of food prepared at a local Chinese restaurant. Common foods consumed by all cases included prawn chips; spring rolls, special fried rice, roast pork plum sauce and chicken and sweet corn soup. Subsequent microbiological sampling on fresh and pre-prepared foods and equipment and environmental surfaces was negative.

October, South Australia. Eleven cases of salmonellosis, one of whom reported a history of overseas travel. Of the remaining ten (6 female, 4 male) cases, the age range was 16 to 80 years. Cases were reported from both metropolitan and rural areas of South Australia. All ten cases reported eating at an Adelaide metropolitan restaurant between the 4 and 7 October 2000. One urine and nine stool specimens obtained from cases were positive for *Salmonella* Typhimurium phage type 44. There were no reports of gastrointestinal illness in restaurant employees. A case-control study suggested de-boned roast pork and apple sauce as two possible vehicles for the infections. Although the source for this outbreak was not established, patrons reported lapses in restaurant hygiene practices. These included the presence of insects in the restaurant environment and flies in prepared food and drinking water.



## 4. Risk Profiles of Milk and Dairy Products in South Australia

### 4.1. Dairy production in South Australia

In 2000-01 the South Australian dairy industry produced almost 700,000,000L of cow's milk from almost 630 dairy farms spread across the state. Of this total, 205,000,000L are manufactured into a range of white and flavoured liquid milk products and 275,000,000L into cheese; around 1,500t of butter was manufactured. Liquid milk (220m litres) was also shipped interstate to dairy factories in western Victoria.

In 2001 the state had eight producers of unpasteurised milk; four farms produced 40,000t of goat's milk and a further four farms 80000L cow's milk. Products were retailed mainly in the Adelaide Hills and health food shops in the metropolitan area.

The state exported \$44m dairy products to overseas markets, including 6,000,000L UHT milk, 10,000t processed cheese, 1,360t butter and 320t of other products. Some \$18m of dairy products and \$29m of processed milk (18,000,000L) were exported interstate. In 2000-01 the state imported \$39m of dairy products from overseas.

It is estimated that each year, South Australians consumed 165,000,00L of processed milk, 16,000t of cheese, 4,000t of butter and 5,000t of other dairy products.

### 4.2. Hazard identification

There have been very few documented food poisonings from dairy products in Australia since the salmonellosis which emanated from milk powders manufactured in Victoria in the late-1970s. Crerar *et al.* (1996) surveyed food poisonings over the period 1980-1995 and documented only two connected with dairy foods – two incidents of salmonellosis from deep-fried ice cream, though it was possible that these emanated from the breadcrumbs, which coated the ice cream.

Since 1995 only one documented case from dairy products can be found on the Communicable Diseases Intelligence database – *S. Oranienberg* in gelati in South Australia. The South Australian database, however, contains two outbreaks from unpasteurised milk, a salmonellosis involving 11 people in 1999 and a campylobacteriosis involving 12 consumers in 2000 (Table 1). Two further outbreaks from unpasteurised milk were registered by OzFoodNet (Kirk, 2002).

Table 1: Causes of dairy-borne outbreaks in Australia, 1996-2001

Organism	State	Cases	Outbreaks	Cause
<i>Salmonella Oranienberg</i>	SA	102	1	Gelati
<i>Salmonella Typhimurium</i> PT 44	SA	11	1	Raw milk
<i>Campylobacter</i>	SA	12	1	Raw milk

<i>Cryptosporidium</i>	Qld	6	1	Raw milk (pet cow)
<i>Campylobacter</i> (suspected)	Vic	6	1	Raw milk (suspected)

In Table 2 an additional means of characterising risk may be assessed from product recalls monitored by FSANZ during the period 1990-2001. In all, there were 64 recalls of dairy products, mainly involving cheese (20 recalls), liquid milk (18) and ice cream (13).

Reasons for the recalls were microbiological in 43/64 (67%) cases, with foreign matter 13/64 (20%) and chemical contamination 8/64 (12%) making up the remainder (Table 3). A full listing of all recalls is included as Appendix 1.

Table 2: Recalls of dairy products as monitored by FSANZ (1990-2001)

Product category	Number of recalls
Cheese	20
Butter	1
Cream	4
Milk	18
Yoghurt	5
Ice cream	13
Cream cheese	1
Custard	1
Milk powder	1
Total	64

Table 3: Recalls of dairy products as monitored by FSANZ (1990-2001)

Cause of recall	Number
Contamination - detergent	4
Contamination - chemical	4
Foreign matter	13
Spoilage	11
<i>E. coli</i>	8
<i>L.monocytogenes</i>	20
<i>Salmonella</i>	3
<i>S. aureus</i>	1
Total	64

Based on the foregoing hazard identification, pathogenic *E. coli* in unpasteurised milk is of special significance in South Australia.

Chemical hazards have caused recalls, usually because of problems associated with cleaning. There is the possibility of chemicals entering milk via environmental and

veterinary sources. All states participate in the Australian Milk Residue Analysis Survey which covers:

- Antimicrobials
- Triclabendazole
- Organochlorines, organophosphates, synthetic pyrethroids and polychlorinated biphenyls

In the last two surveys (July 1999-June 2001) no sample of South Australian milk (total 81) tested positive for any of the above criteria.

In terms of veterinary chemicals (especially antibiotics) the dairy industry undertakes its own testing, particularly at cheese plants, because of the inhibitory effect of antibiotics on starter cultures.

Based on the foregoing, chemical residues have not had any public health impact from milk and dairy products and the participation of the state in residue surveys is likely to reveal any problems in this area.

### 4.3. Risk profiling

From the hazard identification phase (Section 4.2) was established the dairy products most likely to cause illness, together with the microbial agents. Accordingly, a risk profile was established for pathogenic *E. coli* in unpasteurised milk and, for comparison, with pasteurised milk (Table 4).

Table 4: Risk rankings of HUS from consumption of unpasteurised and pasteurised milk

Risk criterion	Unpasteurised milk	Pasteurised milk
<b>Dose and severity</b>		
Hazard severity	Severe	Severe
Susceptibility	General – all population	General – all population
<b>Probability of exposure</b>		
Frequency of consumption	Daily	Daily
Proportion consuming	All (100%)	All (100%)
Size of population	1,000 consumers	South Australian (1.5 million)
<b>Probability of contamination</b>		
Probability of raw product contaminated	0.01%	0.0000001%
Effect of processing	No effect	Reliably eliminates
Possibility of recontamination	None	None
Post-process control	Well controlled	Well controlled
Increase to infective dose	None	10x
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard

Total predicted illnesses per annum in selected population	36	0.05
Risk ranking (0-100)*	77	43

\* Every change in Risk Ranking of 6 units is equivalent to a 10-fold change in risk

Assumptions used in constructing the risk rankings

- Raw milk is consumed daily by 1,000 consumers, each of whom consumes a 250mL serving.
- Pasteurised milk is consumed daily by all of South Australia's 1.5 million consumers.
- Raw milk has a prevalence of pathogenic *E. coli* of 0.01%. DASA testing has shown the presence of Shiga toxin genes in raw milk.
- In unpasteurised milk this prevalence is unchanged and a 250mL serve contains sufficient pathogens to cause infection
- During the heat stage of pasteurisation the hazard is completely eliminated but is recontaminated during cooling
- In pasteurised milk a 10-fold increase is needed to achieve an infective dose because the count/mL will be lower than that in unpasteurised milk.

Based on these assumptions, consumption of unpasteurised milk has a risk ranking of 77, with 36 predicted illnesses per annum among the 1,000 consumers.

For pasteurised milk the risk ranking is 43 (there are 500 million serves per annum in the State) and there is one predicted illness every 20 years. The model is conservative for pasteurised milk as a proportion is consumed with some heat treatment, in beverages or in cooking. The epidemiology of raw and pasteurised milk consumption in South Australia is broadly supportive of the model's predictions.

#### 4.4. Risk context for DASA

From the Hazard Identification phase of this study it can be seen that, over the past three decades, dairy products have not caused documented food poisonings with the exception of two mentioned by Crerar *et al.* (1996) and three associated with South Australia. This undoubtedly reflects the uptake of quality and food safety systems which integrate dairy farms, transport and processing. The dairy industry was the first Australian food sector to install HACCP systems in its processing plants which, in turn, have traditionally imposed food safety parameters on farm supplies.

The South Australian dairy industry has adopted the same food safety controls and disciplines as other states and the results are obvious from the generally low bacterial counts obtained in raw milk. The DASA annual report provides summaries of monitoring programs for chemical and microbial residues in milk. The Authority also monitors the HACCP systems of individual plants within its jurisdiction.

##### 4.4.1. Unpasteurised milk sales in SA

There is only one area where the South Australian dairy industry bears any unusual risk and that is bound up with state legislation which allows the sale of unpasteurised milk (cow, goat and sheep). As indicated in Table 4, the risk ranking of pathogenic *E. coli* in

unpasteurised milk is 77, with predicted annual illness of 36, among a group of 1,000 consumers.

Given that consumption of unpasteurised milk is an emotive issue it is necessary to document the role of this product in illness both within the state and internationally. In Table 5 is presented outbreaks of illness and number of cases from consumption of unpasteurised or improperly pasteurised milk in United Kingdom (1987-89 and 1992-96). During the seven years surveyed there were more than 1,200 cases of illness and at least two deaths following consumption of milk which had either not been pasteurised or had been improperly pasteurised. Salmonellosis and campylobacteriosis were by far the most prevalent causes of illness.

Table 5: Outbreaks of illness following consumption of unpasteurised and improperly pasteurised milk (Anon. 1995; Sockett, 1991 and Djuretic *et al.*, 1997)

Unpasteurised milk	Organism	Outbreaks	Cases (deaths)
	<i>Salmonella</i>	12	122
	<i>Campylobacter</i>	11	484
	Pathogenic <i>E. coli</i>	1	7
	<i>Streptococcus zooepidemicus</i>	1	(2)
Improperly pasteurised milk			
	<i>Campylobacter</i>	4	650
	<i>Salmonella</i>	2	70
	Pathogenic <i>E. coli</i>	1	6

In Table 6 are documented illness and death associated with global consumption of cheeses between 1983 and 1997; none of the outbreaks occurred in Australia. Over the 15-year period more than 6,600 consumers became ill, 95 of whom died after consuming cheese either made entirely from unpasteurised milk or from a mixture of pasteurised and unpasteurised milk. Over the same period there were 184 illnesses and no deaths from cheese made from pasteurised milk. The difference in servings between cheeses made from pasteurised *versus* unpasteurised/improperly pasteurised milk is not know but is expected to favour heavily the former.

Consumers of unpasteurised milk and dairy products cite two factors in support of their practice:

- They prefer unpasteurised milk on sensory and nutritional grounds
- They should be allowed to decide whether or not to continue drinking raw milk

As well, suppliers of the product invariably claim that they drink the product and have never been ill (a claim made by suppliers of all food products, not just dairy).

While it is generally accepted that consumption of unpasteurised and pasteurised milk has no significant effect on the nutritional plane of the consumer, the claims regarding sensory quality and absence of illness cannot be assessed.

Table 6: Illness and death following global consumption of cheese made from unpasteurised milk (Anon., 1998)

Milk source	Organism	Outbreaks	Cases (deaths)
Unpasteurised	<i>Salmonella</i>	6	3,164 (7)
	<i>Listeria</i>	4	284 (86)
	Pathogenic <i>E. coli</i>	4	3,023 (1)
	<i>S. aureus</i>	1	13
	<i>Brucella mellitus</i>	1	135 (1)
Pasteurised	<i>Salmonella</i>	2	174
	<i>Brucella mellitus</i>	1	11

In several aspects, for the Dairy Authority of South Australia, the continued consumption of unpasteurised milk represents a significant risk. This risk is posed by a small number of producers with an output of 120,000L, equivalent to approximately 500,000 servings per annum, each of 250mL. The risk is borne, however, by the state dairy industry as a whole which has an annual value to the state around \$530 million.

The Authority is placed in a difficult position by current legislation allowing production and sale of unpasteurised milk because there are no known scientific or technological strategies which can be pursued to mitigate the high risk rating of unpasteurised milk and products.

The Authority seeks to control the food safety risk in two ways via:

- On-farm HACCP plans
- A microbiological testing regime

The effectiveness of these measures merits attention and it is recommended that the Authority:

- Undertakes a scientific assessment of the HACCP plans of suppliers of unpasteurised milk to ensure there is a validated Critical Control Point (CCP) to prevent contamination of milk by pathogens during milking.
- Confirms that a CCP (if identified) is properly monitored.
- Commissions a statistical evaluation of the microbiological sampling plan for testing unpasteurised milk to ensure the program provides a high level of confidence that contaminated milk is not being drawn and offered for sale.

In making the assessment the Authority should take into account:

- Producer and consumer risks associated with the Operational Characteristics curve of the sampling plan.
- Difficulty in isolating *Campylobacter* from food samples
- Whether the sample size is adequate to detect pathogens given the attendant risk of failure
- That outbreaks of salmonellosis (1999) and campylobacteriosis (2000) from unpasteurised milk occurred while the sampling program was operated

The Authority may view with interest the following statement to the Minister for Agriculture by the Richmond Committee into the Microbiological Safety of Food in the United Kingdom: *Having considered milk and milk product manufacture in detail the Committee now reports the strongly held view that consumption of untreated milk is hazardous. The hazard primarily concerns Salmonella and Campylobacter infections; however we note that a particularly serious outbreak occurred as a result of contamination of raw milk with Streptococcus zooepidemicus; twelve people were admitted to hospital , of whom eight died.... This episode well illustrates why we are concerned at the continuing consumption of raw milk.* (Anon, 1990).

