1997/98 New Zealand
Total Diet Survey

Part 1 : PESTICIDE RESIDUES

Prepared as part of a Ministry of Health
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by

Peter Cressey, ESR
Richard Vannoort, ESR
Karen Silvers, C&FR
Barbara Thomson, ESR

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1997/98 New Zealand
Total Diet Survey

Part 1 : PESTICIDE RESIDUES

Peter Cressey
Food Programme Manager

Richard Vannoort
Project Leader

Jefferson Fowles
Peer Reviewer

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

The 1997/98 New Zealand Total Diet Survey (NZTDS) was carried out for the Ministry of Health by the Institute of Environmental Science & Research Limited (ESR) as the lead agency, the New Zealand Institute for Crop & Food Research Ltd (C&FR), and Health Protection Officers (HPOs).

The documented objectives of the 1997/98 NZTDS were:

- to assess the health implications of levels of selected pesticide residues, contaminant and nutrient elements in the New Zealand food supply (based on the NZTDS food list, which represents at least 70% of the most consumed food items);

- to estimate the potential dietary exposure to selected pesticide residues, contaminant and nutrient elements by interpreting data from the NZTDS in terms of simulated typical diets of a number of New Zealand population sub-groups. The project:
  - assessed the chemical status of the New Zealand food supply;
  - indicated any potential exposure concerns;
  - demonstrated trends in dietary exposure; and
  - made comparisons with exposure estimates derived in other countries;

- to contribute data to the World Health Organization (WHO) Global Environmental Monitoring System (GEMS)/Food programme, so that accurate international comparisons can be made of New Zealand dietary exposure to chemical contaminants;

- to provide, where appropriate, data on the pesticide residue, contaminant and selected nutrient element (iodine, selenium, and zinc) content of food, suitable for incorporation into the New Zealand Food Composition Database for use by interested parties; and

- to make data on the pesticide residue, contaminant and selected nutrient element (iodine, selenium, and zinc) content of food available to stakeholders in a timely manner during the course of the NZTDS.

The 1997/98 NZTDS involved sampling 114 different foods, of which 105 were considered to be those most commonly consumed by the majority of New Zealanders, and analysing these foods to determine the concentrations of selected pesticide residues, contaminant and nutrient elements. Changes to the food list since the 1990/91 NZTDS included addition of a wider range of snack and takeaway foods, a wider range of vegetables, and inclusion of some vegetarian foods such as hummus and tofu. Foods were allocated into 11 food groups - Grains, Dairy, Oils and Fats, Animal (chicken, eggs, fish and meat), Vegetables, Fruits, Spreads and Sweets, Alcoholic Beverages, Takeaways, Nuts, and Non-alcoholic Beverages. This was to enable comparison with previous NZTDSs and to identify food groups which were likely to contain specific pesticide residues, contaminant or nutrient elements.

Fortnightly simulated typical diets using these 114 foods were derived mainly from food frequency and 24 hour diet recall data from the 1989/90 Life in New Zealand (LINZ) survey because data from the 1997 National Nutrition Survey (NNS) were not yet available. The fortnightly simulated typical diets were established for six age-sex groups, 19-24 years young male (YM), 25+ years male (M), 25+ years female (F), 19-40 years lacto-ovo vegetarian female

(VF), 4-6 years child (C) and 1-3 years young child (YC). From these fortnightly diets, the weight of each individual food item consumed was determined.

The exposures to pesticides residues, and contaminant or nutrient elements from a food could then be estimated by multiplying the mean concentration of the particular chemical by the amount of that food consumed. By adding the contributions of all foods in the simulated diet, the total dietary exposure to the chemical could be estimated.

The 114 foods were, for the purpose of sampling, split into two groups - one comprising 66 national foods and the other 48 foods sampled on a regional basis. National foods were defined as those that were manufactured in one location and distributed throughout New Zealand, or they were imported and distributed nationally (such as bananas and sultanas). The geographical region where the national foods were purchased should have no bearing on the levels of pesticide residues, contaminant or nutrient elements in the product, so they were all purchased in supermarkets in Palmerston North. Regional foods may be expected to vary in pesticide residue, contaminant or nutrient element levels, so regional foods were sampled in four centres - Auckland, Napier, Christchurch and Dunedin. All national and regional foods were prepared ready for consumption, prior to analysis.

This report includes results for pesticide residues. Results relating to the contaminant elements (arsenic, cadmium, lead, mercury and tin) and nutrient elements (iodine, selenium and zinc) are presented in a separate report.

Pesticide Residue Overview

Of the 460 samples screened for 90 pesticides residues, 272 samples (59%) were found to contain detectable residues. This is very similar to the percent (56%) found in the 1990/91 NZTDS. However, residues of 30 different pesticides were detected in the 1990/91 survey out of a total screen of 73 different pesticide residues, whereas only 20 different pesticide residues were detected in the 1997/98 NZTDS out of a screen of 90 different pesticide residues. Of these, none of the pesticide residue levels detected exceeded the New Zealand Food Regulations 1984 Maximum Permissible Proportion (MPP), where one was listed for the specific food item.

Two factors should be remembered when considering these statistics:

- The sampling plan was devised to look more closely at foods that were more likely to contain pesticide residues. For example, previous NZTDSs have indicated that orange juice is unlikely to contain pesticide residues and only two composite samples were analysed. By contrast, bread often contains residues of organophosphorus pesticides and eight samples of each of three different types of bread were analysed.
- The current survey employed improved analytical methods compared with the 1990/91 survey and it should be noted that of the 272 samples with detectable residues in the current survey, 160 of these would not have been detected with the methods employed in the 1990/91 survey. This means that while the percentage of samples with detectable pesticide residues has risen slightly, the majority of the residue levels were significantly lower than those in the 1990/91 NZTDS.

Of the approximately 29,000 individual analytical pesticide residue results, only 397 results (1.4%) represented detectable residues. Of these, 223 of the pesticide residues were detected in the 1997/98 NZTDS because of significantly improved limits of reporting from those used in the 1990/91 NZTDS.

The pesticide residues have been considered in their four classes - organochlorine, organophosphorus, fungicides, and others.

Organochlorine Pesticide Residues

Five out of 23 organochlorine pesticide residues analysed were detected. They were all detected at low levels and calculated exposures were all well within their Acceptable Daily Intakes (ADIs).

DDT and derivatives were primarily detected in the form of **pp-DDE**, a breakdown residue of pp-DDT. The parent compound, **pp-DDT** was detected in one food sample (eggs) analysed in the 1997/98 NZTDS. Residues of DDT derivatives were detected in most foods of animal origin (chicken, eggs, fish, meat, dairy products) and some imported plant products (raisins/sultanas and chocolate biscuits).

Total DDT estimated dietary exposure for YM reduced to 0.2% of the ADI (compared to 0.3% in 1990/91). YC and C were found to have estimated dietary exposures of 0.4% (compared to 0.5% in 1990/91) and 0.4% (compared to 0.7% in 1990/91) of the ADI, respectively. This is an expected, yet positive downward trend, as this banned but persistent pesticide slowly disappears from the New Zealand food chain. Estimated dietary exposure to total DDT has decreased in each of the total diet studies that have been performed in New Zealand.

For **total endosulfan**, all estimated exposure levels were at less than 0.1% of the ADI. Residues of **alpha-endosulfan** and **beta-endosulfan** were found in the survey on both cucumbers and tomatoes.

Dicofol was detected for the first time in New Zealand total diet studies, possibly due to improved analytical procedures since the previous NZTDS. Dicofol residues were detected on nectarines, pears and raisins/sultanas. Exposure estimates for all age-sex groups were at or less than 1% of the ADI.

Organophosphorus Pesticide Residues

Five organophosphorus pesticide residues were detected out of the 33 screened in the 1997/98 NZTDS, compared to eleven out of 25 detected in the 1990/91 NZTDS.

Chlorpyriphos residues were mainly detected in fruits, such as apples, pears, and bananas. Estimated dietary exposures have decreased five to ten fold since 1990/91. All estimates were less than 0.2% of the ADI for all age-sex groups.

Chlorpyriphos-methyl residues were detected in grain products and foods containing grain products such as meat pies and pizza. The estimated dietary exposures from the current survey were less than or equal to 1.8% of the ADI for adults and 2.8% of the ADI for children. Estimated exposures have gone up slightly since the last survey, but still remain low and well below the ADI.

There was a significant decrease in the estimated exposure to **fenitrothion,** which was only detected in two foods (bran cereal and dried spaghetti) in the 1997/98 NZTDS, compared to 20 foods in the 1990/91 NZTDS. Estimated exposures have decreased 30-45 fold since the last survey, with the estimated daily exposure for a young child being 0.2% (compared to 7.6% in 1990/91 NZTDS) of the ADI. This is an encouraging trend.

Pirimiphos-methyl residues were detected in grain products and foods containing grain products such as meat pies and pizza, and on nuts and nut products. Estimated exposures continue to show a downward trend. Estimated dietary exposures were all less than 2.5% (compared to 5.2% in 1990/91 NZTDS) of the ADI.

Dimethoate was detected for the first time in this survey, with residues being detected on fruiting vegetables (capsicums, courgettes, and tomatoes). All estimated dietary exposures were less than 1.7% of the ADI.

Fungicide Residues

Seven out of 18 fungicides screened were detected in the current survey.

Estimated dietary exposures for **chlorothalonil**, **dicloran**, **diphenylamine, procymidone** and **vinclozolin** were all less than or equal to 0.6% of the ADI. Residues of these pesticides were detected in fresh fruits and vegetables or in fruit products (jam and wine).

Iprodione residues were detected in fruit, fruit products (jam and wine), and products containing fruit (muesli and yoghurt). All estimated dietary exposures in the current survey were less than or equal to 2.1% (compared to 0.1% in 1990/91 NZTDS) of the ADI. Some of this increase is due to reduction in the ADI for iprodione from 300 to 60 µg/kg body weight/day since reporting of the 1990/91 NZTDS. Although estimated dietary exposure to iprodione is very low, estimates have increased and this trend should be monitored in the future.

The **dithiocarbamates** break down rapidly and are best analysed in fresh fruits and vegetables. Residues were detected on 18 fruits or vegetables, compared with six in the 1990/91 NZTDS. However, improved analytical methods have resulted in a significant improvement in the ability to detect dithiocarbamates such that none of the residues detected in the current survey would have been detectable in the 1990/91 NZTDS.

While there has been very little change in the estimated exposure of the population to dithiocarbamates, there has been an increase when expressed as a percentage of the ADI. This is due to a downward revision of the lowest ADI for the dithiocarbamate group from 10 to 3 µg/kg body weight/day. The estimated dietary exposure from uncooked vegetables and fruit was less than or equal to 14% of the ADI for adults and less than 23% for children.

This represents a worst case conservative estimate as it is based on the lowest available dithiocarbamate ADI. The degree of overestimation could be as much as a factor of ten if all dithiocarbamates actually present were from the group with the highest ADI (30 μg/kg body weight/day). It should also be noted that currently used international analytical methods employed in this survey are unable to differentiate dithiocarbamates from natural compounds in some vegetables (eg brassicas). Apparent residues on brassicas contribute approximately 20% of the total estimated exposure to dithiocarbamates.

Other Residues

Three out of 16 other residues screened were detected in the current survey.

Bromopropylate was detected in two fruits/fruit products (jam and raisins/sultanas), **piperonyl butoxide** was detected on a wide range of grain-based products, and **propham** was detected exclusively on potatoes and potato-based foods. Estimated dietary exposures to bromopropylate and piperonyl butoxide were all less than 0.1% of the ADI. Propham's estimated exposures have decreased in all age-sex categories since the 1990/91 NZTDS. There is no ADI for propham.

Health Implications and Conclusions

The pesticide residue levels found in this survey are unlikely to have any adverse health implications for the New Zealand population. This conclusion is drawn from the comparison of the findings of this survey with internationally recognised ADI values, which are based on chronic, lifetime exposure. Future studies should also consider the use of acute exposure assessments based on reference doses. New Zealand authorities and scientists need to watch developments in this area.

With the exception of dithiocarbamate fungicides, which have previously been discussed, none of the estimated dietary exposures to pesticide residues for the six age-sex group simulated typical diets exceeded 3% of the level of their ADI.

Only 20 different pesticide residues were detected in the 1997/98 NZTDS out of a screen of 90 different pesticide residues. Of these, none exceeded the New Zealand Food Regulations 1984 Maximum Permissible Proportion (MPP) where one was defined for the specific food/ residue combination.

While the percentage of samples with detectable residues in the 1997/98 NZTDS (59%) is slightly up from that of the 1990/91 NZTDS (56%), this is mainly a result of improved methods of analysis. It is encouraging to see that the majority of residue levels are lower than in the 1990/91 NZTDS.

RECOMMENDATIONS

1. That future NZTDSs consider inclusion of a wider range of pesticide screening techniques, including specific screens for N-methyl carbamate pesticides and benzimidazole fungicides.

2. Dioxins and polychlorinated biphenyls (PCBs) should be considered for inclusion in future New Zealand Total Diet Surveys. Analyses should target fatty foods, such as meat, fish, and dairy products as these foods are the most likely dietary sources of these highly fat-soluble compounds.

3. Given that Total Diet Studies provide a scientific basis for public health risk assessments and that the contaminant content of foods can vary significantly over time, the New Zealand Total Diet Survey should be carried out on a regular basis. More complex and expensive analyses could be included in the NZTDS on a less frequent basis.

4. New Zealand maintains a watching brief in the areas of health impact assessments for pesticide residues, including variability and acute dietary exposure methodologies. It will be important to develop and maintain appropriate networks and information linkages.

5. It is recommended that high (90th or 95th) percentile energy diets be included in future NZTDSs, to ensure the public health risk to these sectors of the population is adequately assessed.

6. New Zealand should continue to contribute pesticide residue concentration and exposure data to the World Health Organization (WHO) Global Environmental Monitoring System (GEMS) programme on an on-going basis.

7. Further work should be undertaken to identify whether the presence of pp-DDT in eggs is a common occurrence, as its presence indicates use of, or exposure to, a deregulated pesticide.

8. Ongoing monitoring of fruit and vegetables for dithiocarbamates is recommended, especially considering the wide range of products on which they were detected.

9. That emerging methodologies for the determination of individual dithiocarbamate fungicides be implemented in New Zealand in order to develop a more accurate estimate of the potential risk posed by these fungicides. That the contribution from naturally occurring sulphur compounds be assessed by analysing untreated samples.

GLOSSARY OF TERMS, ABBREVIATIONS AND ACRONYMS

acute RfD	Acute reference dose is the estimate of the amount of a substance in food and/or drinking-water that can be ingested over a short period of time, usually during one meal or one day, without appreciable health risk.
ADI	Acceptable Daily Intake is the daily intake of a chemical which, during the entire life-time of the consumer, appears to be without appreciable risk to health. This is derived from all known toxicological data at the time of the evaluation of the chemical (for pesticides - internationally by the Joint FAO/WHO Meeting on Pesticide Residues, JMPR). The JMPR sets WHO ADIs which are normally adopted by New Zealand.
AMBS	Australian Market Basket Survey
analyte	a substance detected by chemical analyses.
arithmetic mean	simple average calculated by summing all values in the data set and dividing by the number of values in the data set.
bw	body weight
C	Child, 4-6 years, 20 kg bw, 6.6 MJ/day diet
C&FR	New Zealand Institute for Crop & Food Research Ltd
composite	a sample produced by combining portions of each of a number of constituent samples. In this report composite refers to the product resulting from mixing equal portions of constituent samples.
default MPP	is a legal 'negligible' limit 0.1 ppm in New Zealand, (that is 1 part of pesticide in ten million parts of food). This limit is specified in the Food Regulations 1984 Regulation 257 (2A) for any pesticide in food not otherwise covered by a MPP.
EPA	United States Environmental Protection Agency
ESR	Institute of Environmental Science and Research Limited
F	Female, 25+ years, 65 kg bw, 6.8 MJ/day diet
FAO	Food and Agriculture Organization
g	grammes
GAP	Good agricultural practice
GEMS	Global Environmental Monitoring System

HPOs	Health Protection Officers
IPCS	International Programme on Chemical Safety
JMPR	the Joint FAO/WHO Meeting on Pesticide Residues
kg	kilogrammes
L	litres
lacto-ovo vegetarian	a person maintaining a diet free of animal products other than dairy products and eggs.
LINZ	Life in New Zealand
LOR	Limit of Reporting is the minimum concentration of a component in a dietary sample that can be determined quantitatively with acceptable accuracy and consistency. The limit of reporting is also referred to as the 'limit of quantitation' in the international literature.
M	Male, 25+ years, 80 kg bw, 9.8 MJ/day diet
MAF	Ministry of Agriculture and Forestry (New Zealand)
MAFF	Ministry of Agriculture, Fisheries and Food (United Kingdom)
MfE	Ministry for the Environment (New Zealand)
mg/kg	milligrammes per kilogramme
μg/kg	microgrammes per kilogramme
MJ	megajoules
mls	millilitres
MoH	Ministry of Health (New Zealand)
MPP	Maximum Permissible Proportion is the New Zealand equivalent to MRL (see below). It is the maximum concentration of a pesticide residue legally permitted (or recognised as acceptable) in or on a food, agricultural commodity or animal feed. These limits are recommended by Ministry of Agriculture and Forestry (MAF) or the Codex Alimentarius Commission and are set out in the New Zealand Food Regulations 1984.

MRL	Maximum residue limit is international terminology for the maximum concentration of a pesticide residue legally permitted (or recognised as acceptable) in or on a food, agricultural commodity or animal feed. These limits are recommended by the Codex Alimentarius Commission to be the maximum to result from the use of the pesticide according to GAP, and which is toxicologically acceptable (units ppm or mg/kg of the commodity).
NNS	National Nutrition Survey of New Zealand, undertaken in 1997.
NRC	National Research Council (United States)
NZTDS	New Zealand Total Diet Survey
PCBs	Polychlorinated biphenyls
pesticide	is a generic term for any substance intended for preventing, destroying, attracting, repelling, or controlling any pest including unwanted species of plants or animals during the production, storage, transportation, distribution, and processing of food, agricultural commodity, or animal feed. The term includes fungicides, insecticides, herbicides, and chemicals which may be administered to animals for the control of ectoparasites. It includes substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transportation.
pesticide residue	is any specified substance in food, agricultural commodity, or animal feed resulting from the use of a pesticide (from known, unknown or unavoidable sources). Includes any derivatives of a pesticide, such as conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance.
Q1, Q2, etc.	Quarter 1, quarter 2, etc. Sampling periods for the 1997/98 NZTDS.
samplings	refers to the number of discrete combinations of 5 brands and 2 seasons (National foods), or 4 regions and 2 seasons (Regional foods). Details of the sampling procedures are described in section 2.4.
UNEP	United Nations Environment Programme
USFDA	United States Food and Drug Administration
VF	Lacto-ovo vegetarian female, 19-40 years, 65 kg bw, 8.6 MJ/day diet
WHO	World Health Organization
YC	Young child, 1-3 years, 13 kg bw, 4.7 MJ/day diet
YM	Young male, 19-24 years, 70 kg bw, 11.5 MJ/day diet

1 INTRODUCTION

1.1 Objectives of the New Zealand Total Diet Survey

The 1997/98 New Zealand Total Diet Survey (NZTDS) was carried out for the Ministry of Health by the Institute of Environmental Science & Research Limited (ESR) as the lead agency, the New Zealand Institute for Crop & Food Research Ltd (C&FR), and Health Protection Officers (HPOs).

The documented objectives of the 1997/98 NZTDS were:

- to assess the health implications of the levels of selected pesticide residues, contaminant and nutrient elements in the New Zealand food supply (based on the NZTDS food list, which represents at least 70% of the most consumed food items);

- to estimate the potential dietary exposure to selected pesticide residues, contaminant and nutrient elements by interpreting data from the NZTDS in terms of simulated typical diets of a number of New Zealand population sub-groups. The project:
    - assessed the chemical status of the New Zealand food supply;
    - indicated any potential exposure concerns;
    - demonstrated trends in dietary exposure; and
    - made comparisons with exposure estimates derived in other countries;

- to contribute data to the World Health Organization (WHO) Global Environmental Monitoring Systems (GEMS)/Food programme, so that accurate international comparisons can be made of New Zealand dietary exposure to chemical contaminants;

- to provide, where appropriate, data on the pesticide residue, contaminant and selected nutrient element (iodine, selenium, and zinc) content of food, suitable for incorporation into the New Zealand Food Composition Database for use by interested parties; and

- to make data on the pesticide residue, contaminant and selected nutrient element (iodine, selenium, and zinc) content of food available to stakeholders in a timely manner during the course of the NZTDS.

1.2 History of the New Zealand Total Diet Survey

In each of the four previous total diet surveys, each type of food was sampled from four different geographic regions, so as to take into account different regional pesticide usage and the different levels of trace elements due to the varying soil conditions. Sampling was also carried out from each district on more than one occasion to take into account any seasonal variation in the foods. A more detailed explanation of the sampling protocols can be found in the appropriate publications (Dick et al, 1978a,b; Pickston et al, 1985; ESR/Ministry of Health, 1994; Vannoort et al, 1995a,b; Pickston and Vannoort, 1995; Hannah et al, 1995).

The first two total diet surveys, undertaken in 1974/75 (Dick et al, 1978a,b) and 1982 (Pickston et al, 1985) by the Ministry of Health (then the Department of Health) and ESR (then DSIR

Chemistry Division), were based on a food group composites approach. Foods of a similar type, for example fruits, were combined in proportions relative to their level of consumption in the diet. Individual food items were not analysed. In the 1974/75 NZTDS, exposure estimates were determined based on a worst case scenario. This scenario used the diet for an active adolescent male with a total energy intake of 16.7 MJ/day (4000 kilocalories/day). Adolescent males are the population group with the highest average food intake levels. The exposure estimates determined in the 1982 NZTDS used the same 16.7 MJ diet, but also scaled the diet down to give a 11.3 MJ diet for a 23-50 year old male, and a 8.4 MJ diet for a 23-50 year old female. In 1974/75 and 1982, foods were prepared for consumption (eg vegetables washed and/or peeled, meat trimmed) but not cooked.

In the 1987/88 NZTDS (ESR/Ministry of Health, 1994), the design was changed to an individual foods approach. For each of the 105 foods involved, a total of 24 samples were obtained to provide a broad sampling base and yielded a total of 2520 samples. The 24 samples were composited (a subsample from each of the 24 samples was taken and combined) to give one analytical sample for each of the 105 foods. In addition, the diet for the young male was now based on a median (50th percentile) energy diet, and specific diets were developed for a wider range of age-sex groups (adult male, adult female, child, young child). Foods were prepared table-ready (eg meat cooked).

The 1990/91 NZTDS was the fourth survey of this type carried out in New Zealand (Vannoort et al 1995a,b; Hannah et al, 1995; Pickston and Vannoort, 1995). The food list had been increased to 107 foods and included drinking water. The foods analysed and the simulated typical fortnightly median energy diets for the five age-sex group were essentially the same as the 1987/88 NZTDS and comparison between these two surveys is appropriate.