## References

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### Appendix 1: Dairy recalls 1990-2001 monitored by FSANZ

States involved in recall	Product	Cause
<b>1990</b>		
	Skim milk	<i>Lactobacillus</i> contamination
	UHT flavoured milk	Non sterile
	White milk	High coliforms
<b>1991</b>		
	Ice cream cakes	<i>Salmonella</i>
	Thickened cream	Dieldrin
	Havarti cheese	<i>L. monocytogenes</i>
	UHT flavoured milk	<i>B. cereus</i>
<b>1992</b>		
Qld	Ice cream	<i>L. monocytogenes</i>
	White milk	Taint
<b>1993</b>		
WA	Ambrosia cheese	<i>L. monocytogenes</i>
	White milk	<i>L. monocytogenes</i>
<b>1994</b>		

Qld	Low fat milk	Contamination
National	Cheese	Plastic
Qld, NSW, NT	Flavoured milk	Spoilage
	Fruit yoghurt	Foreign matter
<b>1995</b>		
NSW	Milk powder	<i>S. Anatum</i>
Qld, NT	Cheese	Spoilage
Vic, SA, Qld	Cheese	<i>L. monocytogenes</i>
All except WA	Yoghurt	Glass
Tas, Qld	Cheese	<i>L. monocytogenes</i>
ACT	White milk	Glass
WA, SA, Qld	Ice cream	<i>E. coli</i>
NSW, ACT, Qld	Mozzarella cheese	<i>L. monocytogenes</i>
SA	Ice cream	<i>L. monocytogenes</i>
Vic, NSW, ACT	Ice cream	<i>L. monocytogenes</i>
<b>1996</b>		
NSW	Fetta cheese	<i>L. monocytogenes</i>
All except SA	Ice cream	Contamination - mercury
NSW	Soft cheese	<i>E. coli</i>
NSW, ACT	Cream cheese	Metal
Qld	Low fat milk	Contamination - detergent
<b>1997</b>		
All except Qld	Mozzarella cheese	Plastic
Vic	Salamina cheese	<i>L. monocytogenes</i>
SA, Vic	Thickened cream	<i>L. monocytogenes</i>
Vic	White milk	Contamination – detergent
All	Ice cream	Lead, cadmium
Vic	Butter	Metal
All	Cheese	Plastic
Vic	White milk	Spoilage
<b>1998</b>		
SA, NT	Gelati	<i>S. Oranienberg</i>
NSW, Qld	Ice cream	Metal
<b>1999</b>		
WA	Raw goat's milk, cheese	High bacterial count
NSW, Vic	Thickened cream	<i>L. monocytogenes</i>
Vic	Cheese	<i>L. monocytogenes</i>
All except WA	Ice cream	Contamination – detergent
National	Yoghurt	Almonds – not labelled
NSW	Cheese	<i>S. aureus</i>
ACT, NSW	White milk	<i>L. monocytogenes</i>

WA	Cream	<i>E. coli</i>
<b>2000</b>		
All	UHT flavoured milk	Spoilage
WA	Fetta cheese	<i>E. coli</i>
WA	Yoghurt	<i>E. coli</i>
All	Fruche	Metal
All	Cheese	Plastic
Vic	Cheese	<i>L. monocytogenes</i>
WA	UHT milk	Spoilage
NSW, Qld	Ice cream	Metal
<b>2001</b>		
Vic	Cassata	<i>L. monocytogenes</i>
All	Cheese	<i>E. coli</i>
Qld	Flavoured milk	<i>L. monocytogenes</i>
WA	Fetta	<i>E. coli</i>
NSW	White milk	Contamination - detergent
Vic	Flavoured milk	<i>L. monocytogenes</i>
Qld, NSW	Custard	<i>L. monocytogenes</i>
WA, NSW	Ice cream	Plastic

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# 5. Risk Profiles of Horticulture Products in South Australia

## 5.1. Production of horticulture products in SA

In 2000-01, the SA horticulture industry produced almost 900,000t of product (excluding wine grapes) with a farm gate value of almost \$500 million (Table 1).

Table 1: Production and value of South Australia horticulture products (2000-01)

Product	Volume (t)	Farm Value (\$m)
Almonds	6,840	30.7
Apples	30,400	22.8
Pears	8,000	5.4
Citrus	252,000	123.4
Avocados	1,200	2.4
Melons	4,200	3.1
Other Berries	22	0.3
Strawberries	2,375	10.4
Cherries	1,202	7.2
Peaches	7,800	8.5
Plums/Prunes	4,500	7.2
Nectarines	2,900	6.2
Apricots	12,800	18.5
Potatoes	330,000	99.0
Onions	86,000	38.7
Carrots	35,000	8.7
Pumpkin	5,800	1.7
Beetroot	120	0.07
Broccoli	2,000	2.8
Cabbage	4,800	1.2
Cauliflower	4,600	2.7
Brussels Sprouts	2,750	1.6
Lettuce	5,000	3.5
Spinach	2,000	1.2
Tomatoes	24,000	24.0
Grapes (other than wine grapes)	20,000	14.0
Table olives	650	1.1
Olives for Oil	4,750	3.0
Cucumbers	16,000	16.0
Asparagus	123	0.05
Beans (French & Runner)	43	0.04

Capsicum (inc Chillies)	7,000	11.2
Celery	5,400	3.3
Spring Onions	345	0.5
Sweet Corn	956	0.4
Zucchini, Marrows, Squash	128	0.2
Parsnips	610	0.8
Mushrooms	4,160	15.8
<b>Total</b>	<b>896,474</b>	<b>497.7</b>

Within the State, a number of companies process horticulture products, some of which are included in Table 2.

Table 2: South Australian processors of horticulture products

Company	Products
<b>Salads, vegetables</b>	
Barker Boys Processing	Prepared vegetables for the food processing industry
Daily Fresh Vegetable Processing	Fresh cut potatoes
All Seasons Vegetable Processors	Fresh cut vegetables
Rainbow Fresh	Fresh cut salads
Springfresh Salads	Salads for foods service sector
<b>Sprouted seeds</b>	
Star Tu	Mung beans
Sunshine Sprouts	Various seeds
Montena	Various seeds
<b>Living herbs (sold with roots intact in poly sleeves)</b>	
Hollafresh	
Herbivorous	
<b>Horseradish</b>	
B J Meakins	Ground horseradish roots
<b>Fruit juices</b>	
Auldwood Pty Ltd	Apple juice
Berri Ltd	Range of fruit juices
Crusta Fruit Juices Pty Ltd	Fruit juices
Nippy's Natural Fruit Juices	Fruit juices

## 5.2. Hazard identification

Hazards associated with horticultural products may be assessed from four sources:

- Implicated in food poisoning outbreaks in Australia
- Imported products failing inspection criteria
- Recalls monitored by FSANZ
- Overseas outbreaks caused by horticulture products

### 5.2.1. Australian outbreaks

Outbreaks associated with horticulture products in Australia (Table 3) indicate that salmonellosis was by far the most common illness contracted from horticulture products. One outbreak was of South Australian origin when more than 500 consumers of unpasteurised orange juice became ill.

Table 3: Food poisoning outbreaks associated with horticulture products

Year	Product	Pathogen	Cases (Deaths)
1990	Unpasteurised orange juice	Norwalk virus	>3,000
1996	Peanut butter	<i>S. Mbandaka</i>	Several hundred (1)
1999	Unpasteurised orange juice	<i>S. Typhimurium 135as</i>	502
2001	Peanuts	<i>S. Stanley</i>	27
2001	Salad	Norwalk virus	25
2001	Iceberg lettuce	<i>S. Bovismorbificans 32</i>	36
2001	Helva (imported)	<i>S. Typhimurium DT 104</i>	23

### 5.2.2. Import inspections testing

Products failing import inspection tests during the period 1995-99 were spices, coconut and peanuts, with limits for *Salmonella* and aflatoxin being exceeded (Table 4).

Table 4: Horticulture products failing import inspection tests (1995-99)

Product	Cause of failure	Criterion failed	Failure (%)	Tests (number)
Peanuts	Aflatoxin	15mg/microgram	7.1	1,438
Paprika	<i>Salmonella</i>	Not detected in 25g	4.5	369
Pepper	<i>Salmonella</i>	Not detected in 25g	1.6	1,584
Coconut	<i>Salmonella</i>	Not detected in 25g	0.8	524
Cinnamon	<i>Salmonella</i>	Not detected in 25g	0	102

### 5.2.3. FSANZ-monitored recalls

Over the period 1990-2001, there were 81 recalls of horticulture products monitored by FSANZ, a proportion of which were imported products (Table 5). The causes of recall were microbiological in 45/81 (56%) of cases, foreign matter in 18/81 (22%) with chemical and labelling defects accounting for the remainder. Note that recalls associated with canned fruits and vegetables where the cause was a canning defect *per se* have not been included. Details are supplied in Appendix 1.

#### 5.2.4. Overseas outbreaks

There have been numerous outbreaks of food poisoning outside Australia involving horticulture products leading to a worldwide level of concern, which has been manifested by several important developments.

In October 2001, the Codex Committee on Food Hygiene (CCFH) developed draft codes of hygienic practice for fruits and vegetables: one focused on primary production and the other on processed products. The Codex Committee also focused on sprouts with a draft code on "Sprout production". In 2002, the European Commission released a risk profile on microbiological contamination of fruits and vegetables eaten raw.

Within Australia, in May, 2002 the Technical Advisory Group of the Food Regulations Standing Committee considered food safety regulations relating to sprouts. The FSANZ have written to AFFA raising concern at the fact that a recent outbreak of salmonellosis from sprouts in the USA was caused by contaminated seeds from Australia. The Food Authority expressed its concern that contaminated sprouts could be sold in Australia and termed them a high-risk food.

Table 5: Causes in Australia of recall of horticulture products, 1990-2001

Cause of recall	Number
<b>Microbiological</b>	
Microbial contamination	18
<i>L. monocytogenes</i>	3
<i>Salmonella</i>	15
Aflatoxin	9
Subtotal	45
Foreign matter	
Faeces	1
Metal, glass, plastic, stones	13
Insect, rodent parts	4
Subtotal	18
Chemical	
Rancidity	2
Additives, HCN, SO <sub>2</sub>	4
Taint	3
Subtotal	9
Labelling	9
Total	81

In Tables 6-9 are described outbreaks from horticulture products which received no further processing before sale. The causative organisms (viruses, protozoans and bacteria) are of faecal origin.

Table 6: Outbreaks associated with intact products in contact with soil and/or water

Product	Country	Organism	Ref
Salad	UK	<i>S. Enteritidis</i> PT4	1
Potato salad	UK	<i>S. Enteritidis</i> PT4	1
Coriander	UK	<i>S Typhimurium</i>	1
Melon	US	<i>S. Javiana</i>	2
Cantaloupe	US	<i>S. Chester</i>	2
Tomato	US	<i>S. Javiana</i>	2
Meney	US	<i>S. Typhi</i>	3
Mango	US	<i>Salmonella spp</i>	3
Lettuce, tomato	UK	<i>E. coli</i> O157	1
Mixed salad	UK	<i>E. coli</i> O157	1
Lettuce	US	<i>E. coli</i> O157:H7	2
Salads	US	<i>E. coli</i> O157	4
Lettuce	UK	<i>Campylobacter</i>	1
Salad vegetables	UK	<i>Shigella flexneri</i>	1
Salad	UK	<i>Shigella sonnei</i>	1
Iceberg lettuce	UK, GDR, Sweden	<i>Shigella sonnei</i>	5
Baby corn	Denmark	<i>Shigella spp</i>	4
Parsley	US	<i>Shigella spp</i>	3
Lettuce	US	<i>Hepatitis A virus</i>	2
Raspberries	UK	<i>Hepatitis A virus</i>	2
Strawberries	US	<i>Hepatitis A virus</i>	2
Tomato	US	<i>Hepatitis A virus</i>	2
Carrot	UK	Small Round Structured Virus	1
Salad (mixed)	UK	Small Round Structured Virus	1
Salad (green)	UK	Small Round Structured Virus	1
Salad (raw)	UK	Small Round Structured Virus	1
Salad (raw)	UK	Small Round Structured Virus	1
Tomato	UK	Small Round Structured Virus	1
Watercress	UK	Small Round Structured Virus	1
Celery	US	Norwalk virus	2
Onions	US	<i>Cryptosporidium sp</i>	2
Raspberries	US, Canada	<i>Cyclospora cayetanensis</i>	3
Mesclun lettuce	US	<i>Cyclospora cayetanensis</i>	2
Lettuce, onion	US	<i>Giardia lamblia</i>	4
Basil	US	<i>Cyclospora cayetanensis</i>	3

1 Personal communications to the EU Commission

2 Tauxe *et al.* (1997)

3 US FDA (2000)

4 Anonymous (2000)

5 Gilbert (2000)

6 Taormina *et al.* (2000)

In Table 7 are presented outbreaks following consumption of sprouts. It is generally agreed that the outbreaks in Finland (1994, 95) and US (2001) were caused by seeds imported from Australia.

Table 7: Outbreaks associated with seed sprouts (1973-99)

Year	Organism	Location	Cases	Type of sprout
1973	<i>B. cereus</i>	US	4	Soy, cress, mustard
1988	<i>S. St Paul</i>	UK	143	Mung
1989	<i>S. Gold-coast</i>	UK	31	Cress
1994	<i>S. Bovismorbificans</i>	Sweden, Finland	595	Alfalfa
1995	<i>S. Stanley</i>	USA, Finland	242	Alfalfa
1995	<i>S. Newport</i>	USA, Canada, Denmark	133	Alfalfa
1996	<i>S. Montevideo, S. Meleagridis</i>	US	ca 500	Alfalfa
1996	<i>E. coli</i> O157:H7	Japan	11,000	Radish
1997	<i>E. coli</i> O157:H7	Japan	126	Radish
1997	<i>S. Meleagridis</i>	Canada	78	Alfalfa
1997	<i>S. Infantis, S. Anatum</i>	US	109	Alfalfa, mung
1997	<i>E. coli</i> O157:H7	US	85	Alfalfa
1997	<i>S. Senftenberg</i>	US	52	Alfalfa, clover
1998	<i>E. coli</i> O157:NM	US	8	Alfalfa, clover
1998	<i>S. Havana, S. Cubana, S. Tennessee</i>	US	34	Alfalfa
2000	<i>S. Enteritidis PT 4b</i>	Netherlands	27	Mung
2001	<i>S. Kottbus</i>	US	24	Alfalfa

In Table 8 are presented details of outbreaks associated with processed horticulture products. In each case the contaminant is thought to have entered the products from faeces, either directly from the field or via water during processing.