Improvements in analytical methodology meant that it was possible to handle a larger number of samples in the 1990/91 survey. When the 1990/91 NZTDS was being designed, it was decided that where a food was thought to be a potentially large contributor to exposure to an analyte or where the food was likely to have carryover of the analyte from the raw product, such as processed grain or vegetable products, it would also be analysed on an individual basis. Individual food concentration data also offered the advantage that they could not only be used for determining dietary exposures but could also potentially be used for checking the compliance of that food with the New Zealand Food Regulations 1984.

1.3 The 1997/98 NZTDS and Changes in Approach Compared to the 1990/91 NZTDS

The 1997/98 NZTDS was very similar to the 1990/91 NZTDS. Significant differences were:

- the food list was further increased to a total of 114 foods. Some foods were removed to reflect changes in dietary patterns since the previous NZTDS. The additions to the 1997/98 NZTDS were mainly snack foods for children, vegetarian foods (eg hummus and tofu), an increased range of vegetables, and more takeaway foods to reflect the increasing role they play in the New Zealand diet;
- the revision of the simulated typical diets and addition of a new age-sex group (lacto-ovo vegetarian female). The revised diets generally reflected a lower overall energy intake,

consistent with national nutrition survey data, for each age-sex group compared to the diets used for the 1987/88 and 1990/91 NZTDSs;

- extension of the range of pesticides included in the multi-residue screen from 73 to 90 pesticides and pesticide metabolites;
- a sharpening of the focus of the survey to traditional chemical food safety issues. This resulted in exclusion of almost all nutrient elements, with the exception of iodine, selenium, and zinc, and removal of the specific regulatory compliance component which was part of the 1990/91 NZTDS. The majority of the nutrient elements included in the 1987/88 and 1990/91 NZTDSs, but not included in the 1997/98 NZTDS, have been addressed in the 1997 National Nutrition Survey (NNS; Russell et al, 1999); and
- substituting Dunedin for Wellington as a regional sampling location. The decision to base the NZTDS on four regional sampling locations means that changes may occur from survey to survey, to ensure greater coverage of the country over a number of surveys.

1.4 Other 1997/98 NZTDS Reports

A procedures manual for the 1997/98 NZTDS has been prepared, including purchasing instructions and sample preparation instructions (Vannoort et al, 1997b).

Separate reports have also been produced detailing the 1997/98 NZTDS food list (Hannah, 1997) and the simulated typical diets (Brinsdon et al, 1999).

All analytical data associated with the 1997/98 NZTDS have been released in four quarterly reports (Vannoort et al, 1997a; 1998a; 1998b; 1998c).

A separate report has also been prepared for the contaminant elements (arsenic, cadmium, lead, mercury and tin) and the nutrient elements (iodine, selenium and zinc) included in the 1997/98 NZTDS (Vannoort et al, 1999).

2 METHODS USED IN THE 1997/98 NEW ZEALAND TOTAL DIET SURVEY

2.1 Food Selection

The food items used in the 1990/91 NZTDS were used to form the basis of the 1997/98 NZTDS. Where foods from the 1990/91 NZTDS have been excluded or substituted, this is because of changes in patterns of consumption during the intervening period. Details of changes and additions are given in the food list report, which was prepared as a separate project for the Ministry of Health (Hannah, 1997).

The 114 foods of the 1997/98 NZTDS are those likely to represent approximately 70% of the total foods consumed in New Zealand. To sample for 80% would require about 250 foods and for 90% over 500 foods (Pennington, 1983). Of the 114 foods, 105 were selected as generally consumed by most people, while the remaining nine were considered to be important for certain sub-groups such as children and vegetarians. Although they are consumed in relatively small amounts, shellfish and lamb's liver were included due to particular concerns related to their contaminant element content and to monitor trends.

Foods were prepared ready for consumption prior to analysis. Details of food preparation are given in Appendix 1.

Foods were classified as either:

- National foods. Food manufactured at a single or small number of sites, or imported foods, and all are distributed nationally.
- Regional foods. Foods produced/processed and consumed in the same area.

Details of the sampling procedures for national and regional foods are described in section 2.4.

Table 1 summarises the 114 foods included in the 1997/98 NZTDS. Foods are classified into one of 11 food groups, and also identified as national or regional foods.

Table 1 Foods included in the 1997/98 NZTDS

National Foods	Regional Foods
GRAINS (G) - *19 foods*	
Bran cereal	Bread, mixed grain
Biscuits, chocolate	Bread, white
Biscuits, cracker	Bread, wheatmeal
Biscuits, plain sweet	Cake, plain
Cornflakes	
Corn or flour snacks, cheese flavoured	
Flour, white	
Muesli	
Noodles, instant	
Oats, rolled	
Rice, white	
Spaghetti, dried	
Spaghetti in sauce, canned	
Wheatbix	
Tortilla chips, corn	

National Foods	Regional Foods
DAIRY PRODUCTS (D) - ***7 foods***	
Butter, salted Cheese Dairy Dessert Ice cream Yoghurt	Milk, 0.5% fat (Trim) Milk, 3.25% fat
OILS & FATS (O) - ***3 foods***	
Margarine Oil, olive Oil, salad and cooking	
CHICKEN, EGGS, FISH, & MEAT (CEFM) - ***17 foods***	
Chicken Fish fingers, frozen Salmon, canned Soup, chicken, canned	Bacon Beef, mince Beef, rump Egg Fish, terakihi Lamb/mutton leg Lamb/mutton shoulder Lamb's liver Luncheon sausage Mussels Oysters Pork pieces Sausages, beef
VEGETABLES (V) - ***28 foods***	
Beans, baked, canned Beans, frozen Beetroot, canned Corn, creamed, canned Hummus Peas, frozen Potato crisps Soya milk Tofu Tomato pasta sauce, canned Tomato sauce, canned Tomatoes in juice, canned	Broccoli/Cauliflower Cabbage Capsicum Carrots Celery Courgette Cucumber Kumara Lettuce Mushrooms Onion Potatoes with skin Potatoes, peeled Pumpkin Silverbeet Tomato
FRUITS (F) - ***13 foods***	
Apple based juice Apricots, canned Bananas	Apples Kiwifruit Nectarines

National Foods	Regional Foods
Dates Orange juice Peaches, canned Pineapple, canned Raisins/Sultanas	Orange Pears
SPREADS AND SWEETS (S&S) - *7 foods*	
Confectionery Chocolate, plain Honey Jam Jelly dessert Marmalade Yeast extract	
ALCOHOLIC Beverages (AL) - *4 foods*	
Beer, draught Beer, lager Wine, still red Wine, still white	
TAKEAWAYS (TA) - *7 foods*	
	Chicken nuggets Chinese dish, chicken chow mein Fish in batter Hamburger Pie, meat Pizza Potato, hot chips
NUTS (N) - *2 foods*	
Peanut Butter Peanuts, whole raw	
BEVERAGES, Non-alcoholic (B) - *7 foods*	
Breakfast drink powder Carbonated lemonade Carbonated cola Chocolate beverage Coffee Tea	Water

2.2 Simulated Diets

Fourteen day simulated typical diets were developed for six selected population age-sex groups:

- young male, 19-24 years (YM);
- adult male, 25+ years (M);
- adult female, 25+ years (F);
- female, 19-40 years, lacto-ovo vegetarian (VF);
- child, 4-6 years (C); and
- young child, 1-3 years (YC).

Unfortunately, the data from the 1997 National Nutrition Survey (NNS) were not available when the simulated typical diets were developed for the 1997/98 NZTDS. The 1997 NNS was based on a nationally representative sample of 4,636 New Zealanders, living in selected households and aged 15 years and over. A 24 hour dietary recall and a food frequency questionnaire, as well as other survey items, were included (Russell et al, 1999).

Available research data on the food consumption patterns of each of the selected population groups were used to develop the diets (Horwath et al, 1991; Life in New Zealand, 1992). In addition AC Nielsen Scantrack (Ministry of Health, 1996a) and information from industry groups was used to ensure the diets represented each selected population's food consumption. Each diet included only foods relevant to a particular age-sex group.

Consistent with previous NZTDSs, the young male (YM) was selected as the group with the highest total energy intakes for the New Zealand population (Horwath et al, 1991; Life In New Zealand, 1992). This age-sex group constitutes a high consumer group whose consumption behaviour will increase exposure to food contaminants and pesticide residues. The diets for the adult male (M) and adult female (F) were chosen to represent the median (50^{th} percentile) energy intake adult population and are also consistent with previous NZTDSs.

The lacto-ovo vegetarian female (VF) category was added to the 1997/98 NZTDS because vegetarians were identified by the Ministry of Health as a group which is becoming more significant amongst females. Vegetarians may be at increased risk from exposure to particular food contaminants and pesticide residues, as a result of their greater dependence on a narrower range of foods than the general population. Two New Zealand studies provided the basis for the development of the vegetarian diets (Alexander, 1994; Harman and Parnell, 1998).

The inclusion of diets for children (C) and young children (YC) is an important part of any TDS, as children's low body weights proportional to energy intake may place them at a higher risk of exposure to contaminants and pesticide residues than the adult population. No national data exist about the macronutrient intake distribution of New Zealand children's diets so the Australian Recommended Dietary Intakes (Truswell, 1990) and the Food and Nutrition Guidelines for children 2-12 years (Ministry of Health, 1997) were used to develop these diets.

The Xyris software *FoodWorks*, which has the available New Zealand food composition data, was used to help simulate the diets. The diets were constructed using these data and following the steps shown below.

Information was gathered from: 1 the Food List including details about the preparation of the foods, and 2 ESR on the actual food brands and varieties sampled.

The information gathered above was used to match the food composition data and the 114 foods on the Food List to create a subset of the 114 foods to be used in constructing the simulated typical diets. This enabled a combination of foods from the food composition data to be used for any one food in the food list. For example three varieties of apples were sampled for the 1997/98 NZTDS and these three combined to create the composition data for the item *apple* on the Food List[1].

Diets for each of the groups were constructed using the subset of composition data for three meals and in-betweens each day on 14 separate days. *FoodWorks* enabled the energy and macronutrient contributions for each diet to be easily tracked.

The diets were then imported into Microsoft Access where they were able to be further manipulated and summaries of the amounts of each food for each population group were produced.

[1]The exception to this was for food composition data for meat. In this case analysis for pesticide residues and contaminants was undertaken on samples that were lean and dry fried. As this did not represent the way in which the general population consumes such foods, the diets were constructed using meat cuts which contain amounts of fat and usual cooking methods.

The weights of each individual food estimated to be consumed by each age-sex group in the 1997/98 NZTDS are listed in Appendix 2.

A summary of the estimated energy intakes for each age-sex group is shown in Table 2. Excluding vegetarian females (VF), adults obtained 36-38% of energy from fat, 15-16% from protein and 42-44 % from carbohydrate. As would be expected, vegetarian females had lower intakes of fat and protein and a higher carbohydrate intake. Children obtained 37% of energy from fat, 14-15% from protein and 47% from carbohydrate.

Children's body weights were taken from the *Well Child Health Book* (Ministry of Health, 1996b) and for adults, they were based on the Life in New Zealand (LINZ) survey conducted by the Hillary Commission (Mann et al, 1991).

Table 2 Age-sex groups and their body weights, total weights of diets, median energy intakes, and macronutrient composition included in the 1997/98 NZTDS

Age-sex category	Body weight (kg)	Total weight of diet (g/day)[a]	Mean energy (MJ/day)[a]	Mean macronutrient composition of diet[c]		
				% Fat	% Protein	% CHO[b]
Young male (YM)	70	2817 (3990)	11.5 (13.8)	38	15	43
Adult male (M)	80	2797 (3530)	9.8 (11.3)	37	15	42
Female (F)	65	2608 (3180)	6.8 (8.4)	36	16	44
Vegetarian Female (VF)	65	2801	8.6	33	13	51
Child (C)	20	1961 (1930)	6.6 (7.1)	37	14	47
Young child (YC)	13	1450 (1595)	4.7 (5.4)	37	15	47

a 1990/91 NZTDS figures in brackets b CHO carbohydrate
c the difference between the sum of the percentage energy contributions from fat, protein, and carbohydrate and 100%, for the adult diets, is the energy contribution from alcohol.

Drinking water included in the diets was based on the New Zealand Dietetic Association Clinical Handbook (NZDA, 1998). This reference specifies 1500-2000 mls of fluid per day for adults, 80-100 mls of fluid/kg body weight/day for children 1-2 years, and 70-80 mls of fluid/kg body weight/day for 4 year olds. The amount of drinking water in the diet was based on the difference between fluid intake in the diets and the NZDA guideline.

The total weight of food, fluid and additional water consumed was lower in all adult groups compared with figures reported in the 1990/91 NZTDS (Vannoort et al, 1995a,b; Hannah et al, 1995). This is because weights of food consumed in the 1997/98 NZTDS simulated diets were derived from Life in New Zealand survey data for energy content (Horwath et al, 1991; Wilson et al, 1994), rather than recommended United States Recommended Dietary Allowance (US RDA) levels, as was the case in the 1990/91 NZTDS.

2.3 Sampling Rationale

Food samples for total diet surveys are taken over a relatively short time scale to reflect the typical dietary exposure at a given point of time. The reason for this is that over time, changes occur in food consumption patterns, the amount of imported food, type and usage of pesticides, minerals or manufacturing practices.

Many foods sampled in the 1997/98 NZTDS were produced in New Zealand, but a number of imported foods were also sampled. However, no attempt has been made to separate out the imported foods in this survey. During the sampling period, many imported cereals and dried fruits would have been included in foods manufactured in New Zealand. Most of the fruit and vegetables would have been New Zealand grown, but New Zealand also imports a range of fruits and vegetables.

2.4 Sampling Procedures

A detailed procedures manual, including shopping lists and food purchasing instructions, was prepared for the 1997/98 NZTDS (Vannoort et al, 1997b).

For the purpose of sampling, the 114 foods were split into two groups - one comprising 66 national foods and the other 48 foods sampled on a regional basis (these two groups of foods were explained and the 114 foods detailed in section 2.1).

Four sampling occasions were scheduled for the 1997/98 NZTDS. These were designated Q1, Q2, Q3, and Q4 (for quarter 1, quarter 2, etc).

Q1 18 August - 8 September 1997
Q2 28 October - 1 December 1997
Q3 16 February - 9 March 1998
Q4 4 May - 8 June 1998

Q1 and Q3 were nominated for sampling of regional foods and Q2 and Q4 were nominated for the sampling of national foods. However, the preparation of meat samples was seen as a labour intensive step in the food preparation process and some of these samples were sampled in Q2 and Q4 to spread this time commitment. These meat samples were still sampled on a regional basis, as for those sampled in Q1 and Q3.

2.4.1 Sampling of National foods

Foods which were included in the national food category were all purchased by the New Zealand Institute for Crop & Food Research Ltd (C&FR) from supermarkets in Palmerston North, as their food preparation laboratory was located in that city. These foods were sampled on two separate occasions, Q2 and Q4.

For each food type, up to five manufacturer's brands were purchased, depending on how many brands of each food type were available. Where more than five brands were available, the five most commonly consumed brands to be purchased were specified (Hannah, 1997; Vannoort et al, 1997b). In general, at least two packages of every brand of food sampled were purchased in Q2 and another two in Q4. On each occasion, the two packages of each brand came from different retail outlets. The two purchases of a particular product brand were also obtained with different batch numbers or use by dates. This resulted in a minimum of ten (10) samples of each food, although in some cases more samples had to be purchased to obtain sufficient weight of sample for all analyses. Total weights of each food sampled are detailed in Appendix 1.

On each sampling occasion, the two or more packages of each brand were combined after sample preparation to give one composite sample for each brand. Samples were prepared table ready as outlined in Appendix 1. For those foods to be analysed on an individual sample basis, a

subsample was taken and frozen at -18°C for a maximum of two months pending analysis. For foods to be analysed as seasonal composites, subsamples of each of the brands were then combined to yield two composite samples, one for each half of the survey, and stored at -18°C pending analysis. In a number of cases, foods were analysed as individual brand samples for some analytes and as seasonal composites for other analytes. Details of which food/analyte combinations were analysed individually and which were analysed as composites is summarised in Appendix 3.

2.4.2 Sampling of Regional foods

Regional foods were mainly fresh fruit and vegetables, fresh meat and milks, for which there was an expectation that foods purchased in one centre may differ significantly in pesticide residue, contaminant or nutrient element content from the same food purchased in other centres. Regional foods were most likely to be produced near to where they were consumed.

Regional sampling was carried out by Health Protection Officers (HPOs) in four regions (Auckland, Napier, Christchurch and Dunedin). All HPOs involved in sample collection for the 1997/98 NZTDS were provided with a copy of the procedures manual (Vannoort et al, 1997b). In addition to this, all HPOs were sent:

- a letter confirming the sampling dates and outlining any exception to the agreed sampling schedule;
- copies of regional sample collection tick checklists;
- a set of water collection bottles and associated instructions; and
- a set of sample labels, one for each food sample to be purchased, and associated documentation list, two weeks before sampling began.

Regional foods were sampled by the HPOs during Q1 and again in Q3 to ensure that some degree of seasonal variation was taken into account. The total weight of a food was specified, as well as the weight of individual purchases (this was particularly important for chicken nuggets, chicken chow mein and fish in batter). Details of total weights of each regional food sampled are included in Appendix 1. Whenever appropriate, foods were maintained in their point-of-sale packaging. Where this was likely to be insufficiently secure, the sample was placed into a clip top or whirlpak bag in its point-of-sale packaging. Sample identification labels, with all appropriate information completed, were attached to the final external packaging for each sample.

Samples requiring refrigeration (meats, seafoods, milks) were packed in a separate container from other foods (breads and cakes, eggs, fruits, vegetables). The samples which required refrigeration were packaged in accordance with the Ministry of Health poster on transportation of perishable food samples. The regional food sampling checklist was photocopied and included with the packaged foods.

Mussels and oysters were sourced directly from the processors, to ensure that a representative mix of the product available in New Zealand was obtained.

For any one (seasonal) sampling, two purchases of each regional food were made for the food in all four geographical regions. This allowed for a greater range of retail outlets to be represented in the sampling. For instance, meat would be purchased from a supermarket and

from a specialist butcher. This resulted in a maximum of eight samples of each food arriving at the food preparation laboratory. The two purchases from each geographical region were composited in all cases after sample preparation and prior to analysis. Samples were prepared table ready as outlined in Appendix 1. For those foods to be analysed on an individual sample basis, a subsample was taken and frozen at -18°C for a maximum of two months pending analysis. For foods to be analysed as seasonal composites, subsamples of each of the regional samples were then combined to yield two composite samples, one for each half of the survey, and stored at -18°C for a maximum of two months pending analysis. In a number of cases, foods were analysed as individual regional samples for some analytes and as seasonal composites for other analytes. Details of which food/analyte combinations were analysed individually and which were analysed as composites is summarised in Appendix 3.

Fruit and vegetable samples for dithiocarbamate fungicide analyses were minimally processed (for example, apples were cored and quartered) if normally eaten raw, or prepared table ready, by the food preparation laboratory. Due to the known instability of dithiocarbamates, samples were forwarded immediately to the analytical facility and analysed immediately on receipt.

2.5 Sample Statistics

Appendix 3 details for each of the 114 food items, whether the food was a national or regional food, the total number of samples collected, the total number of samples actually analysed and the total number of samples with pesticide residues detected. Data for the separate dithiocarbamate fungicide screen are also included.

2.6 Nature of Pesticides Included in the 1997/98 NZTDS

The pesticides selected for analysis in the 1997/98 NZTDS were chosen for the following reasons:

- potential exposure of the population;
- because they were known to have been used in agriculture; and
- it was possible with existing scientific technology to accurately analyse for such.

In the 1997/98 NZTDS, 90 different pesticide residues were screened. The full list of 23 organochlorine pesticides, 33 organophosphorus pesticides, 18 fungicides, and 16 other pesticides are listed, with their associated limits of reporting in Table 3.

The pesticides listed in Table 3 are registered for use in New Zealand unless marked otherwise.

The multi-residue pesticide screening technique used for the 1997/98 NZTDS is the most cost effective means of analysing food samples for a wide range of pesticide residues. As new pesticides are released for use in New Zealand they are assessed to determine if they can be added to multi-residue analytical screens. However, not all pesticides are amenable to multi-residue analysis and some require specialised screening techniques for their analysis. A separate screening technique has been used in the 1990/91 and 1997/98 NZTDSs for the determination of dithiocarbamate fungicides in total diet samples.

Table 3 Pesticide residues screened in the 1997/98 NZTDS and their limits of reporting (mg/kg or ppm)

Multi-residue screen					
Organochlorine Pesticides (OC) - 23 Compounds[a]					
Aldrin [c]	0.01	op-DDT [c]	0.003	HCB [c]	0.01
BHC, alpha [c]	0.01	pp-DDT [c]	0.003	Heptachlor [c]	0.01
BHC, beta [c]	0.01	Dicofol [d]	0.01	Heptachlor epoxide [c]	0.01
BHC, gamma (Lindane) [c]	0.01	Dieldrin [c]	0.02	Kepone [c]	0.02
Chlordane, alpha [c]	0.01	Endosulfan, alpha	0.01	Mirex [c]	0.02
Chlordane, gamma [c]	0.01	Endosulfan, beta	0.01	op-TDE [b, e]	0.003
pp-DDE [e]	0.003	Endosulfan Sulphate [f]	0.01	pp-TDE [e]	0.003
op-DDE [b, e]	0.003	Endrin [c]	0.02		
Organophosphorus Pesticides (OP) - 33 Compounds[a]					
Bromophos[c]	0.01	Fenthion [c, g]	0.01	Phorate sulphoxide [b, j, k]	0.05
Bromophos-ethyl [b, c]	0.05	Heptenophos [c]	0.10	Phosalone [c]	0.05
Chlorpyriphos	0.003	Isazophos	0.01	Phosmet	0.10
Chlorpyriphos-methyl [c]	0.003	Malathion	0.01	Phosphamidon, alpha [c]	0.01
Diazinon	0.01	Methidathion [c]	0.02	Phosphamidon, beta [b, c]	0.01
Dichlorvos	0.01	Mevinphos [c, h]	0.01	Phosphamidon, gamma [c]	0.01
Dimethoate [i]	0.03	Naled [b, c]	0.10	Pirimiphos-methyl	0.01
Ethion [c]	0.01	Parathion [c]	0.01	Prothiofos	0.01
Etrimphos [c]	0.01	Parathion-methyl	0.01	Pyrazophos [b]	0.04
Fenchlorphos [c]	0.01	Phorate [b, j]	0.01	Tolclofos-methyl [b]	0.01
Fenitrothion	0.01	Phorate sulphone [b, j, k]	0.01	Triazophos [b, c]	0.02
Fungicides (F) - 17 Compounds[a]					
Captafol [c]	0.05	Fenarimol	0.03	Procymidone	0.01
Captan	0.03	Folpet	0.06	Propiconazole [b]	0.10
Chlozolinate [b, c]	0.50	Imazalil [b]	0.05	Triadimefon [b]	0.05
Chlorothalonil	0.02	Iprodione	0.03	Triadimenol [b]	0.20
Dicloran [b]	0.01	Metalaxyl	0.20	Vinclozolin [c, l]	0.01
Diphenylamine [c]	0.01	Nitrothal isopropyl	0.02		
Other Pesticide Residues (O) - 16 Compounds[a]					
Alachlor [b]	0.02	Deltamethrin	0.07	Permethrin, trans	0.20
Bromacil [b]	0.05	Fenvalerate [c]	0.20	Piperonyl butoxide	0.01
Bromopropylate	0.04	Linuron [b]	0.10	Pirimicarb	0.10
Cyfluthrin [b]	0.50	Pendimethalin [b]	0.03	Propham	0.01
Cypermethrin, alpha	0.05	Permethrin, cis	0.10	Propyzamide	0.02
Cypermethrin, beta	0.20				