Table 8: Outbreaks associated with cut, sliced, skinned and shredded products

Product	Organism	Location	Reference *
Shredded coconut	<i>S. Java</i> PT Dundee	US	5
Cantaloupe salad	<i>S. Poona</i>	US, Canada	5
Watermelon	<i>Salmonella</i>	US	2
Shredded lettuce	<i>Shigella</i>	US	2

Coleslaw	<i>E. coli O157</i>	US	4
Cabbage?	<i>L. monocytogenes</i>	Canada	5
Sliced raw vegetables	<i>Giardia lamblia</i>	US	4
Fruit salad	<i>Giardia lamblia</i>	US	4

\* References listed beneath Table 6

In Table 9 are presented outbreaks associated with unpasteurised fruit juices. In each process there was no Critical Control Point for the organisms, all of faecal origin.

Table 9: Outbreaks associated with fruit juices

Product	Organism	Location	Reference
Melon & papaya	SRSV	UK	1
Apple juice	<i>E. coli O157:H7</i>	US	2
Apple juice	<i>S. Typhimurium</i>	US	2
Apple juice	<i>Cryptosporidium spp</i>	US	2
Coconut milk	<i>Vibrio cholerae 01</i>	US	4
Orange juice	<i>S. Hartford</i>	US	2
Orange juice	<i>S. Anatum</i>	US	3
Orange juice	<i>S. Typhi</i>	US	3
Orange juice	<i>S. Muenchen</i>	US, Canada	3
Coleslaw	<i>S. Anatum</i>	US	3
Cabbage	<i>B. cereus</i>	US	3

1 Personal communications to the EU Commission

2 Tauxe *et al.* (1997)

3 US FDA (2000)

4 Gilbert (2000)

All the hazards, above, are microbial, usually of faecal origin. In the South Australian context should be considered the use of reclaimed water for irrigation. Work has been done on the implications for growers of using reclaimed water ("*Sustainable use of reclaimed water on the Northern Adelaide plains. PN: 975416 – Grower manual*" by Kelly *et al.*). The report suggests that the levels of microbial hazards, especially faecal bacteria pose little risk to consumers, providing that produce receives final washes in potable water. The report also found that chemical residues meet standards for irrigation water.

It seems likely that processing by growers is PIRSA's responsibility since harvesting and washing do not substantially transform the product. It is PIRSA's task to confirm that food safety implications for growers listed in the Kelly report are enshrined in the company HACCP plan and for this reason it is recommended that PIRSA maintain surveillance on use of reclaimed water.

There are potential chemical hazards stemming from use of agricultural chemicals such as:

- Synthetic pyrethrins are used for control of Western flour thrip in greenhouses
- Chlorpirifos is an insecticide and may be taken up by sprouts; it has a low LD<sub>50</sub>

- Fungicide dips are used, post-harvest on cherries, apples and oranges

There are also potential issues with Cadmium in potatoes.

### 5.3. Risk profiling of horticulture products

#### 5.3.1. Microbial hazards

From the hazard identification phase (Section 5.2) was established the horticulture products most likely to cause disease, together with the microbial agents. Accordingly, risk profiles were generated for a number of hazard:product pairings:

- *Salmonella* in sprouts
- Pathogenic *E. coli* in sprouts
- *Salmonella* in green salads e.g. lettuce
- *Salmonella* in unpasteurised fruit juice
- *L. monocytogenes* in prepared salads

It should be noted that alfalfa sprouts are grown from lucerne seeds for which the grain section of PIRSA also have some responsibility.

A summary of Risk Rankings is presented below (Table 10), rankings ranging from 49 (*Salmonella* in prepared salads) to 65 (pathogenic *E. coli* in sprouts and *L. monocytogenes* in prepared salads).

Table 10: Summary of risk rankings for horticulture products in South Australia

Hazard	Product	Risk ranking*
<i>Salmonella</i>	Sprouts	60
Pathogenic <i>E. coli</i>	Sprouts	65
<i>Salmonella</i>	Prepared salads	49
<i>L. monocytogenes</i>	Prepared salad	55
<i>Salmonella</i>	Unpasteurised fruit juice	65

\* Note an increment of “6” in risk ranking is equivalent to a 10x change.

Full details of risk rankings and underlying assumptions used in reaching them are presented in Tables 11-13.

Table 11: Risk ranking of consumption of *Salmonella* and pathogenic *E. coli* in sprouts

Risk criteria	<i>Salmonella</i>	Pathogenic <i>E. coli</i>
<b>Dose and severity</b>		
Hazard severity	Moderate	Moderate
Susceptibility	General – all population	General – all population
<b>Probability of exposure</b>		
Frequency of consumption	Monthly	Monthly
Proportion consuming	Some (25%)	Some (25%)
Size of population	South Australian (1.5 million)	South Australian (1.5 million)
<b>Probability of contamination</b>		
Probability of seeds contaminated	Rare (1 in 1000)	Rare (1 in 1000)
Effect of growth (sprouting)	Increases by 10x	Increases by 10x
Possibility of recontamination	None	None
Post-process control	Not controlled – 10x increase	Not controlled – 10x increase
Increase to infective dose	1,000x	10x
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard
Predicted illnesses per annum in selected population	460	4600
Risk ranking (0-100)	60	65

Contamination of 0.1% is assumed, as is 10x increase during sprouting and during marketing  
 Increase to infective dose for *Salmonella* based on infective dose of  $10^{5-6}$  and for pathogenic *E. coli*  $10^{3-4}$  (see “Foodborne microorganisms of public health significance, 1997, AIFST, Sydney).

Table 12: Risk ranking of consumption of unpasteurised fruit juice contaminated with *Salmonella*

Risk criteria	Salmonella in unpasteurised juice
<b>Dose and severity</b>	
Hazard severity	Moderate
Susceptibility	General – all population
<b>Probability of exposure</b>	
Frequency of consumption	Weekly
Proportion consuming	Very few (5%)
Size of population	South Australian (1.5 million)
<b>Probability of contamination</b>	
Probability of raw fruit being contaminated	(0.01%)
Effect of processing	Increases the hazard 10x
Possibility of recontamination	None
Post-process control	Not relevant
Increase to infective dose	None
Further cooking before consumption	Not effective in reducing hazard
Predicted illnesses per annum in selected population	4000
Risk ranking (0-100)	65

Prevalence of *Salmonella* contamination of raw fruit is assumed, as is increase during juicing due to build-up of *Salmonellas* in washing baths

It is assumed that the pH and storage temperature both prevent *Salmonella* growth

Data used in increase to infective dose are based on 100g consumption of product with a low concentration (1-10 organisms/g). Infective doses for non vulnerable consumers re around  $10^5$ /g for *Salmonella* (see “Foodborne microorganisms of public health significance, 1997, AIFST, Sydney.

Table 13: Risk ranking of consumption of prepared salad contaminated with *Salmonella* or *Listeria*

Risk criteria	<i>Salmonella</i>	<i>Listeria</i>
<b>Dose and severity</b>		
Hazard severity	Moderate	Moderate
Susceptibility	General	General
<b>Probability of exposure</b>		
Frequency of consumption	Daily	Daily
Proportion consuming	Some (25%)	Some (25%)
Size of population	South Australian (1.5 million)	South Australian (1.5 million)
<b>Probability of contamination</b>		
Probability of raw product contaminated	Rare (0.1%)	Rare (0.1%)
Effect of processing	Slight decrease (50%)	Slight decrease (50%)
Possibility of recontamination	None	None
Post-process control	Well controlled - cold chain	Not controlled – 10x increase
Increase to infective dose	1,000x	10,000x
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard
Predicted illnesses per annum in selected population	7	70
Risk ranking (0-100)	49	55

Prevalence of *Salmonella* and *Listeria* on raw product is assumed, as is reduction during preparation

Refrigerated storage allows increase of *Listeria*

Data used in increase to infective dose are based on 100g consumption of product with a low concentration (1-10 organisms/g). Infective doses for non vulnerable consumers are around  $10^5$ /g for *Salmonella* (see “Foodborne micro organisms of public health significance, 1997, AIFST, Sydney.

## 5.4. Risk context for PIRSA

Based on the Risk Rankings established in section 6.3, it is clear that risk is concentrated in several sectors of the SA horticulture industry:

Gram-negative pathogens in unpasteurised fruit juices

Gram-negative pathogens and *L. monocytogenes* in prepared salads

Gram-negative pathogens in sprouts

### 5.4.1. Gram-negative pathogens in unpasteurised fruit juices

The risk ranking is based on the assumption that only a small proportion (5%) of South Australia's population consuming unpasteurised juice on a weekly basis. Actual consumption patterns should be adduced.

Recommendation 1:

PIRSA should survey the unpasteurised fruit juice industry in South Australia to identify companies manufacturing such products, the complete range of unpasteurised products and volumes consumed.

Recommendation 2:

PIRSA review all HACCP plans of companies, which manufacture unpasteurised fruit juice. If a Critical Control Point (CCP) is claimed for preventing, eliminating or reducing pathogens to an acceptable level, PIRSA should obtain a scientific validation to support the CCP.

Recommendation 3:

Based on the outcome of recommendation 10 PIRSA should work with DHS to regulate the sale of unpasteurised fruit juice.

*Note: Unpasteurised fruit juice should be recognised under the new South Australian Food Act as a high risk food and therefore food safety programs and microbiological testing should be mandated, and a sampling plan formulated for testing unpasteurised fruit juice to ensure the program provides a high level of confidence that contaminated juice is not offered for sale.*

### 5.4.2. Gram-negative pathogens and *L. monocytogenes* in prepared salads

Given the ecology of products used for salads it is inevitable that soil and waterborne pathogens will be natural contaminants. As well, pathogens from animals, especially birds, will come into contact with salad items.

The prevalence of contamination can increase markedly if contaminated water supplies are used. Fertilisers such as silages may also introduce high concentrations of pathogens

Recommendation 4:

PIRSA should maintain surveillance of the use of water and fertilisers by suppliers of salad products, with particular reference to use of reclaimed waters.

Recommendation 5:

PIRSA should identify each supplier of salad items and assess whether their processes have CCPs which prevent, eliminate or reduce pathogens to an acceptable level.

### 5.4.3. Gram-negative pathogens in sprouts

During the sprouting process, conditions are suitable for the growth of bacteria and 100-1,000-fold increases have measured in the total microflora; in the present risk profiles, a 10-fold increase in pathogens was assumed. In view of the involvement of Australian seed stock in salmonellosis in Finland and USA, together with the concern expressed by the FSANZ that contaminated seeds may be used for local production, PIRSA should treat this hazard:product pairing with priority.

#### Recommendation 6:

PIRSA (both horticulture and grains sections) should undertake a comprehensive review of processes in the South Australian sprouting industry centred on:

- (a) Identifying all key process parameters which impact on pathogen growth.
- (b) Using a predictive microbiology exercise to assess pathogen multiplication.
- (c) Undertaking a survey of pathogens in seed stock used for sprouting.

#### Recommendation 7:

Based on the outcome of recommendation 14 PIRSA should consider regulating the sprouting industry based on the ability of companies to demonstrate control of pathogen growth.

## References

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#### Appendix 1: Recalls of horticulture products recorded by FSANZ 1990-2001

States involved in recalled	Product	Cause
<b>1990</b>		
Qld	Chilli sauce	Mould
	Potato salad	Metal
	Orange fruit juice	High sulphur dioxide
	Canned beetroot	Underfilling

	Walnuts	Faeces
	Apple juice	Fermentation
<b>1991</b>		
National	Canned peaches	Blown cans
	Paprika	<i>Salmonella</i>
	Apricot kernels	Hydrocyanic acid
	Dates	Insects
	Fruit juices	High sulphur dioxide
<b>1993</b>		
Vic, NSW	Desiccated coconut	<i>Salmonella</i>
	Peanut butter	Aflatoxin
Qld	Dried fruit	Rodent parts
	Cherries	Glass
National	Peanut bar	Glass
SA, NT, WA	Peanuts	Aflatoxin
<b>1994</b>		
NSW	Shredded coconut	<i>Salmonella</i>
NSW, Qld	Dates	Metal
Vic	Cayenne pepper	<i>Salmonella</i>
WA	Fruit juice	Low preservative
NSW	Desiccated coconut	<i>Salmonella</i>
<b>1995</b>		
Qld, Vic	Paprika	<i>Salmonella</i>
Vic	Onion dip	<i>L. monocytogenes</i>
<b>1996</b>		
NSW, Qld, Vic, SA	Dates	Foreign matter
National	Fruit bars	Metal
NSW, ACT, Qld, Tas	Chilli sauce	Microbial contamination
Vic, NSW	Orange juice	Metal
Vic	Passionfruit	Microbial contamination
Qld, NSW	Parsley	<i>L. monocytogenes</i>
National	Peanut butter	<i>Salmonella</i>
National	Muesli bar	<i>Salmonella</i>
NSW	Crushed nuts	<i>Salmonella</i>
<b>1997</b>		
National	Muesli bars	<i>Salmonella</i>
SA, NT, Vic	Dip	Labelling
WA	Pickled vegetables	Chemical contamination
NSW	Peanut snack	Fungal contamination
WA	Water chestnuts	Microbial contamination
NSW	Peanut snack	Aflatoxin
National	Vegetables	Plastic
NSW, ACT, Vic, Qld	Apple desert	Glass
<b>1998</b>		

National (except WA)	Desiccated coconut	<i>Salmonella</i>
National	Fruit yoghurt	Labelling (peanuts)
<b>1999</b>		
WA	Coconut	Chemical contamination
National	Fruit juices	<i>Salmonella</i>
National	Sultanas	Labelling (peanuts)
	Coconut	<i>Salmonella</i>
NSW	Fruit salad	<i>L. monocytogenes</i>
NSW	Peanuts	Aflatoxin
QLD, NSW	Pepper	<i>E. coli</i>
National	Pasta sauces	Glass
Vic	Apples	Glass
<b>2000</b>		
NSW, ACT, Vic	Chillies	Microbial contamination
NSW, Qld, Vic	Alfalfa sprouts	<i>E. coli</i>
Vic, Qld, NSW, ACT	Sundried tomato pesto	Labelling (peanuts)
National	Sultanas	Labelling (peanuts)
NSW	Siu Mai	Labelling (peanuts)
NSW, Vic	Pistachio kernels	Aflatoxin
National	Hazelnut snack	Microbial contamination
<b>2001</b>		
NSW	Pistachio kernels	Aflatoxin
National	Halva with pistachios	<i>Salmonella</i>

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# 6. Risk Profiles of Honey and Apiary Products in South Australia

## 6.1. Honey production in South Australia

In 2001, there were approximately 820 registered apiarists in South Australia operating 67,633 hives, comprising 14% of the apiarists and 13% of the hives in Australia.