Dithiocarbamate fungicide screen		
Dithiocarbamate pesticides	(as CS_2)	0.01 mg/kg
Dithiocarbamate pesticides	(as ziram)	0.02 mg/kg

a details number of pesticides of this type screened for
b added to pesticide screen in 1997/98 NZTDS
c not registered for use in New Zealand (MAF,1999a,b)
d only pp dicofol was analysed
e metabolite or breakdown product of DDT
f metabolite of endosulfan
g fenthion only was analysed
h sum of cis and trans isomers
i dimethoate only was analysed
j no oxygen analogues were included
k metabolite of phorate
l vinclozolin only

Further specialised screening techniques were not included in the 1997/98 NZTDS, due to resource constraints. It is recommended that certain of these techniques be considered for use in future NZTDSs. N-methyl carbamate pesticides, such as carbaryl and methomyl, are known to be used in New Zealand (Holland and Rahman, 1999), but are not well suited to analysis by multi-residue techniques. Separate pesticide screens for N-methyl carbamates are included in several overseas total diet surveys (Jalón et al, 1997; MAFF, 1997; US FDA, 1999). Similarly, the benzimidazole fungicides, including benomyl and thiabendazole, are of interest in New Zealand (Holland and Rahman, 1999), but are not amenable to multi-residue methodology. Levels of these fungicides in some NZTDS foods are currently the subject of a separate study.

Recommendation 1:

> *That future NZTDSs consider inclusion of a wider range of pesticide screening techniques, including specific screens for N-methyl carbamate pesticides and benzimidazole fungicides.*

Polychlorinated biphenyls (PCBs) were included in the multi-residue pesticide screen used in the 1987/88 and 1990/91 NZTDSs. However, the detection limits achieved for PCBs using this method mean that levels of PCBs typically found in foods would go undetected (Ministry for the Environment, 1998). The recent food chemical contamination incident in Belgium involving dioxins and polychlorinated biphenyls (PCBs) highlights the need to consider these contaminants for inclusion as analytes in future NZTDSs. The New Zealand Ministry for the Environment (MfE) has carried out a wide-ranging study of organochlorine compounds in the environment (Ministry for the Environment, 1998). This study included an estimation of dietary exposure to PCBs and dioxins, based on analysis of 22 foods or food group composites. The estimates derived in the MfE study provide a valuable baseline for assessing future changes in the dietary exposure to these toxic compounds.

Recommendation 2:

> *Dioxins and polychlorinated biphenyls (PCBs) should be considered for inclusion in future New Zealand Total Diet Surveys. Analyses should target fatty foods, such as meat, fish, and dairy products as these foods are the most likely dietary sources of these highly fat-soluble compounds.*

It should be noted that the very high toxicity of these compounds means analytical techniques capable of detecting these compounds at the parts per trillion (ppt) level are necessary if meaningful exposure estimates are to be derived. This would require the use of highly specialised analyses with, consequent, significant resource implications. Due to the high cost of analyses it is envisaged that PCBs and dioxins would not be included in every NZTDS, but would be considered for inclusion on a periodic basis.

The range and number of foods able to be analysed for dioxins and PCBs will be dependent on resources. It may be appropriate to analyse food group composites, rather than individual food samples, as long as the methodologies are sufficiently sensitive to counter the dilution effect of compositing foods and still lead to the derivation of meaningful exposure estimates.

2.7 Methods of Pesticide Analysis

The details of methods of analysis and quality control procedures employed in this study are given in Appendix 4.

3 PESTICIDE RESIDUE RESULTS AND DISCUSSION

3.1 Introduction

Pesticides are used widely in agriculture (Holland and Rahman, 1999). Their application has improved crop yields and has increased the quantity of fresh fruits and vegetables available to the consumer (NRC, 1993). Pesticides may also cause harm. Some may damage the environment and accumulate in ecosystems. If the dose is sufficiently high, some pesticides can cause a range of adverse effects on human health, including acute and chronic injury to the nervous system, lung damage, reproductive dysfunction, possibly cancer and dysfunction of the endocrine and immune systems (NRC, 1993). However, foods produced in accordance with good agricultural practice (GAP) should not contain levels of pesticide residues from which adverse effects are likely to result.

Pesticide residues are present in foods as the result of intentional application to crops or stored food products for a defined purpose at a particular time. While levels of nutrients in foods are relatively well established in food composition databases (Athar et al, 1999), the pesticide content of foods can vary significantly over time and from place to place. The analyses included in NZTDSs allow temporal and geographical trends to be examined. Many developed countries conduct regular Total Diet Surveys for this purpose, with frequencies typically yearly (eg USA, UK) or biennially (eg Australia). Previous NZTDSs have been carried out in 1974/75, 1982, 1987/88 and 1990/91.

Recommendation 3:

> *Given that Total Diet Studies provide a scientific basis for public health risk assessments and that the contaminant content of foods can vary significantly over time, the New Zealand Total Diet Survey should be carried out on a regular basis. More complex and expensive analyses could be included in the NZTDS on a less frequent basis.*

Pesticides fall into a number of generic classes, and these are detailed below along with their chemical structure, historical development, their stability in the environment and ability to accumulate up the food chain, their mode of action, and effects of acute and chronic toxicity.

The 1997/98 NZTDS analysed foods for residues of the following classes of pesticides:
- organochlorine pesticides;
- organophosphorus pesticides;
- fungicides; and
- other pesticides.

The other pesticides class includes synthetic pyrethroids (analogues of the naturally-occurring pyrethrins), some herbicides, synergists (compounds which are applied in conjunction with other pesticides to increase their effectiveness), post-harvest sprout inhibitors and any other pesticide which does not fit in the preceding three major categories.

3.1.1 Pesticide concentration data and calculation of mean concentration values

The primary focus of the NZTDS is public health risk assessment based on estimated dietary exposure to pesticide residues. Exposures are estimated by multiplying concentration data by the amount of food consumed. Therefore, concentration data are an intermediate, but important step in obtaining exposure estimates.

While a very wide sampling base for each food in the NZTDS is desirable, the number of analytical samples for each food is usually a compromise depending on the range of analytes to be covered, the size of the food list, and the resources available for the project. The number of samplings, the number of analytical samples and summary concentration data for foods with detectable residues in the 1997/98 NZTDS are included in Appendix 5.

It is recognised that considerable variability in pesticide residue concentrations can occur (MAFF, 1995; FAO/WHO, 1997). This is particularly relevant for the assessment of public health risk from acute pesticide residue exposure (FAO/WHO, 1999).

Mean concentrations of pesticides in foods were calculated as simple arithmetic means. Pesticides are intentionally applied to crops at specific times to achieve a specific purpose. Pesticide residues may be present at a detectable level, may be present at a level below the limit of detection, or may not be present. Where no residue was detected in the sample, the true concentration of the pesticide in that sample was assumed to be zero, an assumption that will be valid in most cases. This is the most commonly used international protocol for estimating dietary exposure to pesticides (FAO/UNEP/WHO, 1985; Gunderson, 1995; Hardy, 1998).

The United States Environmental Protection Agency (EPA) take a rather more rigorous approach; zero values are assigned to “the proportion of the data set corresponding to the percentage of commodities known not to be treated with the pesticide” (EPA, 1998). The necessary information to follow this approach is not currently available in New Zealand.

3.1.2 Estimated dietary exposure to pesticides

Possible public health risks have been based on a comparison with acceptable daily intake (ADI). This is the level of pesticide exposure, at or below which there will be no appreciable risk of adverse health effects, if consumed over an entire lifetime. Thus the health implications are assessed from the perspective of chronic toxicity.

ADIs are set using the information obtained from toxicological studies, including data from acute and chronic studies on various laboratory animals. From these studies, a no observable effect level (NOEL) is calculated. The NOEL is the highest dose level that produces no observable toxic effect in the most sensitive test species. The NOEL is divided by a safety factor, taking into account the difference between test animals and humans and the difference between different individuals, to give the ADI expressed in terms of mg pesticide/kg body weight/day. Safety factors for pesticides are usually in the range 100 to 1000, depending on the reliability and interpretation of the toxicological data available.

Safety factors lower than 100, down as low as 10, may be used if good human epidemiological data are available, but this is rarely the case. New Zealand usually adopts ADIs recommended by the Joint WHO/FAO Meeting on Pesticide Residues (JMPR).

The most recent ADIs promulgated by JMPR are summarised in Appendix 6.

Internationally there is a move towards assessing health significance of acute pesticide residue exposures (ie intake on a single eating occasion or a single day) by comparing with the acute reference dose (acute RfD; Mascall et al., 1999; Shaw, 1999). There are insufficient reference data to apply this approach at the present time but New Zealand authorities and scientists need to be mindful of international developments in this area.

Recommendation 4:

> *New Zealand maintains a watching brief in the areas of health impact assessments for pesticide residues, including variability and acute dietary exposure methodologies. It will be important to develop and maintain appropriate networks and information linkages.*

It should also be noted that the dietary exposures to pesticides estimated in this report are based on 50th percentile (median) energy consumption figures. As a rule of thumb, extreme consumers at 95th percentile levels may approximate three times the population average consumption figure for individual foods and up to twice the total amount consumed by the population as a whole (FAO/UNEP/WHO, 1985).

Recommendation 5 :

> *It is recommended that high (90th or 95th) percentile energy diets be included in future NZTDSs, to ensure the public health risk to these sectors of the population is adequately assessed.*

3.1.3 Trends in estimated dietary exposure to pesticides

The 1997/98 NZTDS is the fifth carried out in New Zealand. While there were significant changes in the survey design between the 1982 NZTDS (Pickston et al, 1985) and the 1987/88 NZTDS (ESR/Ministry of Health, 1994), the procedures for performance of the NZTDS have been fairly consistent for the last three surveys (1987/88, 1990/91, and 1997/98). Therefore, changes in estimated dietary exposure from one survey to the next can be assumed to reflect:

- changes in usage patterns of pesticides; or
- changes in food consumption patterns; or
- changes in analytical procedures allowing detection of pesticides at previously undetectable levels.

These trends will be reported and discussed for all pesticides detected in the 1997/98 NZTDS.

3.1.4 International comparisons of estimated dietary exposure to pesticides

The results of the 1997/98 NZTDS have been compared with the 1996 Australian Market Basket Survey (AMBS; Hardy, 1998) and the 1986-91 United States Total Diet Surveys (Gunderson, 1995). There are a limited number of TDSs available for comparison and these two studies were selected for the cultural similarities between these countries and New Zealand and because the methodologies for estimating exposure are comparable.