Table 1: Registered apiarists and hives in South Australia (1996-2001)

	1996	1999	2000	2001
Registered apiarists	649	747	820	820
Registered hives	63,595	66,055	67,951	67,633

In the same year, most SA apiarists (622/820, 75.8%) had fewer than 50 hives while 59 apiarists (8%) had 41,063 (60%) of the state's hives (Table 2).

Table 2: Distribution of hives in South Australia (2001)

Hives/apiarist	Apiarists	Total number of hives
1-50	622	5789
51-100	33	2416
101-200	54	6331
201-400	52	12034
401-600	34	18959
> 600	25	22104
Total	820	67,633

On average, 3-3,500t of apiary products are produced annually, the value of which to the South Australian economy is \$4-7m, comprising sales of honey and beeswax, together with the provision of pollination services. In production, SA ranks fourth behind NSW (41%), Victoria (18%) and Queensland (15%).

Most South Australian honey is sold domestically, with only a small proportion exported to Japan and the European Union. In addition to the 3-3,500t of honey sold to the five major processors it is said that an additional 500t (17%) of South Australia honey is sold privately.

## 6.2. Hazard identification

### 6.2.1. Microbial hazards

There have been few reports of illness associated with honey and apiary products. Honey has caused cases of infant botulism, some of which have been linked with Sudden Infant Death Syndrome (SIDS). In many countries, including Australia, infant botulism is the most

common form of botulism. It occurs in children under 1 year with 95% occurring in infants younger than 6 months. Infant botulism occurs when ingested spores of *C. botulinum* germinate, multiply and produce neurotoxin in the gastrointestinal tract. Intensive care facilities have reduced the incidence of death from infant botulism to around 2%.

Honey has been implicated as one source of the spores of *C. botulinum* and is not recommended for infants of less than 1 year. In one case, 80 spores/g were reported in one sample of incriminated honey (Midura et al., 1979), but in a UK survey spores were not isolated from 122 samples (Berry et al., 1987).

Royal jelly has also been implicated in a case of haemorrhagic colitis involving a 53-year-old woman. Prior to the onset of symptoms the patient had taken royal jelly for 25 days.

In Australia, there have been two recalls monitored by FSANZ (Table 3).

Table 3: Recalls of honey and honey-containing products as monitored by FSANZ (1990-2001)

Product category	Number of recalls	Defects
Honey coated peanut bar	1	Fungal contamination
Honey in glass jar	1	Glass

### 6.2.2. Chemical hazards

Several categories of chemicals have been associated with honey:

- Agricultural chemicals - pesticides, herbicides, rodenticides
- Antibiotics used to control bee diseases
- Heavy metals which accumulate in environments
- Cleaning compounds used to sanitise hives and processing equipment
- Naturally-occurring toxins e.g. Pyrrolizidine alkaloids (PAs)

In general there are Maximum Residue Limits (MRLs) for veterinary, agricultural and heavy metals. Given the small serving size of honey (<50g) it is unlikely that consumption of contaminated honey will have a food safety impact. Rather the impact is important as a trade perception.

One antibiotic, which has been found in honey, among other farmed products, is chloramphenicol. This antibiotic does have a public health impact as it causes aplastic anaemia and exposure is equated with a 30,000:1 to 75,000:1 chance of contracting anaemia. In early 2002, chloramphenicol was detected in a range of Chinese foods, including honey, imported to several countries including Germany, USA and Canada. In some cases, Chinese honey was blended with local honey or used in a range of confectionery and bakery products.

Via PIRSA, the South Australian industry participates in the National Residue Survey with samples of honey being tested for a range of agricultural and veterinary chemicals. Pyrrolizidine Alkaloids (PAs) have been identified by FSANZ as potentially of concern.

## 6.3. Risk profiling

### 6.3.1. Microbial hazards

The major microbial hazard is *C. botulinum* and consumption of honey by infants (Table 4).

Table 4: Risk rankings of infant botulism from consumption of honey

Risk criterion	Infant botulism and <i>C. botulinum</i>
<b>Dose and severity</b>	
Hazard severity	Severe
Susceptibility	Neonates
<b>Probability of exposure</b>	
Frequency of consumption	Few times a year
Proportion consuming	Some (25%)
Size of population	South Australian neonates (20,000/annum)
<b>Probability of contamination</b>	
Probability of raw product contaminated	0.0001%
Effect of processing	No effect
Possibility of recontamination	None
Post-process control	Not relevant
Increase to infective dose	None
Further cooking before eating	Not effective in reducing hazard
Total predicted illnesses per annum in selected population	0.14
Risk ranking (0-100)*	56

\* Note an increment of “6” in risk ranking is equivalent to a 10x change

Assumptions are made regarding:

- Proportions of babies consuming honey during their first year
- Prevalence of *C. botulinum* in honey

The predicted illnesses are indicative only

## 6.4. Risk context for PIRSA

Based on the hazards established in Section 6.2 and the risk ranking in Section 6.3 it is clear that the focus for PIRSA must be on clostridial spores and chemical residues.

### 6.4.1. Clostridial spores

There is no CCP for preventing spores of *C. botulinum* either entering honey, or for eliminating/reducing them to an acceptable level. Management therefore is linked with

advising mothers to avoid feeding honey to babies until their gut microflora has matured sufficiently to prevent spore germination and colonisation (usually 12 months).

Recommendation 1:

Because spores of *Clostridium botulinum* are present in honey and have been linked with Sudden Infant Death Syndrome, PIRSA should ascertain whether, in South Australia, parents are actively informed not to feed honey to children younger than 12 months.

#### **6.4.2. Chemical residues**

In line with other primary production sectors, suppliers will be required to operate Food Safety Plans for production and processing of honey. The B-Qual system advocates a HACCP-based quality system but has not rigorously identified hazards, critical control points and critical limits for various agrichemicals and for natural toxins such as PAs.

Recommendation 2:

PIRSA should consider whether to proactively supply South Australian apiarists and processors with food safety information and HACCP plans.

*Note: The B-Qual approach is clearly at an early stage of development and operators would be unable to prepare a HACCP plan without considerable (and costly) assistance for HACCP practitioners.*

#### **References**

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# 7. Risk Profiles of Seafood and Aquaculture Products in South Australia

## 7.1. Seafood production in South Australia

In 200-01, South Australia produced 32,212t with a landed value of \$480.5m. Of the 17798t (\$220m) generated by the wild caught fishery, lobsters, prawns and abalone comprised 6000t and \$170m, 32% of the volume and 87% of the value, respectively. In the aquaculture sector bluefin tuna (8960t and \$224m) comprised 69% of the volume and 89% of the value, respectively (Table 1).

Table 1: Production and value of South Australia seafood, 2000-2001

Species	Production	
	Volume (t)	Value (\$ '000)
<b>Wildcaught</b>		
Lobster	2,700	86,400
Abalone	889	40,005
Prawns	2,416	43,729
Squid	426	2,114
Blue Crabs	466	2,889
Other shellfish & molluscs	1,816	5,266
<i>Total Shellfish and Molluscs</i>	<b>8,713</b>	<b>180,403</b>
Freshwater Fin Fish	1,085	2,507
Yellow Eye Mullet	224	434
Tommy Ruff	303	360
Aust. Salmon	461	569
Snook	94	224
Snapper	520	2,931
Whiting	574	5,394
Garfish	477	1,906
Ocean Jackets	316	579
Shark	351	1,404
Commonwealth Fisheries other than Tuna	680	4,923
Total other marine fish	4,000	18,724
<i>Total Fish</i>	<b>9,085</b>	<b>39,955</b>
<b>Total Wildcaught</b>	<b>17,798</b>	<b>220,358</b>
<b>Aquaculture</b>		
Abalone	100	4,100
Salmon	55	500
Tuna	8,960	224,000

Barramundi/other	400	4,500
Marron/yabbies	30	750
Oysters	3,984	15,139
Other molluscs	100	300
Yellowtail kingfish	50	400
Total other aquaculture	735	10,550
	<b><i>Total aquaculture</i></b>	<b><i>14,414</i></b>
	<b><i>260,239</i></b>	
<b>Total production and value of SA Seafood</b>	<b>32,212</b>	<b>480,597</b>

Thus aquaculture and wild caught shellfish are by far the most important sectors of South Australian seafood industry. The state industry has more than trebled in value over the past decade from around \$150m in 1991-92 to around \$480m in 2000-01. This growth has been largely from the aquaculture sector, in general and from bluefin tuna, in particular.

South Australia has more than 1,200 operations which harvest, process and retail seafoods and aquaculture products (Table 2).

Table 2: Seafood businesses in South Australia

	Number of businesses
<b>Harvesting</b>	
Abalone	34
Blue crab	6
Freshwater crayfish	10
Inland aquaculture	76
Mussels	5
Oysters	105
Prawns	52
Rock lobster	250
Scalefish	550
<b>Processing/wholesaling</b>	41
<b>Export processing</b>	48
<b>Retailing (not supermarkets)</b>	65

South Australia exports both interstate and overseas, mainly bluefin tuna, prawns, lobsters and oysters to a value of \$607m (\$157m interstate and \$450m overseas). Bluefin and other tuna comprise more than \$320m (54%) of exports.

The state imports around \$150m from interstate and overseas, based on a direct proportion of total imports to Australia based on the state's population. This portion comprises mainly frozen finfish and crustaceans and canned fish.

## 7.2. Hazard identification

In Table 3 are presented statistics for seafood-related illness in Australia as published in the literature. Details of both South Australian outbreaks are presented in Table 4.

Table 3: Causes of seafood-borne outbreaks in Australia, 1990-2000

Category	Cases	Outbreaks	Cases/outbreak
Ciguatera	616	10*	12
Histamine	28	10	3
Viruses	1,737	3	579
Bacterial pathogens	159	6	27
Biotoxins	102	3	34
Total	2,642	32	82

\* Includes an annual estimate of 48 cases/annum in coastal Qld (Lehane and Lewis, 2000)

Table 4: Seafood-related outbreaks of food poisoning in South Australia (1990-2000)

Cause of poisoning	Date	Location	Number affected (deaths)	Reference
Histamine	1990	Adelaide	3	Smart (1992)
	1991	Adelaide	4	Smart (1992)

In Appendix 1 are listed details of all seafood-based illnesses during the period 1990-2000.

In Table 5 are listed seafood recalls monitored by FSANZ during the period 1993-2001. In all, there were 45 recalls of seafoods, 33 for microbiological and 12 for chemical hazards.

Table 5: Recalls of seafoods as monitored by FSANZ (1993-2001)

Product category	Number of recalls	Defects
Microbiological		
Canned seafood	7	Faulty seams or gas production
Smoked seafood	18	<i>L. monocytogenes</i>
Shellfish	4	Microbiology
Frozen seafood	3	Microbiology or packaging
Cooked seafood	1	<i>S. Lexington</i>
Subtotal	33	
Chemical		
Mackerel	2	Histamine
Reef fish	1	Ciguatera
Shellfish	6	Biotoxin
	1	Aflatoxin
	1	Zinc
Smoked oysters	1	Lead
Subtotal	12	

### 7.3. Risk profiling

From the hazard identification phase (Section 7.2) was established the seafood products most likely to cause disease, together with the microbial agents are:

- Scombrototoxicosis (histamine poisoning)
- Algal toxins in molluscs during a hazardous algal bloom (HAB)
- *Listeria monocytogenes* in ready-to-eat seafood such as smoked fish
- Viral contamination of shellfish

In Table 6 is summarised risk profiles (based on risk ranking) of the above hazard:commodity pairings while Tables 7-10 contain the criteria, assumptions and assessments which led to these rankings.

Table 6: Summary risk rankings for hazard:product pairs of importance in South Australia

Hazard	Product	Risk ranking*
<i>L. monocytogenes</i>	Smoked seafood – general population	33
	Smoked seafood - foetus	62
Scombrototoxin	Canned fish	40
	Chilled fish	40
Shellfish biotoxin	Controlled waters	31
	Uncontrolled waters in HAB	71
SRSVs in oysters	Controlled waters	31
	Uncontrolled waters in HAB	72

\* Note an increment of “6” in risk ranking is equivalent to a 10x change

Rankings ranged from 31 (SRSVs in oysters from controlled waters) to 72 for oysters in uncontrolled waters. Note that an increased risk ranking of “6” leads to a 10-fold increase in risk. The difference in risk between 31 and 72 is therefore more than 1 million times.

Other pairings of lesser importance to SA are:

- Parasites in raw fish for sushi/sashimi
- Contamination of cooked crustaceans with enteric (non-*Vibrio*) organisms
- Vibrios in molluscs and crustaceans
- Ciguatera poisoning
- Mercury in seafood
- Clostridium botulinum* in canned and vacuum-packed ready-to-eat fish products

In Table 11 are summarised hazard:product pairings for which South Australian are exposed similarly to the Australian population, in general. It is recommended that SeaQual Australia’s risk assessments be read for fuller detail (Seafood Services Australia, 19 Hercules St, Queensland 4007).

Seafood may also become contaminated with chemicals, particularly chemicals used in the aquaculture business.

Chemical hazards impacting on fish farming and processing are:

- **Heavy metals**

Metals such as lead, cadmium, copper, arsenic etc.

- **Organic chemicals**

Agricultural residues such as organochlorine residues.

PIRSA monitors for organophosphates and organochlorines in aquaculture products.

- **Antibiotics**

Oxolinic acid and oxytetracycline has been administered directly or via formulated feeds to South Australian farmed abalone. The process requires a withholding period prior to harvest and release of product and will require documentation as part of the HACCP system.

- **Anaesthetics**

Alcohol, carbon dioxide, magnesium sulphate and benzocaine are commonly used anaesthetics in removing abalone for grading. It is unlikely that anaesthetics will be used during harvest. However, if it is used, a withholding period will be required with inclusion in the HACCP system.

Table 7: Risk rankings of scombrototoxicosis from canned and frozen tuna

Risk criterion	Canned fish	Chilled fish
<b>Dose and severity</b>		
Hazard severity	Mild - sometimes requires medical attention	Mild - sometimes requires medical attention
Susceptibility	General – all population	General – all population
<b>Probability of exposure</b>		
Frequency of consumption	Monthly	Monthly
Proportion consuming	Most (75%)	Most (75%)
Size of population	South Australian (1.5 million)	South Australian (1.5 million)
<b>Probability of contamination</b>		
Probability of raw product contaminated	0.01%	0.01%
Effect of processing	No effect	No effect
Possibility of recontamination	None	None
Post-process control	Well controlled	Well controlled
Increase to infective dose	10000x	10000x
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard
Total predicted illnesses per annum in selected population	1.4	1.4
Risk ranking (0-100)*	40	40

\* Note an increment of “6” in risk ranking is equivalent to a 10x change

Assumptions made:

- South Australian consumption of canned and chilled/frozen fish is identical with that of Australians, in general.
- Most Australians eat canned tuna, sardines or mackerel once a month is based on consumption of 200 million serves of 150g (see SeaQual Australia risk assessment).
- For Chilled/frozen scombrototoxic species, annual consumption is 30,000t edible weight (200 million serves of 150g), which is known to produce histamine.
- The prevalence of contamination of raw material at landing with histamine-producing organisms is 0.1%.
- On-board processing has no effect on the hazard.
- The post-process handling of canned seafoods is well controlled since the product is commercially sterile.
- Post-process handling of frozen and chilled fish is well controlled, preventing increase of histamine levels.
- The increase of histamine-producing bacteria is at least five log scales to a level commensurate with potentially toxic levels in the fish.

Table 8: Risk characterisation of consumption of shellfish with shellfish poison

Risk criteria	General population	Uncontrolled gathering during HAB
<b>Dose and severity</b>		
Hazard severity	Moderate - often requires medical attention	Moderate - often requires medical attention
Susceptibility	General – all population	Small, specific population in affected area
<b>Probability of exposure</b>		
Frequency of consumption	Monthly	Weekly
Proportion consuming	Some (25%)	Most (75%)
Size of population	South Australian (1.5 million)	10,000
<b>Probability of contamination</b>		
Probability of raw product contaminated	0.0000001% contaminated	1% contaminated at toxic level
Effect of processing	No effect on hazard	No effect on hazard
Possibility of recontamination	None	None
Post-process control	Not relevant	Not relevant
Increase to infective dose	None	None
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard
Total predicted illnesses per annum in selected population	0.04	300
Risk ranking (0-100)*	31	71

\* Note an increment of “6” in risk ranking is equivalent to a 10x change

Assumptions made:

- South Australian consumption of shellfish is identical with that of Australians, in general.
- A small population of consumers may eat pipis from uncontrolled areas during a Hazardous Algal Bloom
- Prevalence of pipis which contain biotoxin is 1%
- Control of harvesting under the SASQAP limits prevalence of contamination to 0.0000001%

Epidemiology surrounding the NSW DSP outbreaks is broadly in line with model predictions

South Australia has several abalone farms and, it should be noted that overseas (South Africa in 1999-2000 and Spain in 1991) abalone both farmed and in the wild became toxic with PSP. Although PSP predominates in the viscera, rather than the edible portion (the foot), at least one SA processor typically concentrates abalone viscera into flavour compounds for the food processing and service industries.

Table 9: Risk characterisation of consumption of smoked seafood containing *L. monocytogenes*

Risk criteria	General	Extremely susceptible (foetus)
<b>Dose and severity</b>		
Hazard severity	Mild	Severe
Susceptibility	General – all population	Very susceptible
<b>Probability of exposure</b>		
Frequency of consumption	Few times	Few times
Proportion consuming	Some (25%)	Some (25%)
Size of population	South Australian (1.5 million)	18,000
<b>Probability of contamination</b>		
Probability of raw product contaminated	1% contaminated	1% contaminated
Effect of processing	Slight reduction	Slight reduction
Possibility of recontamination	Minor	Minor
Post-process control	Not relevant	Not relevant
Increase to infective dose	100,000x	1,000x
Further cooking before eating	Not effective in reducing hazard	Not effective in reducing hazard
Predicted illnesses per annum in selected population	0.1	10
Risk ranking (0-100)*	33	62

\* Note an increment of “6” in risk ranking is equivalent to a 10x change

Assumptions made:

- South Australian consumption of smoked fish is identical with that of Australians, in general.
- In Australia there are 25 million servings, each of 100g, of smoked seafood available for consumption equivalent to some (25%) Australians eating smoked seafoods a few times a year.
- Listeriosis is a factor in the final trimester of pregnancy for 18,000 South Australians each year.
- Contamination levels in finished product are referenced in SeaQual’s risk assessment
- Increase to infective dose is based on FAO/WHO’s risk assessments (2000-01) available on their websites

Table 10: Risk characterisation of consumption of SRSVs contamination of oysters from contaminated and non-contaminated waters

	Approved waters	Restricted waters, unmanaged incident
<b>Dose and severity</b>		
Hazard severity	Mild	Mild
Susceptibility	General - all population	General - all population in small, specific area
<b>Probability of exposure</b>		
Frequency of consumption	Monthly	Weekly
Proportion consuming	Some (25%)	Most (75%)
Size of population	South Australian (1.5 million)	10,000
<b>Probability of contamination</b>		
Probability of raw product contaminated	0.0001% contaminated	15% contaminated
Effect of processing	Does not eliminate the hazard	Does not eliminate the hazard
Possibility of recontamination	None	None
Post-process control	Not relevant	Not relevant
Increase to infective dose	None	None
Further cooking before eating	None	None
Total predicted illnesses per annum in selected population	0.04	4,500
Risk ranking (0-100)*	31	72

\* Note an increment of “6” in risk ranking is equivalent to a 10x change

Assumptions made:

- South Australian consumption of shellfish is identical with that of Australians, in general.
- Across Australia there are about 35 million servings each of six oysters, each year
- The contamination level in oysters from approved waters is assumed
- The contamination level for unmanaged incidents is taken from the Wallis Lake incident (see Sea Qual’s risk assessment)

Table 11: Risk rankings of hazards and commodities in the general Australian community (from SeaQual Australia risk assessment)

Hazard:product pairing	Risk ranking*
Ciguatera in reef fish	45
Mercury in predaceous fish	24
<i>V. parahaemolyticus</i> in cooked prawns	37
<i>V. cholerae</i> in cooked prawns	37
<i>V. vulnificus</i> in oysters	41
<i>C. botulinum</i> in canned fish	25
<i>C. botulinum</i> in vacuum packed smoked fish	28
Parasites in sushi/sashimi	31
Enteric bacteria in imported cooked shrimp	31

\* Note an increment of “6” in risk ranking is equivalent to a 10x change

## 7.4. Risk context for PIRSA

Based on the risk rankings established in Section 7.3 it is clear that the products, which merit most attention from PIRSA, are tuna, smoked seafoods and shellfish.

### 7.4.1. Bluefin tuna

This product is mostly exported either chilled or frozen, mainly to Japan. Since a small number of companies are involved in production and shipping it should be possible to monitor closely their CCPs. Fortunately, histamine production and sensory quality are closely linked so that, if good quality product is landed in Japan, it will also be low in histamine.

The risk ranking (40) for histamine in both canned and chilled tuna reflects the level of control which is exercised by the industry to prevent temperature:time abuse.

Since most tuna from SA is exported, the responsible agency is AQIS. However, PIRSA should make itself aware of any volumes of farmed tuna which are released to the local and Australian market.

#### 7.4.2. Smoked seafoods

Smoked seafoods are manufactured in South Australia and it is accepted that *L. monocytogenes* will be present on final products, usually by recontamination. The high risk ranking for the foetus from smoked seafoods reflects the relatively low increase needed to an infective level. For most consumers a 100,000-fold increase is needed before listeriosis is contracted.

The organism in smoked seafoods is considered high risk by FSANZ who have imposed the management options of zero tolerance (absence in 25g of product) and advising pregnant women not to eat the product.

Recommendation 1:

PIRSA should monitor processes and CCPs of smoked seafoods and assess their scientific validity for control of *Listeria monocytogenes*.

#### 7.4.3. Shellfish biotoxins

The risk of adventitious gathering and sale in an unregulated environment is an obvious risk for PIRSA.

Recommendation 1:

PIRSA should consider regulating the adventitious gathering and sale of:

- Pipis from the Goolwa/Coorong area;
- Scallops along the SA coast;
- Shellfish gathered from Port River.

There is the need to bring these areas into the SA Shellfish Quality Assurance Program (SASQAP) and it is believed that at least one of the above (pipis from Goolwa area) is the subject of PIRSA monitoring. The Coorong area is currently being classified under SASQAP and the Goolwa area will be completed in 2003.

#### 7.4.4. Heavy metals

PIRSA is investigating levels of mercury and other heavy metals from mud cockles from Port River sold to the local market. When the results of this survey are known they should be considered as part of this risk profile.

Table 12: Seafood-related outbreaks of food poisoning in Australia (1990-2000)

Cause of poisoning	Date	Location	Number affected (deaths)	Reference
Ciguatera	1991	Darwin	3	Merianos <i>et al.</i> (1991)
	1994	Sydney	43	Capra (1997)
	1995	Queensland	15	Harvey (1995)
	1995	Queensland	4	Fenner <i>et al.</i> (1997)
	1996-	NSW	41	Voetsch (see Ross, 2000)

	98			
	1997	Victoria	30	Ng and Gregory (2000)
	Annual	Queensland	48	Lehane (2000)
Histamine				
	1990	Adelaide	3	Smart (1992)
	1991	Adelaide	4	Smart (1992)
	1993	Brisbane	2	Brown (1993)
	1995	WA	>6	Ruello (1999)
	1997	Sydney	2	Ruello (1999)
	1998	Sydney	>1	Ruello (1999)
	1999	Sydney	3	Ruello (1999)
	1999	Unknown	2	Ruello (1999)
	1999	Victoria	>1	Ruello (1999)
	1999	NSW	4	Voetsch (2000)
Viruses				
	1990	Sydney	1,200	Kraa (1990)
	1996	NSW	93	Stafford <i>et al.</i> (1996)
	1997	Wallis Lake	444 (1)	CDI (1997b)
Bacterial pathogens				
<i>V. parahaemolyticus</i>	1990	Sydney	>100 (1)	Kraa (1995)
	1992	Sydney	>50	
	1992	Sydney	(1)	Kraa (1995)
<i>V. vulnificus</i>	1992	NSW	4 (2)	McAnulty (1990)
<i>L. monocytogenes</i>	1991	Hobart	3	Misrachi <i>et al.</i> (1991)
Shellfish biotoxins				
	1997	NSW	102	Quaine <i>et al.</i> (1997)

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# 8. Risk Profiles of Grains and Grain-based Products in South Australia

## 8.1. Production of grains products in SA

In 2000-01, the South Australian grains industry produced more than 7.6 million tonnes of products with a farm gate value of \$1.3 billion. The majority of production (87%) and value (82%) was from two grains, barley and wheat.

Table 1: Production and value of South Australian grain products (2000-01)

Product	Production volume (t)	Value (\$m)
Chick Peas	3,041	1.3
Ryecorn	12,303	1.7
Lentils	34,800	17.4
Lupins	98,276	19.6
Oats	151,561	18.8
Beans	152,227	45.6
Other Feed Crops	157,652	23.6
Field peas	196,204	44.1
Canola	209,911	69.2
Barley	2,189,918	334.6
Wheat	4,440,310	767.3
Totals	7,646,203	1,343.2

Major South Australian processors of grains products are presented in Table 2.

Table 2: South Australian processors of grains products

Processor	Product
San Remo	Pasta
Balfours	Cakes
Adelaide Malting	Malt
Vili's	Bakery products
Laucke Flour mills	Flour
Pizza haven	Pizza
Weston Milling	Flour
Mexican Express	Taco
Copper Pot	Dips
Blue Lake Milling	Cereal products
Pea and Grain	Pulses

South Australian feed millers are Laucke Mills and Ridley Agri Products Pty Ltd.

## 8.2. Hazard identification

Hazards associated with grains products may be assessed from four sources:

- Implicated in food poisoning outbreaks in Australia
- Recalls monitored by FSANZ
- Overseas outbreaks caused by field crop products
- Plant health Australia and State Govt Plant Health Officers.

### 8.2.1. Australian outbreaks

In Table 3 are presented examples of illness associated with grains products which serves to identify products and hazards. There have been no outbreaks associated with grains products in Australia over the past 25 years; then, *B. cereus* in boiled and fried rice proved a problem because of poor temperature control.

Table 3: Food poisoning outbreaks associated with grains products

Product	Pathogen/agent	Country	Cases (deaths)
Red kidney beans	Lectins	UK	50
Noodles	<i>S. aureus</i>	USA	80
Tofu	<i>Y. enterocolitica</i>	USA	87
Bread	Pyrrrolizidine Alkaloids (PAs)	Afghanistan	3,906 (200)

### 8.2.2. FSANZ-monitored recalls

Over the period 1990-2001, there were 20 recalls of grains products monitored by FSANZ (Table 4). The causes of recall were microbiological in 9/20 (45%) of cases, foreign matter in 5/20 (25%) with chemical and labelling defects accounting for the remainder.

### 8.2.3. Mycological hazards

Several mycological hazards are important in grains products:

- Ergot  
Ergot affects wheat, barley, ryecorn and annual ryegrass and other grasses. It is a sclerotium of *Claviceps purpurea* and grows if conditions are cool and damp. The mould produces a number of alkaloids, which may be the cause of disease in humans such as gangrenous necrosis, hallucinations or convulsions.  
The Food Standards Code allows 500 mg/kg
- Phomopsis  
The toxin is produced by *Phomopsis leptostromiformis*, which grows primarily on lupins and causes lupinosis, a disease livestock.  
The Food Standards Code allows up to 5 µg/kg in any food.