Comparison of estimated dietary exposure to pesticides for the New Zealand population with estimates made in other countries can be problematical due to differences in:

- analytical procedures
- agricultural practices
- analytical quality assurance/quality control
- total diet survey design (individual foods or food group composites)
- definition of age-sex groups and body weights used
- protocols for dealing with 'not detected' analytical results
- diets (different foods, levels of consumption)
- ethnic differences.

Because of these factors it is considered inappropriate to compare absolute numbers between studies. Consequently, comparisons with international studies have been presented graphically as this enables relative orders of magnitude to be recognised more easily.

Comparison has been made against estimated daily dietary exposures calculated for the New Zealand young male (YM, 19-24 years, 70 kg body weight). The studies and the relevant age-sex group for comparison are given in Table 4 below. The YM age-sex group was chosen as a point of comparison to maintain consistency with previous NZTDSs and with the elements report for the 1997/98 NZTDS. While the international studies used as comparison points for this report include a number of age-sex groups, some of the comparison studies for the elements report only calculate exposures for an 'average adult' or an 'average adult male'. The YM was viewed as the best compromise for wide comparability with other studies.

Table 4 Overseas total diet studies used for comparison with results from the 1997/98 NZTDS

Country	Name of study	Age-sex group	Body weight (kg)	Age (years)
New Zealand	*1997/98 New Zealand Total Diet Survey*	*Young male*	*70*	*19-24*
Australia	1996 Australian Market Basket Survey (AMBS; Hardy, 1998)	Adult male	75	25-34
United States	1986-91 Total Diet Surveys (Gunderson, 1995)	Male	64	14-16

While the range of suitable comparative studies is relatively narrow at this stage, a number of countries are currently involved in planning Total Diet Studies. These efforts are being supported by the World Health Organization (WHO) through their Global Environmental Monitoring System (GEMS) programme. New Zealand is currently actively involved in this programme and continued involvement will be important to enable access to a wider range of comparative data.

Recommendation 6:

> *New Zealand should continue to contribute pesticide residue concentration and exposure data to the World Health Organization (WHO) Global Environmental Monitoring System (GEMS) programme on an on-going basis.*

3.2 Pesticide Results Overview

Of the 460 food samples screened for 90 pesticide residues, 272 samples (59%) were found to contain detectable residues. This is very similar to the percentage (56%) found in the 1990/91 NZTDS (Vannoort et al, 1995a).

Two factors should be remembered when considering these statistics:

- The sampling plan was devised to look more closely at foods that were more likely to contain pesticide residues. For example, previous NZTDSs have indicated that orange juice is unlikely to contain pesticide residues and only two composite samples were analysed. By contrast, previous NZTDSs have demonstrated that bread often contains residues of organophosphorus pesticides and eight samples of each of three different types of bread were analysed; and
- The current survey employed improved analytical methods and it should be noted that of the 272 samples with detectable residues in the current survey, 160 of these would not have been detected with the methods employed in the 1990/91 survey. This means that while the percentage of samples with detectable pesticide residues has risen slightly, the majority of the residue levels were significantly lower than those in the 1990/91 NZTDS.

Of the 90 pesticides screened for in the 1997/98 NZTDS, a total of 20 different pesticide residues were detected across the 460 different food samples analysed. By way of comparison, 30 different pesticide residues were detected in the 1990/91 NZTDS out of a total of 73 screened for (Vannoort et al, 1995a). The 1996 Australian Market Basket Survey (AMBS) reported detection of 36 different pesticide residues out of a total of 51 screened for (Hardy, 1998).

Two different food types (raisins/sultanas and pears) contained up to six different pesticide residues, although these were not all in the same sample. The maximum number of pesticide residues in any one food sample from the 1997/98 NZTDS was five, on imported sultanas/raisins.

Of the approximately 29,000 individual analytical pesticide residue results, only 397 results (1.4%) represented detectable residues. Of these, 223 of the pesticide residues were detected in the 1997/98 NZTDS because of significantly improved limits of reporting from those used in the 1990/91 NZTDS.

Of the residues detected in the current survey, none exceeded the New Zealand Maximum Permissible Proportion (MPP), where one was specified for the food item. In some cases no MPP is defined for a particular food-pesticide combination and in these cases the New Zealand Food Regulations 1984 specify a default MPP of 0.1 mg/kg. Food-pesticide combinations which did not meet the default criteria are detailed in Appendix 7.

3.3 Organochlorine (OC) Pesticide Residues

Organochlorine pesticides are synthetic compounds that contain chlorine bonded to an organic molecule. They were amongst the first of the modern pesticides, developed during the 1930s (NRC, 1993). With notable exceptions, most organochlorine compounds have a relatively low toxicity to mammals and are highly toxic to insects. They are very stable compounds and persist in soils. They are also fat-soluble and may be stored in the fat of humans and other animals. Many of the older, persistent organochlorine pesticides, such as DDT, have been banned or their use restricted. Newer organochlorines, such as endosulfan and dicofol, are readily degraded in the environment. While some organochlorine compounds are still in active use, the majority of residues found in food are due to the persistence of compounds, such as DDT or its metabolites. These compounds are more accurately classified as environmental contaminants than as pesticides.

Organochlorines are effective as pesticides by disrupting nerve function and act particularly at the axonal membranes of nerves. In mammals, acute poisoning can produce death by respiratory or cardiac failure as a result of nerve dysfunction. Chronic poisoning results in behavioural changes, liver damage and reduced reproductive efficiency. Problems with haematopoiesis (red blood cell synthesis) have also been caused in susceptible individuals (Jones, 1993).

ADIs for organochlorine pesticides range from 0.1 μg/kg body weight/day for the highly toxic compounds aldrin, dieldrin and heptachlor, to 20 μg/kg body weight/day for total DDT (IPCS, 1998).

Levels of organochlorine pesticides detected in individual foods analysed in the 1997/98 NZTDS have been detailed previously (Vannoort et al, 1997a; 1998a,b,c) and are consolidated in this report in Appendix 5.

Residues of three organochlorine pesticides (total DDT, dicofol, and total endosulfan) were detected in foods analysed in the 1997/98 NZTDS, with two forms of each of DDT and endosulfan being detected. The remaining 18 organochlorine residues included in the screen were not detected in any foods in the 1997/98 NZTDS. Residues of organochlorine pesticides account for 16% of all residues detected (65 out of a total of 397).

DDT has not been registered for agricultural use in New Zealand for over 20 years. Therefore the presence of the parent compound, pp-DDT, in eggs is unexpected and warrants investigation. The major metabolite of DDT, pp-DDE, was detected in a wide range of animal products and processed foods containing animal products. It was also detected in 1/10 samples of chocolate biscuits, presumably from the chocolate component of this food, and 2/12 samples of raisins/sultanas. Both of these sources of DDT exposure relate to imported plant-based materials. Residues of DDT were not detected in any plant-based foods of New Zealand origin.

Recommendation 7:

> *Further work should be undertaken to identify whether the presence of pp-DDT in eggs is a common occurrence, as its presence indicates use of, or exposure to, a deregulated pesticide.*

Exposure estimates from previous NZTDSs indicate DDT is gradually decreasing in the New Zealand environment. Table 5 presents comparative data from the 1987/88, 1990/91 and 1997/98 NZTDSs for the mean concentration of total DDT (parent compound plus major metabolites) in selected total diet foods.

Table 5 Comparison of mean concentrations of total DDT in selected total diet foods analysed in the 1987/88, 1990/91 and 1997/98 NZTDSs

Food	**Mean concentration of total DDT in selected NZTDS foods (mg/kg)**		
	1987/88	**1990/91**	**1997/98**
Bacon	0.03	0.02	0.006
Beef, rump	Trace [a]	0.01	0.002 [b]
Butter	0.07	0.04	0.02
Cheese	0.07	0.02	0.008
Chicken	Trace [a]	0.005 [b]	0.002 [b]
Lamb/mutton, shoulder	0.03	0.03	0.01
Lamb's liver	0.05	0.08	0.005
Luncheon sausage	0.02	0.02	0.008
Sausages, beef	0.03	0.03	0.02
Limit of reporting	**0.01**	**0.01**	**0.003**

a Trace refers to situations where the analyte was detected, but at a level below the limit of reporting.
b Reported results which are below the limit of reporting are the result of averaging results above the limit of reporting and results below the limit of reporting (assigned a value of zero).

While the mean concentrations presented here are based on relatively limited sample numbers, there appears to be a general downward trend in the levels of these persistent compounds in New Zealand foods.

Dicofol was detected on both composite nectarine samples analysed, on 1/8 samples of pears, and on 4/12 samples of raisins/sultanas.

Endosulfan residues were detected in 2/8 tomato samples and 1/2 cucumber samples.

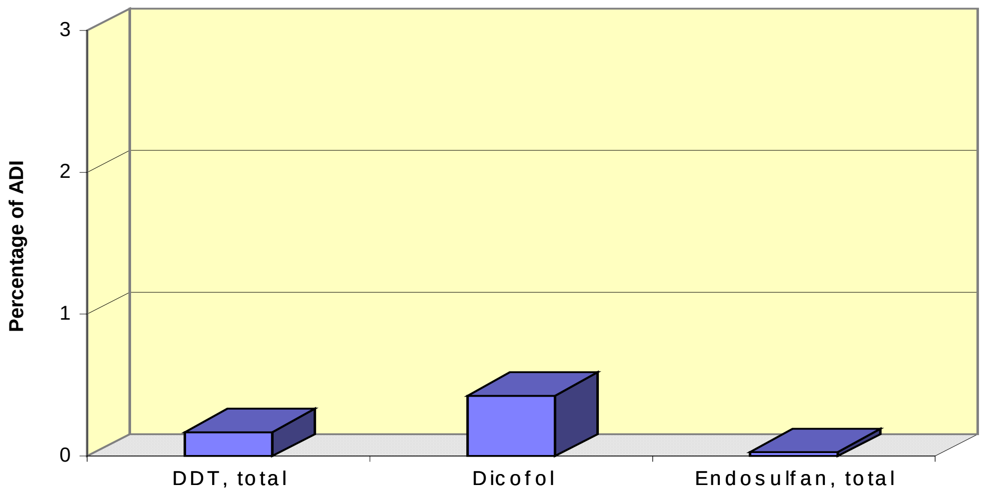
It should also be noted that αHCH and dieldrin, which were both detected in the 1990/91 NZTDS, were not detected in the current survey.

3.3.1 Estimated dietary exposure to organochlorine pesticides

Estimated daily dietary exposures to organochlorine pesticides for each of the age-sex groups considered in the 1997/98 NZTDS are given in Appendix 8. Results are presented as exposures expressed as µg/kg body weight/day, and as a percentage of the relevant Acceptable Daily Intake (ADI), as ADIs differ between organochlorine pesticides.

Figure 1 graphically summarises the estimated daily dietary exposures to organochlorine pesticides for a young male (0.2%, 0.4% and 0.03% of the ADI for DDT total, dicofol and endosulfan total, respectively). Note that the scale has been greatly expanded so that results can be seen more easily. Exposure estimates for the three organochlorine pesticides detected represent a very low level of risk, for YM.

Figure 1 Estimated daily dietary exposure to organochlorine pesticides detected in the 1997/98 NZTDS for a young male



Exposure to total DDT residues is from three of the total diet food groups; the chicken, eggs, fish and meat group; dairy products; and takeaway foods. Dairy products contribute the largest proportion (45%) of the total exposure for a YM. The proportion of total exposure contributed by dairy products is even greater for the VF group (81%) and for children (65% for C and 71% for YC). This pattern of exposure is different to that observed in the 1990/91 NZTDS, in which over 60% of the total DDT exposure for a YM came from the consumption of meat and meat products. However, for all these population sub-groups estimated exposure is still less than 1% of the ADI.