- Fumonisin  
These toxins are produced by *Fusarium moniliformis*, mainly in maize corn. There are no maximum permissible levels stipulated in the Food Standards Code

#### 8.2.4. Chemical hazards

There are several chemical hazards, both naturally occurring and environmental which have relevance, particularly to animal health.

#### 8.2.5. Heavy metals

Lead and cadmium have relevance according to MRLs though market surveys in Australia show little exposure from grain products. PIRSA has alerted parties to high lead levels around Port Pirie.

Cadmium levels from fertilisers are minimised by importing only low-Cd fertilisers. In salinised areas e.g. around Bordertown and north of Port Pirie it is recommended that potatoes are not grown (because of their ability to accumulate cadmium).

#### 8.2.6. Pyrrolizidine alkaloids (PAs)

The toxin occurs naturally in *Heliotrope* (potato weed) and has caused illness and death among pigs in South Australia. It is very seasonal in occurrence. Incidence is greater in SA than other States.

FSANZ has not regulated PAs in the Food Standards Code but some European authorities have set levels of 0.1 - 1.0 µg/kg/day.

#### 8.2.7. Annual ryegrass toxicity (ARGT)

The cause of toxicity is Corynetoxins, which affect a range of livestock. There is a small but significant food safety risk based on a nation wide survey of grain but FSANZ have not regulated intake of the toxin.

Table 4: Recalls of grain products recorded by FSANZ 1990-2001

States involved in recalled	Product	Cause
<b>1990</b>		
	Long grain rice	Rancidity
Qld, NSW	Rive vermicelli	Mineral particles
<b>1991</b>		
NZ only	Tahini paste	<i>Salmonella</i>
	Soya crisps	Rancidity
National	Long grain rice	High level of additives
	Dried peas	Insects
<b>1995</b>		
SA, NT	Tofu	<i>B. cereus</i>
National	Rice	Insects
National	Rice bubbles	Metal

<b>1997</b>		
SA	Tofu	<i>E. coli</i>
NSW, ACT, Qld	Noodles	Microbial contamination
SA	Tofu	Microbial contamination
<b>1999</b>		
National	Tofu	Microbial contamination
National	Long grain rice	Stone
National	Tofu	Microbial contamination
National	Soya crunch	Labelling (peanuts)
<b>2000</b>		
National	Noodles	Microbial contamination
National	Tofu	Microbial contamination
<b>2001</b>		
National	Soya milk	Labelling (cows' milk)
National	Soy bean sauce	Chemical contamination

### 8.3. Risk profiling of field crop products

#### 8.3.1. Microbial hazards

From the hazard identification phase (Section 8.2) was established the hazards which have caused illness in grains products. In general, and as borne out by the epidemiology, the risk of illness from grains products is extremely low. An example is presented in Table 5, for Tofu, which has been the cause of several recalls during the past decade in South Australia. It should be emphasised that soybeans are not grown in South Australia but they are processed in the state.

Table 5: Risk ranking of consumption of *Salmonella* in tofu (unpasteurised)

Risk criteria	<i>Salmonella</i>
<b>Dose and severity</b>	
Hazard severity	Moderate
Susceptibility	General – all population
<b>Probability of exposure</b>	
Frequency of consumption	Weekly
Proportion consuming	Some (25%)

Size of population	South Australian (1.5 million)
<b>Probability of contamination</b>	
Probability of seeds contaminated	Rare (1 in 1,000)
Effect of growth (sprouting)	Decreased by 99%
Possibility of recontamination	None
Post-process control	Well controlled – cold chain
Increase to infective dose	10,000x
Further cooking before eating	Not effective in reducing hazard
Predicted illnesses per annum in selected population	1 in 50 years
Risk ranking (0-100)*	35

\* Note an increment of “6” in risk ranking is equivalent to a 10x change

Assumptions made:

- The process contains a heating step to boiling, coagulation at around 50°C.
- If a pasteurisation step is incorporated into the process the risk ranking will be reduced
- Increase to infective dose for *Salmonella* based on infective dose of  $10^{5-6}$  (see “Foodborne micro organisms of public health significance, 1997, AIFST, Sydney).

### 8.3.2. Mycological and chemical hazards

A qualitative risk ranking is presented in Table 6 based on severity of the hazard, occurrence risk, dietary exposure and epidemiological linkages.

Although the severity of natural toxins (such as PAs) and mycotoxins (such as ergot) are high, their occurrence and dietary exposure are low which, linked with the lack of epidemiological evidence in Australia, leads to a low risk ranking for these hazards.

The key to maintaining a low risk ranking is to maintain a low occurrence of the hazard. This is PIRSA’s shared responsibility with industry via a range of management and processing strategies:

#### 8.3.3. Ergot

Grain can be re-cleaned to remove ergot and meet grain silo receipt standards. Flour millers and maltsters are able to remove ergot contamination in grain via their normal grain cleaning processes that screen the grain prior to processing.

#### 8.3.4. Phomopsis

Phomopsis affects lupin grain and, in SA, only a small quantity of lupins is grown for human consumption. These are bitter albus (*Albus* spp) and are all exported.

### **8.3.5. Fumonisin**

Fumonisin can affect mainly maize corn which, in SA, is mostly grown as forage rather than for grain.

### **8.3.6. Pas**

Management of *Heliotrope* seeds is based on receival standards and, in high-risk seasons, by sampling incoming grain at the mills. If it is found, the grain is screened to remove *Heliotrope* seed.

### **8.3.7. Corynetoxins (ARGT)**

At this stage no acceptable receival standard for corynetoxin in the food chain has been set. Greater risk is to livestock fed the grain offal from grain that has been cleaned and had the toxic galls removed and concentrated in the offal. Promotion of on farm screening of grain prior to delivery would significantly reduce risk.

### **8.3.8. Heavy metals**

The management strategy is to blend grain, where necessary, to ensure bulked cereal grain loads from Port Pirie are below the domestic FSANZ and international Codex standards.

## **8.4. Risk context for PIRSA**

Based on the Risk Rankings established in section 8.3, it is clear that risk in the South Australian industry is not particularly high. There are mycological and chemical hazards which are PIRSA's responsibility and this responsibility covers 50% of Australian lucerne seed and alfalfa seed production.

*Recommendation 1: PIRSA should maintain surveillance of microbial and chemical hazards associated with grain products.*

Note: This recommendation reflects the absence of epidemiological evidence linking grain products with foodborne disease in the Australian community.

Table 6: Qualitative risk ranking of mycological and chemical hazards in South Australian grain products

Hazard	Product	Severity of hazard	Likelihood of occurrence	Exposure in diet	Linkage with epidemiology	Risk mitigated in process?	Risk ranking
<b>Mycological hazards</b>							
Ergot	Cereals	High	Medium	Low	None*	Grain receival standards Screening of sclerotia	Low
Phomopsis	Lupin	High	Medium	Low	None	Little used for human consumption - low exposure	Low
Fuminosins	Maize corn	High	Low	Low	None	Used as forage – not grown for human consumption in SA	Low
<b>Natural toxins</b>							
PAs	Cereals	Medium	Medium	Low	None*	Receival standards Screening of heliotrope seeds	Low
Corynetoxins	Cereals	Low	Medium	Low	None	There is the potential for corynetoxins to be a problem Technology exists for cleaning grain and for elimination of grain offal	Low
<b>Heavy metals</b>							
Lead	Cereals	Medium	Medium	Low	None	Crop from affected areas e.g. around Port Pirie is co-mingled with grain from other, less contaminated areas Lead levels are monitored at out turn	Low
Cadmium	Potatoes	Low	Medium	Low	None	Salinised areas have high Cadmium and it is recommended not to grow potatoes in these areas	Low
Agrivet chemicals	Cereals	Low	Low	Low	None	Recommended rates, timing of sprays and with holding periods	Low

\* No Australian outbreaks have been recorded, though there have been overseas outbreaks



# Appendix A: Definitions associated with risk profiling

These definitions were adopted for microbiological, chemical, or physical agents and Risk Management and Risk Communication on an interim basis at the 22nd Session of the Codex Alimentarius Commission.

## **Dose-Response Assessment**

The determination of the relationship between the magnitude of exposure (dose) to a chemical, biological or physical agent and the severity and/or frequency of associated adverse health effects (response).

## **Exposure Assessment**

The qualitative and/or quantitative evaluation of the likely intake of biological, chemical, and physical agents via food as well as exposures from other sources if relevant.

## **Hazard**

A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

## **Hazard Characterization**

The qualitative and/or quantitative evaluation of the nature of the adverse health effects associated with the hazard. For the purpose of Microbiological Risk Assessment the concerns relate to micro-organisms and/or their toxins.

## **Hazard Identification**

The identification of biological, chemical, and physical agents capable of causing adverse health effects and which may be present in a particular food or group of foods.

## **Quantitative Risk Assessment**

A Risk Assessment that provides numerical expressions of risk and indication of the attendant uncertainties (stated in the 1995 Expert Consultation definition on Risk Analysis).

## **Qualitative Risk Assessment**

A Risk Assessment based on data which, while forming an inadequate basis for numerical risk estimations, nonetheless, when conditioned by prior expert knowledge and identification of attendant uncertainties permits risk ranking or separation into descriptive categories of risk.

## **Risk**

A function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food.

## **Risk Analysis**

A process consisting of three components: risk assessment, risk management and risk communication.

**Risk Assessment**

A scientifically based process consisting of the following steps:

- (i) hazard identification
- (ii) hazard characterization
- (iii) exposure assessment
- (iv) risk characterization.

**Risk Characterization**

The process of determining the qualitative and/or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of known or potential adverse health effects in a given population based on hazard identification, hazard characterization and exposure assessment.

**Risk Communication**

The interactive exchange of information and opinions concerning risk and risk management among risk assessors, risk managers, consumers and other interested parties.

**Risk Estimate**

Output of Risk Characterization.

**Risk Management**

The process of weighing policy alternatives in the light of the results of risk assessment and, if required, selecting and implementing appropriate control options, including regulatory measures.

**Transparent**

Characteristics of a process where the rationale, the logic of development, constraints, assumptions, value judgements, decisions, limitations and uncertainties of the expressed determination are fully and systematically stated, documented, and accessible for review.

**Uncertainty analysis**

A method used to estimate the uncertainty associated with model inputs, assumptions and structure/form.

# Appendix B: Foodborne microbial hazards and their characteristics

In this appendix are identified microbial food-borne hazards that may be associated with meat and poultry products.

For selected pathogens more regularly associated with outbreaks, description is given of the organism, incidence and disease caused, and members of the population at increased risk.

## Cattle and Sheep

Agriculture, Food and Forestry Australia (AFFA) has compiled a list of hazards that may be associated with red meat and food derived from it. That list includes both microbiological and chemical hazards and is divided into primary hazards (i.e. those arising on-farm) and those that may arise during subsequent processing.

### Primary Hazards

#### Microbiological

*Brucella* spp, *Salmonella* spp., *Listeria monocytogenes*, *Bacillus anthracis*, *Clostridium perfringens*; *Coxiella burnetii*, Enterovirulent *E. coli*, *Clostridium* spp., *Staphylococcus aureus*, *Campylobacter jejuni*, *Mycobacterium bovis*, *Yersinia enterocolitica*, viruses & prions.

#### Parasitic

##### Cattle

*Cysticercus bovis*, *Onchocerca* Spp., *Echinococcus granulosus*, *S medusiformis* and *S gigantea* , *T. saginata*.

##### Sheep

*Cysticercus ovis*, *Toxoplasma gondii*, *Fasciola hepatica*

### Secondary Hazards

#### Microbiological

*Salmonella* spp., Enterovirulent *E. coli*, *Clostridium* spp., *Staphylococcus aureus*, *Campylobacter jejuni*, *Mycobacterium tuberculosis*, *Yersinia enterocolitica*, viruses including Hepatitis virus and other pathogens from human carriers and the environment.

#### Parasitic

Parasites such as *Cryptosporidium*, *Cyclospora*, and *Giardia*

Cross contamination from raw meats has been recognised as a mode of transmission for *Campylobacteriosis*. Thermotolerant *Campylobacter*, *E. coli* EHEC, VTEC, EHEC infections, specifically those caused by *E. coli* O157:H7 and predominantly associated with contamination of minced meat, have caused large and serious outbreaks. Most outbreaks of EHEC disease have been associated with the consumption of beef, primarily under-cooked ground beef. Modes of transmission other than foodborne spread have also been identified, including person-to-person transmission, contact with infected farm animals, and from swimming in a faecally contaminated lake. Cattle are considered to be the main reservoir of

the infection (EHEC organisms are part of the normal intestinal flora of a small percentage of cattle).

## Swine

The major causes of foodborne disease associated with pig meat at the on-farm production stages are bacterial, with *E. coli*, *Salmonella* and *Campylobacter* species at the top of the list. A small US survey of *Salmonella*, *Campylobacter*, *Y. enterocolitica*, *S. aureus*, EHECs and total viable bacterial counts in meats from retail display outlets. The sample size chosen (120) gave 95% certainty of including at least one positive sample if 3% or more packs were contaminated with the organism under investigation. No *Salmonella*, *Campylobacter* (*C. jejuni* or *C. coli*), *Y. enterocolitica* or *E. coli* O157 were isolated in the survey. This indicated an incidence of these pathogens of less than 3%, which is at the lower end of the range encountered in the rest of the world. In a survey of pigs in England, non-STE C O157 was isolated from four (0.4%) faecal samples collected (after slaughter) from 1,000 pigs. A 1.4% carriage rate of STE C O157:H7 was reported in Japan. To date, pork has not been identified as a source of human STE C O157:H7 illness in industrialized countries.

## Poultry

*Campylobacter* and *Salmonella* are the pathogens of principal concern to the poultry industry at present and poultry meat is frequently contaminated with both organisms. Currently, over 80% of *Salmonella* positive carcasses are contaminated by *S. Sofia*, a species regarded as having virtually no virulence for humans, with other *Salmonellae* each accounting for less than about 5% of positive carcasses. 30-40% of *Salmonella* isolates from humans are *S. Typhimurium*, a relatively pathogenic bacterium to humans, whereas the incidence of *S. Sofia* is very low, probably due to its low pathogenicity in humans. For *Campylobacter*, about 60% of the types found on poultry carcasses are not found in the human population.

In the USA, foods prepared in commercial establishments and institutions included most of the outbreaks associated with meat, poultry, egg, seafood and dairy foods (Bean and Griffin 1990). In the UK, cooked and processed meat were the most significant vehicles of foodborne illness associated with manufactured food (Sockett 1995).

## Descriptions of Pathogens

- *Salmonella*
- Pathogenic *Escherichia coli*
- *Listeria monocytogenes*
- *Yersinia pseudotuberculosis* or *Y. enterocolitica*
- *Campylobacter jejuni* and *C. coli*
- *Staphylococcus aureus*
- Taeniasis - *Taenia solium* (pork tapeworm), *Taenia saginata* (beef tapeworm)
- Trichinellosis (*Trichinella spiralis*)
- Shigellosis

## Salmonella

**Clinical Features** Fever, abdominal cramps, and diarrhoea (sometimes bloody). Occasionally can progress to sepsis.

**Etiologic Agents** Enterobacteriaceae of the genus *Salmonella*. Approximately 2000 serotypes cause human disease.

### Incidence

A total of 6113 cases of salmonellosis (not elsewhere classified, i.e. not typhoid) were reported in 2000. The annual notification rate was ~40 per 100,000 population, with a decrease evident since 1998. The highest rate was reported in the Northern Territory, with more than twice the notification rates for the States and other Territory. The highest rate of notification (300+ per 100,000 population) was in Kimberley in Western Australia.

Notifications of Salmonellosis (NEC) received by State and Territory health authorities in the period of 1991 to 2000 and year-to-date notifications for 2001 by year - States and Territories

YEAR	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total
1991	36	1161	471	1443	491	210	903	725	5440
1992	19	815	370	1492	348	133	776	661	4614
1993	42	994	384	1367	396	144	722	682	4731
1994	44	1097	475	1450	488	119	1055	599	5327
1995	83	1395	369	1579	648	139	965	717	5895
1996	60	1244	422	2009	377	129	939	639	5819
1997	72	1706	347	1835	570	116	1785	574	7005
1998	75	1828	410	2941	521	110	1146	669	7700
1999	65	1695	367	2159	958	151	1234	701	7330
2000	104	1316	302	1831	453	122	1035	950	6113
2001	0	45	13	55	5	0	15	0	133

- This table was updated on 18 January 2001 for the reporting period to 2 January 2001.
- Please note that 2000 and 2001 data are provisional and may be revised.

### Sequelae

Estimated >500 fatal cases each year in USA; equivalent to ~ 40 in Australia. 2% of cases are complicated by chronic arthritis.

### Transmission

Contaminated food, water, or contact with infected animals.

### Risk Groups

Affects all age groups. Groups at greatest risk for severe or complicated disease include infants, the elderly, and persons with compromised immune systems.

## Pathogenic *Escherichia coli*

**Clinical Features** Acute bloody diarrhoea and abdominal cramps with little or no fever; usually lasts 1 week.

**Etiologic Agent** *Escherichia coli* serotype O157:H7. Gram-negative rod-shaped bacterium producing Shiga toxin(s).

**Incidence** The reported incidence in Australia is ~40 cases/year, much lower than the estimated 73,000 cases occur annually in the United States, but it is notifiable in only two Australian states. Under-reporting was estimated to be 20-fold in USA, but would be expected to be greater in Australia.

Notifications of SLTEC, VTEC received by State and Territory health authorities in the period of 1991 to 2000 and year-to-date notifications for 2001 by year - States and Territories

YEAR	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total
1991	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	20	0	0	0	20
1998	0	0	0	0	11	0	1	0	12
1999	0	0	0	0	37	0	5	0	42
2000	0	0	0	0	36	0	0	0	36
2001	0	0	0	0	0	0	0	0	0

- This table was updated on 18 January 2001 for the reporting period to 2 January 2001.
- Please note that 2000 and 2001 data are provisional and may be revised.
- Not Notifiable until August 1998.
- Not Notifiable in the Australian Capital Territory, the Northern Territory, Queensland, Victoria or Western Australia.

**Sequelae** Haemolytic uraemic syndrome (HUS): Persons with this illness have kidney failure and often require dialysis and transfusions. Some develop chronic kidney failure or neurological impairment (e.g., seizures or blindness). Some have surgery to remove part of the bowel. Death (3-5% with HUS die).

**Costs** The illness is often misdiagnosed; therefore, expensive and invasive diagnostic procedures may be performed. Patients who develop HUS often require prolonged hospitalisation, dialysis, and long-term follow-up.

**Transmission** Major source is ground beef; other sources include consumption of unpasteurised milk and juice, sprouts, lettuce, and salami, and contact with cattle. Waterborne transmission occurs through swimming in contaminated lakes, pools, or drinking inadequately chlorinated water. Organism is easily transmitted from person to person and has been difficult to control in child day-care centres.

**Risk Groups** All persons. Children <5 years old and the elderly are more likely to develop serious complications.

**Risk Groups** All persons. Children <5 years old and the elderly are more likely to develop serious complications.

## Listeria monocytogenes

**Clinical Features** Manifestations are host dependent. In elderly and immunocompromised persons, sepsis and meningitis are the main presentations. Pregnant women experience a mild, flu-like illness followed by foetal loss or bacteraemia and meningitis in their newborns. Immunocompetent persons may experience acute febrile gastroenteritis.

**Etiologic Agent** *Listeria monocytogenes*

**Incidence** Approximately 3 culture-confirmed cases *per* million population annually, in most developed nations. The vast majority of cases are assumed to be foodborne. Annual incidence rates are shown below.

There were 65 notifications for listeriosis in 2000, similar to previous years. The Australian Capital Territory was the only State or Territory with no reports. The notification rate was 0.3 per 100,000 population (Table 2A2), consistent with the rates for the period 1992 to 1999.

Notifications of Listeriosis received by State and Territory health authorities in the period of 1991 to 2000 and year-to-date notifications for 2001 by year - States and Territories

YEAR	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total
1991	0	8	0	7	0	3	26	0	44
1992	0	16	0	6	2	0	14	0	38
1993	1	13	0	7	4	0	24	4	53
1994	1	8	0	13	3	0	8	1	34
1995	3	15	1	8	4	1	23	3	58
1996	3	20	0	8	15	1	19	4	70
1997	0	21	0	9	6	1	15	19	71
1998	1	30	0	4	2	2	15	4	58
1999	0	22	0	11	3	1	13	12	62
2000	0	15	3	13	7	4	11	12	65
2001	0	2	0	0	0	0	0	0	2

- This table was updated on 18 January 2001 for the reporting period to 2 January 2001.
- Please note that 2000 and 2001 data are provisional and may be revised.

**Sequelae** An estimated 60-70 fatal cases each year. Mortality is typically 20 – 30% of diagnosed cases.

**Transmission** Contaminated food. Rare cases of nosocomial transmission have been reported.

**Risk Groups** For invasive disease, immunocompromised individuals, pregnant women and their foetuses and neonates, and the elderly.

## **Yersinia pseudotuberculosis or Y. enterocolitica**

**Clinical Features** Children - fever, abdominal pain, and diarrhoea, which is often bloody. Adults - right-sided abdominal pain and fever. Symptoms develop within 4-7 days. Duration of illness 1-3 weeks, maybe longer

**Etiologic Agent** Most illness caused by *Y. enterocolitica*. *Y. pseudotuberculosis* similar illness though not as common

**Incidence** 1 per 100000 ppl, more common in children and during winter. In Australia it is most commonly reported in Queensland, though reported cases have been falling steadily over the last decade.

There were 74 notifications of yersiniosis in 2000, from all States and Territories except New South Wales. The number of reports of yersiniosis continues to decrease. The greatest number of reports and the highest notification rate were both from Queensland.

Slightly higher numbers were reported early in the year following the same pattern of previous years. The overall male to female ratio was 1.7:1. The highest age group specific rates occurred in the 0-4 years age group for both males and females.

Notifications of Yersiniosis (NEC) received by State and Territory health authorities in the period of 1991 to 2000 and year-to-date notifications for 2001 by year - States and Territories

YEAR	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total
1991	0	0	18	255	180	0	60	2	515
1992	0	0	11	332	172	2	43	7	567
1993	0	0	3	324	79	0	51	2	459
1994	0	0	1	291	97	1	21	3	414
1995	1	0	2	177	96	2	24	4	306
1996	0	0	2	192	53	0	15	6	268
1997	2	0	3	181	43	1	15	0	245
1998	1	0	3	141	35	2	24	1	207
1999	1	0	0	100	18	0	17	6	142
2000	3	0	2	59	0	0	9	1	74
2001	0	0	0	2	0	0	0	0	2

- This table was updated on 18 January 2001 for the reporting period to 2 January 2001.
- Please note that 2000 and 2001 data are provisional and may be revised.

**Transmission** Animal reservoir primarily pigs, also rodents, rabbits, sheep, cattle, horses, dogs, and cats. Contaminated milk or untreated water, contact with infected animals, faecal-oral infections and rarely through contaminated blood

## *Campylobacter jejuni* and *C. coli*

**Clinical Features** Incubation periods of between 2 and 11 days, 3-5 the most common. In adults: onset quite fast. Duration ~<1 week. Recurrence of symptoms in 25% of cases. In children: vomiting in ~50% of cases, few patients with abdominal pain.

**Etiologic Agent** *Campylobacter jejuni* and *C. coli* two most common causes of infection with this genus

**Incidence** Most common foodborne disease notified in Australia. There were 13,441 cases of *Campylobacteriosis* reported in 2000, continuing the increase in the number of notifications of *Campylobacteriosis* from 1992 to 1997. The rate of notification in 2000 is ~100 per 100,000 population, the highest rate for all notifiable infections in Australia. The highest rate by State/Territory continued to be reported in South Australia, with ~130 cases per 100,000 population. New South Wales was excluded from the analysis.

*Campylobacteriosis* was reported from all jurisdictions where it was notifiable. The highest notification rates (160+ per 100,000 population) were seen in the South West in Queensland, Kimberley in West Australia, and Eyre and Yorke and Lower North in South Australia.

Notifications of *Campylobacteriosis* received by State and Territory health authorities in the period of 1991 to 2000 and year-to-date notifications for 2001 by year - States and Territories

YEAR	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total
1991	95	0	409	2644	1581	729	2303	911	8672
1992	35	0	380	3065	2138	445	2066	1007	9136
1993	151	0	368	2467	1646	443	2136	900	8111
1994	308	0	324	2109	2318	503	3479	1076	10117
1995	296	0	353	2094	3272	475	2938	1505	10933
1996	256	0	262	3030	2638	456	3555	1961	12158
1997	261	0	206	4057	1939	361	3612	1415	11851
1998	390	0	196	4454	2284	351	4083	1691	13449
1999	298	0	242	3068	2431	416	4772	1416	12643
2000	334	0	177	3683	1883	444	4919	2001	13441
2001	3	0	10	102	8	0	0	0	123

- This table was updated on 18 January 2001 for the reporting period to 2 January 2001.
- Please note that 2000 and 2001 data are provisional and may be revised.
- In New South Wales reported only as 'foodborne disease' or gastroenteritis in an institution'.

The number of notifications was highest in the warmer months (January, February and October to December). The male to female ratio was 1.1:1. The distribution of notifications was bimodal with a high peak in the 0-4 years age group and a rise in the 20-29 years age groups. The highest rate of notification was seen in the 0-4 year age group (males 377 per 100,000 and females 304 per 100,000 population).

**Sequelae** Symptoms intestinal but sometimes flu-like prodromal period with associated malaise, headache, shivering, dizziness and myalgia.

Intestinal symptoms more pronounced if following a prodrome.  
Diarrhoea – severe and prostrating to a few loose stools. Abdominal pain

**Transmission** When isolated associated with chicken, water and milk  
**Risk Groups** bimodal distribution, in the UK children between 1-4 yrs, and between 15-24yrs. Male homosexuals at greater risk to *Campylobacter* enteritis. Systemic infections mainly in those with underlying predisposition – malignant diseases such as leukaemia, immunosuppression, alcoholism, liver cirrhosis, diabetes, chronic renal failure and gastrectomy (Skirrow, 1984). Pregnancy also a risk factor (Weinberg, 1984). Excluding pregnancy, systemic infections predominantly in males 45yrs or older.

### **Staphylococcus aureus**

**Clinical Features** Symptoms usually appear within 2 - 4 hours. Symptoms generally persist for less than 24 hours

**Etiologic Agent** *Staphylococcus aureus*, a gram positive, coccus-shaped bacterium.

**Sequelae** nausea, retching, vomiting and less frequently diarrhoea. Fever has been found in ~16% of cases. With severe cases – dehydration, shock and collapse, accompanied by shallow breathing and weak pulse. Up to 10% of sufferers seek medical attention. Death rare. Symptoms may be confused with *B.cereus* emetic infection.

**Transmission** Often from food workers. The organism is commonly found on the skin of 25 – 30% of the human population.

**Risk Groups** Wide variation among normal adults, but greatest susceptibility in the young and old. Unhealthy people are at greater risk, but no particular predisposing condition for staphylococcal infection.

### **Taeniasis - *Taenia solium* (pork tapeworm), *Taenia saginata* (beef tapeworm)**

**Clinical Features** Clinical manifestations of infection may include nervousness, anorexia, insomnia, weight loss, abdominal pain and digestive disturbances. Generally non-fatal, however *T. solium* may cause fatal cysticercosis

**Etiologic Agent** Intestinal infection with both organisms, and a somatic infection from the larvae of the pork tapeworm.

**Incidence** Worldwide spread, especially when beef or pork is eaten raw or undercooked and when sanitary conditions allow access of pigs and cattle to have contact with human faeces.

**Sequelae** Incubation may take from days to about 10 years. Eggs appear in stool after 8-12 weeks *T. solium* and 10-14weeks with *T. saginata*

**Transmission** Rare in the US, Canada UK and Scandinavia. Mode of transmission: eggs in stool of infected person only infectious to cattle. Infection in humans due to ingestion of raw/undercooked pork or beef. *T. saginata* not directly transmissible between people, *T. solium* may be.