Exposure to dicofol residues is solely from residues detected in fruit, with nectarines contributing 85% of the total exposure in the current survey for a YM.

Endosulfan exposure is evenly split between two vegetable sources; cucumbers and tomatoes.

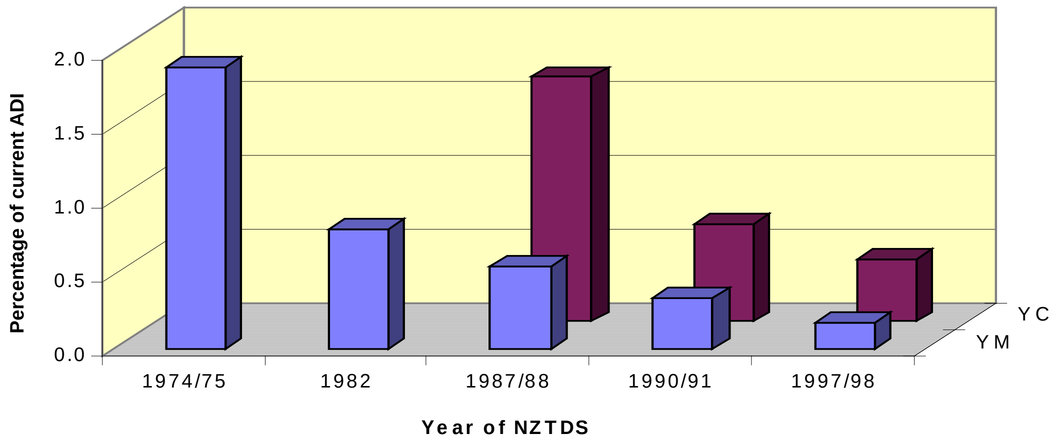
3.3.2 Trends in estimated dietary exposure to organochlorine pesticides

Dicofol has not been detected in previous NZTDSs. Its detection in the current survey may be due to changed patterns of usage or due to improved (tenfold) reporting limits for analyses of this pesticide in the current survey.

Endosulfan residues have been detected in the last three surveys carried out, with exposure estimates increasing from the 1987/88 to the 1990/91 NZTDS, and then decreasing again in the current survey.

Figure 2 shows the estimates of daily dietary exposure for total DDT (DDT and its metabolites) determined in each of the five NZTDSs carried out to date, for a YM and for a YC, using data from the three most recent NZTDSs (1987/88, 1990/91, and 1997/98). The data represented in Figure 2 suggest that dietary exposure to DDT is steadily decreasing as levels of this contaminant gradually reduce in the environment. DDT levels are steadily approaching levels in foods where improved analytical methodologies will be required to detect any residues at all.

Figure 2 Estimated daily dietary exposure to total DDT for a young male (YM) and a young child (YC) in the 1997/98 NZTDS compared to previous NZTDSs



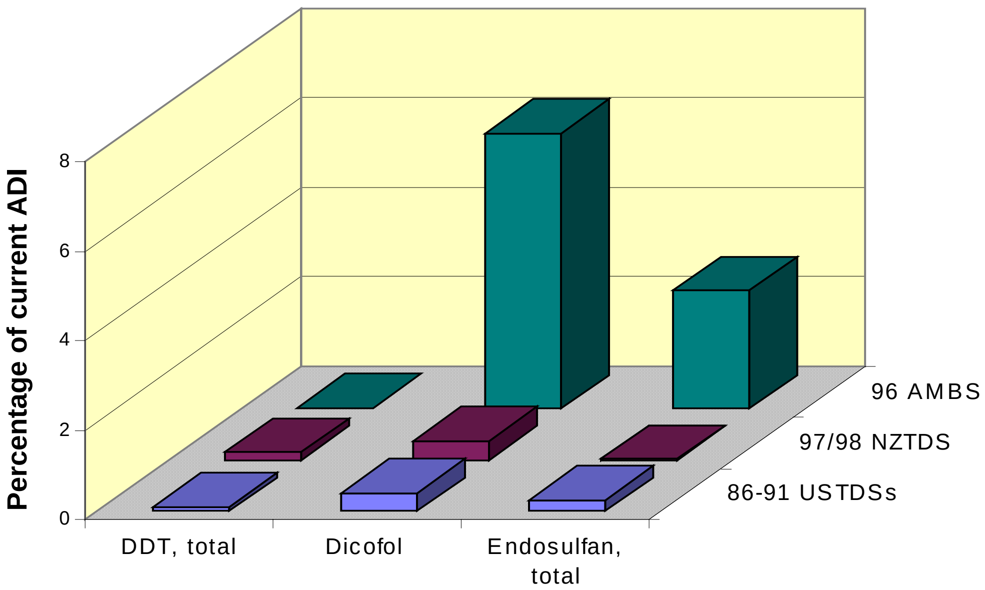
3.3.3 International comparisons of estimated dietary exposure to organochlorine pesticides

Figure 3 compares the estimated daily dietary exposure to detected organochlorine pesticides for a YM in the 1997/98 NZTDS with similar overseas estimates. Details of reference studies and description of age-sex groups is given in section 3.1.4.

Estimated daily dietary exposures to organochlorine pesticides generally compare favourably with overseas estimates. Total DDT estimates for all studies considered were at or less than 1% of the Acceptable Daily Intake (ADI), reflecting the fact that all three countries (New Zealand, Australia, and the United States) deregistered this pesticide over 20 years ago. The Global Environmental Monitoring Systems food programme (GEMS/Food; UNEP/FAO/WHO, 1992) reported estimated total DDT exposure from 12 countries ranging from 0.004 to 69% of the ADI.

Estimated exposure to dicofol and endosulfans is comparable between the New Zealand and United States studies. In the Australian study, exposure to these two pesticide residues is higher.

Figure 3 Comparison of estimated daily dietary exposure to organochlorine pesticides detected in the 1997/98 NZTDS for a young male with overseas total diet surveys



AMBS Australian Market Basket Survey
NZTDS New Zealand Total Diet Survey
USTDSs United States Total Diet Surveys

3.4 Organophosphorus (OP) Pesticide Residues

Organophosphorus pesticides, such as pirimiphos-methyl and fenitrothion, are esters of phosphate-containing acids. They are mostly insecticides for the protection of crops against aphids and soft-bodied insects, and fumigants for the control of weevil during shipping and storage of grain (Jones, 1993). Organophosphorus pesticides are the most heavily used insecticides in New Zealand at present (Holland and Rahman, 1999). The organophosphorus pesticides were mainly developed during the 1970s to replace the organochlorine pesticides. Most organophosphorus pesticides degrade readily in biological systems.

The organophosphorus pesticides act on the central nervous system. These compounds are cholinesterase inhibitors, and by suppressing the activity of this enzyme, allow toxic levels of the neurotransmitter acetylcholine to accumulate. As a class, the organophosphorus pesticides are generally more acutely toxic than the organochlorine insecticides they replaced, but they have the great advantage that they are less persistent in the environment. In mammals, acute poisoning can result in death due to respiratory failure, while chronic exposure results in delayed neuropathy, changed behaviour and reduced reproductive efficiency (Jones, 1993).

Organophosphorus pesticides have a wide range of toxicity, with ADIs ranging from 0.1 µg/kg body weight/day for prothiofos to 300 µg/kg body weight/day for malathion (IPCS, 1998). The full list of ADIs for organophosphorus pesticides included in this survey is given in Appendix 6.

Levels of organophosphorus pesticide determined in individual foods in the 1997/98 NZTDS have been detailed previously (Vannoort et al, 1997a; 1998a,b,c) and are consolidated in this report in Appendix 5. Residues of five organophosphorus pesticides were detected (chlorpyriphos, chlorpyriphos-methyl, dimethoate, fenitrothion, and pirimiphos-methyl) in foods analysed as part of the 1997/98 NZTDS. No residues of the remaining 28 organophosphorus pesticides included in the screen were detected in any food in the 1997/98 NZTDS. Residues of organophosphorus pesticides account for 39% of all residues detected (155 out of a total of 397).

Chlorpyriphos was detected almost exclusively on fruit and foods containing fruit (eg muesli). Dimethoate was detected exclusively on fruiting vegetables (capsicums, courgettes, and tomatoes).

Chlorpyriphos-methyl, fenitrothion, and pirimiphos-methyl were detected almost exclusively on cereal products and processed foods containing cereal products, such as battered fish. Organophosphorus pesticides tend to be deposited on the outer layers of the grain (on the bran or epidermal layer) and removed during milling and processing (WHO, 1992). The results observed in the current survey are consistent with this proposition, with the highest concentrations of chlorpyriphos-methyl and fenitrothion being observed in bran cereal.

The organophosphorus pesticides diazinon, dichlorvos, malathion, methidathion, parathion-methyl, phosmet, and prothiofos which were detected in the 1990/91 NZTDS, were not detected in the current survey.

3.4.1 Estimated dietary exposure to organophosphorus pesticides

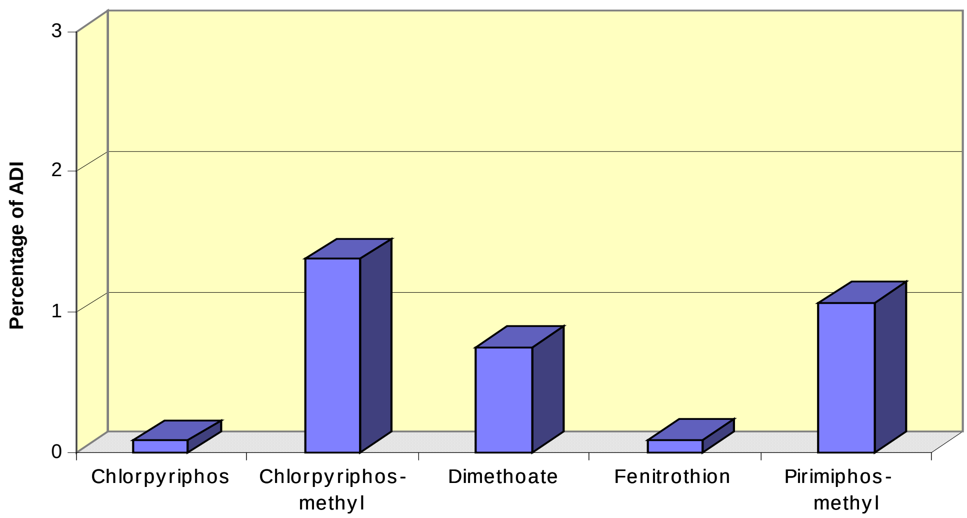
Estimated daily dietary exposures to organophosphorus pesticide for each of the age-sex groups considered in the 1997/98 NZTDS are given in Appendix 8. Results are presented as exposures expressed as µg/kg body weight/day, and as a percentage of the relevant Acceptable Daily Intake (ADI), because ADIs differ between organophosphorus pesticides.

Figure 4 graphically presents the estimated daily dietary exposures for all organophosphorus pesticides detected in the 1997/98 NZTDS, based on the simulated diet for a YM expressed as a percentage of ADI. Note that the scale used in this figure has been expanded.

Estimated dietary exposure to chlorpyriphos is extremely low (0.09% of ADI for a YM). Fruit is the major contributor to chlorpyriphos exposure (greater than 80% of total exposure), with apples being the biggest single contributor (46% of total estimated exposure for a YM). By contrast, exposure to dimethoate (0.7% of ADI for a YM) is entirely due to its application to vegetable crops, with the residues detected on courgettes contributing approximately 60% of the estimated exposure.