**Risk Groups** No particular risk groups. No apparent resistance after infection, however more than one tapeworm/person has rarely been reported

## Trichinellosis (*Trichinella spiralis*)

**Clinical Features** Unapparent infection, to fatal disease. Sudden onset of muscle soreness and pain together with oedema of the upper eyelids are early characteristic signs. Thirst, profuse sweating, chills, weakness, prostration and rapidly increasing eosinophilia.

**Etiologic Agent** Intestinal round worm – *Trichinella spiralis*

**Incidence** Worldwide occurrence, variable incidence depending in part on eating habits and preparation of pork and wild game meats. Prevalence in the US is <2%. Sporadic cases and outbreaks often localised.

**Sequelae** Systemic symptoms generally appear about 8-15 days after ingestion of infected meat. May range from 5 to 45 days depending on the infectious dose.

### Costs

**Transmission** Through ingestion of raw or undercooked flesh of animals containing viable encysted larvae, chiefly pork and pork products. Not transmitted between people.

**Risk Groups** Susceptibility is universal, no particular at risk groups. Infection elicits a partial immunity.

## Shigellosis

486 cases of Shigellosis were notified in 2000, from all States and Territories except New South Wales, continuing a downward trend. The notification rate is 5 per 100,000 population. The highest rate was reported in the Northern Territory (~50 per 100,000 population).

There was a bimodal distribution of notifications with peaks in the 0-4 years and 20-24 years age groups. The highest age group specific rates occurred in the 0-4 years age group for both males and females (males 18.1 and females 21.3 per 100,000 population, respectively). The overall male to female ratio was 1.1:1.

Notifications of Shigellosis received by State and Territory health authorities in the period of 1991 to 2000 and year-to-date notifications for 2001 by year - States and Territories

YEAR	ACT	NSW	NT	Qld	SA	Tas	Vic	WA	Total
1991	4	0	361	87	88	1	80	281	902
1992	3	0	220	88	86	4	90	203	694
1993	3	0	136	186	86	1	104	192	708
1994	8	0	127	148	63	2	87	289	724
1995	7	0	199	222	76	1	82	147	734
1996	3	0	149	242	57	2	73	150	676
1997	5	0	169	207	107	4	79	228	799
1998	11	0	98	163	65	3	120	155	615
1999	5	0	116	125	70	1	116	112	545
2000	7	0	113	106	31	2	116	111	486
2001	0	0	3	3	1	0	0	0	7

- This table was updated on 18 January 2001 for the reporting period to 2 January 2001.
- Please note that 2000 and 2001 data are provisional and may be revised.
- In New South Wales, Shigellosis is reported as 'foodborne disease' or 'gastroenteritis in an institution'.

## Appendix C: MEAN DAILY INTAKE FOR PERSONS AGED 19 YEARS AND OVER: STATE AND TERRITORY (average grams per person)

Selected major and sub-major food groups(a)	State and Territory							
	NSW	Vic.	Qld	SA	WA	Tas.	ACT	Aust. (b)
Persons								
Cereals and cereal products	221.6	225.8	190.5	205.5	222.7	185.4	260.6	215.2
Regular breads, and rolls	89.2	92.2	92.7	91.6	93.4	93.9	98.9	91.3
Breakfast cereals, plain, single source	10.6	11.1	11.0	10.7	9.5	10.4	11.3	10.6
Fancy breads, flat breads, English-style muffins and crumpets	11.2	11.8	8.0	10.5	9.1	7.4	12.6	10.4
Pasta and pasta products	30.4	39.2	20.5	28.1	25.2	22.6	50.6	30.3
Rice and rice products	48.0	39.0	26.8	35.6	51.1	19.9	48.1	40.4
Breakfast cereals, mixed source	12.1	13.5	13.5	13.1	15.0	12A	18.7	13.2
Breakfast cereal, hot porridge type	19.2	18.2	17.0	15.4	19.0	16.6	19.6	18.0
Cereal-based products and dishes	117.7	141.3	119.7	147.1	124.7	103.0	111.9	126.7
Sweet biscuits	9.2	7.9	10.0	10.0	8.4	9.8	9.9	9.0
Savoury biscuits	4.0	4.7	3.6	4.1	3.1	3.3	4.8	4.0
Cakes, buns, muffins, scones, cake-type desserts	21.8	25.3	26.5	27.7	22.8	22.7	21.7	24.0
Pastries	29.1	34.1	29.5	43.0	33.6	32.1	26.7	32.1
Mixed dishes where cereal is the major ingredient	49.6	64.0	46.9	59.7	53.5	33.4	46.8	53.7
Batter-based products	3.9	5.3	3.3	2.5	3.2	* 1.7	* 2.0	3.9
Fruit products and dishes	140.7	140.5	150.0	148.9	155.3	118.7	137.1	143.5
Pome fruit	41.3	44.8	36.1	50.4	55.9	42.0	42.5	43.3
Berry fruit	1.9	2.5	1.6	1.9	2.3	2.5	* 2.6	2.1
Citrus fruit	20.2	22.8	16.9	21.4	21.0	12.0	15.5	20.1
Stone fruit	18.4	16.7	15.5	18.7	16.1	15.7	20.4	17.1
Tropical fruit	28.9	30.2	37.3	30.7	24.8	24.9	29.9	30.4
Other fruit	21.2	15.4	31.0	15.3	27.5	10.4	13.1	21.2
Mixtures of two or more groups of fruit	5.2	5.4	7.1	6.0	3.3	6.3	10.8	5.6

Dried fruit, preserved fruit	2.9	1.7	3.1	3.2	3.3	2.0	1.9	2.7
Vegetable products and dishes	261.4	243.6	273.0	245.4	271.6	280.5	256.2	258.8
Potatoes	86.7	83.3	97.2	91.1	93.2	116.8	81.5	89.3
Cabbage, cauliflower and similar brassica vegetables	19.8	23.2	19.4	20.7	30.1	23.5	25.2	21.8
Carrot and similar root vegetables	20.5	22.2	21.5	21.6	24.1	30.0	19.4	21.8
Leaf and stalk vegetables	21.2	14.8	13.1	15.0	15.9	11.3	17.7	16.8
Peas and beans	18.7	19.3	18.6	16.8	19.3	18.6	17.4	18.7
Tomato and tomato products	37.1	28.2	35.5	29.7	34.6	29.3	37.2	33.4
Other fruiting vegetables	29.4	26.3	37.3	22.9	23.6	25.3	30~8	28.9
Other vegetables and vegetable combinations	24.7	21.3	25.4	23.2	26.9	19.2	23.8	23.9
Dishes where vegetable is the major component	3.3	5.0	4.9	* 4.3	* 4.0	* 6.4	* 3.2	4.3
Legume and pulse products and dishes	10.8	10.0	7.5	8.3	12.4	5.2	12.2	9.8
Mature legumes and pulses	1.7	2.2	1.1	1.7	* 2.0	0.4	* 2.1	1.7
Mature legumes and pulse products and dishes	9.1	7.7	6.4	6.6	10.5	4.8	10.1	8.1
Milk products and dishes	268.4	285.3	306.1	326.1	311.2	269.1	312.4	289.3
Dairy milk	192.7	206.4	218.9	205.3	203.2	196.0	217.6	203.5
Yoghurt	12.0	15.2	14.3	12.0	17.1	11.5	19.0	13.8
Cream	2.4	3.5	2.2	3.9	3.1	4.7	* 3.0	2.9
Cheese	13.3	15.5	14.1	17.5	15.0	13.4	18.7	14.6
Frozen milk products	16.2	16.7	21.0	18.0	17.1	18.3	22.8	17.6
Other dishes where milk or a milk product is the major component	11.7	10.6	14.1	12.0	14.5	13.0	8.2	12.1
Milk substitutes	5.4	5.1	3.6	3.8	* 7.9	2.3	5.3	5.0
Flavoured milks	14.6	12.3	17.9	53.7	33.3	9.9	17.7	19.7
Meat, poultry and game products and dishes	156.2	149.1	169.6	150.3	160.1	149.8	187.6	157.4
Muscle meat	45.8	46.2	53.8	47.2	42.8	58.0	49.7	47.5
Poultry and other feathered game	21.8	19.4	23.8	20.5	27.8	15.7	23.1	21.9
Organ meats and offal, products and dishes	**1.6	0.9	* 1.0	1.3	0.8	* 1.0	1.2	1.2
Wages, frankfurts, and saveloys	9.2	10.0	14.5	9.5	8.2	12.8	7.0	10.3
Processed meat	5.7	4.9	5.7	6.2	5.3	3.3	4.8	5.4
Mixed dishes where beef or veal is the major component	40.2	40.2	43.8	38.0	41.5	36.4	58.5	41.2
Mixed dishes where lamb or pork, bacon, ham is the major component	8.1	7.5	7.8	7.3	12.3	5.3	11.6	8.2
Mixed dishes where poultry or								

game is the major ingredient	23.8	19.9	19.0	19.3	21.4	17.1	31.5	21.5
Fish and seafood products and dishes	31.5	20.5	18.5	22.5	34.1	31.3	26.9	25.7
Fin fish (excluding canned)	8.4	4.8	4.9	5.4	7.4	8.5	* 4.4	6.4
Crustacea and molluscs (excluding canned)	4.5	1.1	1.4	* 2.0	* 3.6	0.9	* 2.6	2.7
Packed (canned and bottled) fish and seafood	3.4	3.5	3.1	2.7	3.6	2.3	* 3.7	3.3
Fish and seafood products	6.4	6.1	7.1	7.0	9.7	14.1	* 6.8	7.0
Mixed dishes with fish or seafood as the major component	8.8	5.0	2.2	* 5.3	* 9.8	5.5	* 9.3	6.3
Egg products and dishes	13.3	13.7	16.6	10.9	13.2	12.4	9.2	13.7
Eggs	7.5	7.7	9.0	6.5	9.5	8.0	6.0	7.9
Dishes where egg is the major ingredient	5.8	6.0	7.6	4.4	3.8	4.4	* 3.2	5.8
Snack foods	3.8	3.8	2.8	4.0	2.9	2.5	4.0	3.5
Potato snacks	2.1	2.2	1.6	2.3	1.6	1.5	* 2.8	2.0
Corn snacks	0.8	1.0	0.9	* 0.9	* 1.0	0.6	* 0.5	0.9
Extruded snacks	0.7	0.5	0.3	* 0.5	* 0.3	0.5	* 0.4	0.5
Sugar products and dishes	17.7	18.8	21.6	19.2	19.2	24.1	20.4	19.1
Sugar, honey and syrups	11.7	13.2	14.9	13.1	11.5	16.8	11.8	12.9
Jam and lemon spreads, chocolate spreads	2.6	3.3	3.1	3.2	3.1	4.1	3.7	3.0
Dishes and products other than confectionery where sugar is the main component	3.4	2.2	3.6	2.9	4.6	3.1	4.9	3.2
Confectionery	7.1	9.5	8.4	11.0	10.6	10.8	12.9	8.8
Chocolate and chocolate-based confectionery	4.6	6.1	5.6	7.3	7.9	8.9	9.2	5.9
Cereal-, fruit-, nut-, and seed-bars	0.9	1.3	1.3	1.1	0.7	0.6	* 1.6	1.0
Other confectionery	1.7	2.1	1.5	2.6	2.0	1.3	* 2.1	1.8
Seed and nut products and dishes	4.8	4.4	4.3	4.4	3.2	2.3	4.7	4.3
Nuts and nut products	4.5	4.3	4.0	4.4	3.1	2.2	4.6	4.2
Fats and oils	12.4	12.5	11.9	11.8	10.9	16.0	11.4	12.1
Dairy fats	3.4	3.6	3.9	2.3	3.0	5.4	2.6	3.5
Margarine	8.0	7.9	7.2	8.3	7.1	9.7	7.7	7.8
Vegetable oil	0.5	0.6	0.3	0.5	0.3	0.1	0.3	0.5
Unspecified fats	0.6	0.3	0.4	0.7	0.4	0.8	0.8	0.5
Soup	51.1	79.6	26.4	59.1	55.7	44.5	69.0	54.8
Soup	50.9	79.4	25.5	58.8	55.6	44.4	68.1	54.4
Savoury sauces and condiments	28.3	31.2	28.4	27.3	30.7	29.4	30.2	29.2
Gravies and savoury sauces	22.1	26.0	23.3	20.1	23.7	23.9	24.3	23.3

Pickles, chutneys and relishes	2.3	2.1	2.2	3.7	3.4	2.5	1.8	2.5
Salad dressings	3.7	2.9	2.5	3.2	3.3	2.9	4.0	3.2
Non-alcoholic beverages	1,892.3	1,853.9	2,287.5	1,940.8	2,145.1	1,678.2	1,875.4	1,983.4
Tea	386.4	406.2	421.8	371.3	411.7	430.5	374.7	399.0
Coffee and coffee substitutes	377.3	462.9	428.5	486.1	436.1	468.9	449.6	426.0
Fruit and vegetable juices and drinks	124.9	123.0	110.0	151.8	117.7	121.9	164.8	124.2
Soft drinks, flavoured mineral waters and electrolyte drinks	189.7	162.0	192.3	168.3	195.5	118.5	137.6	180.3
Mineral waters and water(c)	812.7	695.7	1,134.5	762.3	981.9	538.1	746.9	851.9
Alcoholic beverages	262.7	222.3	272.3	229.0	267.5	265.7	250.0	253.8
Beers	192.5	153.0	224.9	158.4	207.1	230.3	157.0	188.8
Wines	59.0	53.7	34.8	62.7	47.9	29.5	77.2	52.5
Spirits	3.9	2.3	4.8	3.3	3.7	* 2.2	* 3.3	3.5
Other alcoholic beverages	7.3	13.3	7.8	4.6	8.9	* 3.6	12.5	9.0
Miscellaneous	1.5	1.7	1.7	1.5	1.4	1.9	1.5	1.6
Beverage flavourings	0.4	0.6	0.6	0.6	0.5	0.7	0.3	0.5
Yeast; yeast, vegetable and meat extracts	0.9	0.8	1.0	0.8	0.7	1.1	1.0	0.9
Artificial sweetening agents	-	0.1	0.1	0.1	-	-	-	-
Herbs, spices, seasonings and stock cubes	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1
Total	3,503.73	467.8	3,917.2	3,573.3	3,853.6	3,231.3	3,594.2	3,611.3