Exposure to the remaining three organophosphorus pesticides comes exclusively from consumption of grain products and foods incorporating grain products, such as the pastry component of meat pies. This reflects the major usage of these pesticides for the disinfestation of stored grain. Bread is the major contributor to estimated exposure to chlorpyriphos-methyl and pirimiphos-methyl, while approximately 90% of estimated fenitrothion exposure is due to its detection on bran cereal.

Figure 4 Estimated daily dietary exposures to organophosphorus pesticides detected in the 1997/98 NZTDS for a young male



3.4.2 Trends in estimated dietary exposure to organophosphorus pesticides

Of the organophosphorus pesticides detected, dimethoate has not been detected in previous NZTDSs.

Estimated daily dietary exposure to chlorpyriphos has varied over the three most recent NZTDSs. For a YM, the exposure increased from 0.02 µg/kg body weight/day in 1987/88 to 0.06 in 1990/91 and then decreased again to 0.009 in the current survey.

Chlorpyriphos-methyl, pirimiphos-methyl and fenitrothion are principally found on grain products or foods containing grain products, such as luncheon meat and sausages, as a consequence of their use as fumigants of stored grain. The period between the 1987/88 NZTDS and the current survey has shown an apparent change in patterns of usage between these three pesticides. This is demonstrated in Table 6 for the YM age-sex group.

While estimated exposures to pirimiphos-methyl have decreased incrementally, but steadily, there has been an apparent shift in usage patterns away from fenitrothion to chlorpyriphos-methyl. The magnitude of the increase in chlorpyriphos-methyl exposure is considerably less than the estimated decrease in exposure to fenitrothion.

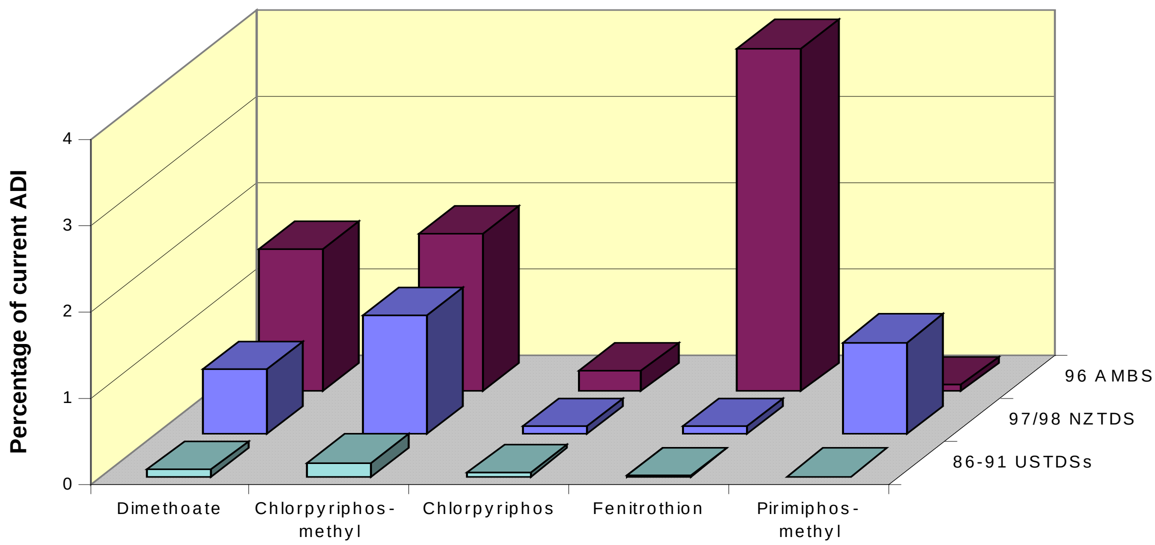
Table 6 Estimated daily dietary exposure to chlorpyriphos-methyl, pirimiphos-methyl, and fenitrothion for a young male in the 1997/98 NZTDS compared to previous NZTDSs

	Estimated daily dietary exposure (as a % of current ADI)		
	1987/88 NZTDS	**1990/91 NZTDS**	**1997/98 NZTDS**
Chlorpyriphos-methyl	0.02	0.15	1.4
Pirimiphos-methyl	1.8	1.2	1.1
Fenitrothion	10	4.1	0.1

3.4.3 <u>International comparisons of estimated dietary exposure to organophosphorus pesticides</u>

Figure 5 summarises comparison of the estimated daily dietary exposure to detected organophosphorus pesticides for a YM in the 1997/98 NZTDS with similar overseas estimates. Details of reference studies and description of age-sex groups is given is section 3.1.4.

Figure 5 Comparison of estimated daily dietary exposure to organophosphorus pesticides detected in the 1997/98 NZTDS for a young male with overseas total diet surveys



AMBS Australian Market Basket Survey
NZTDS New Zealand Total Diet Survey
USTDSs United States Total Diet Surveys

Patterns of estimated exposure to organophosphorus pesticides vary between countries and, presumably reflect usage and climatic conditions. The United States Total Diet Survey (Gunderson, 1995) generally reports very low exposure estimates for all five organophosphorus pesticides which were detected in the New Zealand study. The US study also detected residues of a number of other organophosphorus pesticides, which were not detected in the New Zealand study, however, this may be due to the fact that their analytical limits of reporting are generally lower than those achieved in the current survey.

The results from the Australian Market Basket Survey (AMBS; Hardy, 1998) indicate that fenitrothion is still the major organophosphorus pesticide used for fumigation of Australian grain, whereas it is now rarely observed in New Zealand. Given New Zealand uses imported grain as well as directly importing grain products from Australia, and our 1997/98 NZTDS is 1-2 years more recent than the latest published AMBS, it will be interesting to see if the next AMBS also reflects a reduction in fenitrothion use.

3.5 Fungicide Residues

Fungicides are necessary to control fungal diseases that when unchecked can disrupt the regular supply of varied, quality food commodities to a much greater extent than insect pests. The mycotoxins produced by certain fungal species are typically associated with certain foods including nuts, grains and fruits. Mycotoxins have the potential to cause serious health problems in both humans and stock (WHO, 1979; WHO, 1990). Fungicides are compounds from different chemical families grouped by their prime function.

Levels of fungicides detected in individual foods in the 1997/98 NZTDS have been detailed previously (Vannoort et al, 1997a; 1998a,b,c) and are consolidated in this report in Appendix 5. In the 1997/98 NZTDS residues of seven different fungicides were detected (chlorothalonil, dicloran, diphenylamine, dithiocarbamates, iprodione, procymidone, and vinclozolin). No residues of the remaining 11 fungicides included in the multi-residue screen were detected in any food in the 1997/98 NZTDS. Residues of fungicides account for 35% of all residues detected in this study (138 out of a total of 397). Dithiocarbamates accounted for approximately two thirds of the fungicide residues detected. This is consistent with the findings of a recent review which highlighted that dithiocarbamates are the predominant class of fungicides used in New Zealand (Holland and Rahman, 1999).

Fungicide residues were only detected on fruits and vegetables, or food containing fruit (muesli and yoghurt) or foods made from fruits (wine, jam) and vegetables.

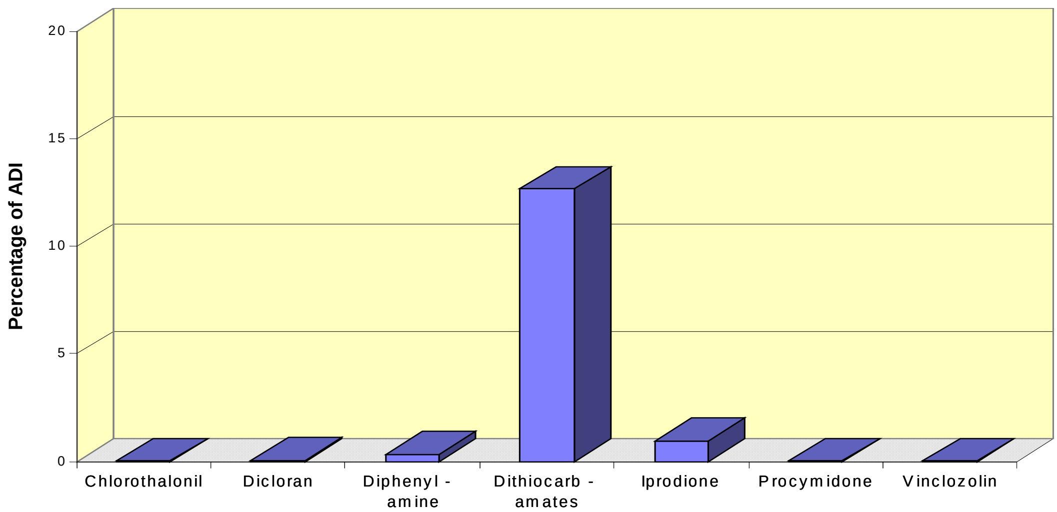
The range of fungicides detected in the 1997/98 NZTDS was very similar to the range detected in the 1990/91 NZTDS. Only dicloran has not previously been detected in NZTDSs. Diphenylamine was not detected in 1990/91, but was in the 1987/88 NZTDS. Captan and dichlofluanid were detected in the 1990/91 NZTDS, but not in the current survey.

3.5.1 Estimated dietary exposure to fungicides

Estimated daily dietary exposures to fungicides for each of the age-sex groups considered in the 1997/98 NZTDS are given in Appendix 8. Results are presented as exposures expressed as µg/kg body weight/day, and as a percentage of the relevant Acceptable Daily Intake (ADI), because ADIs differ between fungicides.

Figure 6 presents graphically the estimated dietary exposures for all fungicides detected in the 1997/98 NZTDS. Exposures are presented here for the YM age-sex group and are expressed as a percentage of the relevant ADI. Estimated exposures for fungicides, with the exception of dithiocarbamates, are all less than 1% of the relevant ADI.

Figure 6 Estimated daily dietary exposures to fungicides detected in the 1997/98 NZTDS for a young male



A wide range of fruits and vegetables contribute to the total exposure to dithiocarbamate fungicides. Major contributors include apples (approximately 20% of exposure), brassica vegetables (cabbage, broccoli, cauliflower; approximately 20% of exposure), and bananas (approximately 17% of exposure).

Recommendation 8:

Ongoing monitoring of fruit and vegetables for dithiocarbamates is recommended, especially considering the wide range of products on which they were detected.

The estimated exposure to dithiocarbamate fungicides equates to 13% of the ADI for a YM. This level of exposure should be viewed as a worst case estimate. Dithiocarbamates consist of a group of eight agricultural pesticides (ferbam, mancozeb, maneb, metiram, propineb, thiram, ziram, and zineb) which are conventionally listed as a group on the basis of the common analytical method for their determination. This involves decomposition of the parent compounds in acid and analysis of the resultant carbon disulphide. This method is unable to differentiate which dithiocarbamate is present.

International assessments have suggested that these compounds should be considered as two groups on the basis of their toxicological endpoints (FAO, 1998);

- mancozeb, maneb, metiram and zineb have been assigned a group ADI of 30 μg/kg body weight/day based on their thyroid toxicity (WHO, 1994; FAO/WHO, 1996), propineb is also included in this group due to its thyroid toxicity, but has a lower ADI (7 μg/kg body weight/day; WHO, 1994), and
- ferbam, thiram, and ziram have been assigned a group ADI of 3 μg/kg body weight/day, based on similar toxicities but different to the above group because the toxicity endpoints are not associated with thyroid toxicity (FAO, 1998).

From a risk assessment perspective, the lower group ADI for ferbam, thiram and ziram (3 μg/kg body weight/day) has been applied in the current study for characterisation of the dithiocarbamate exposure. If the other group of dithiocarbamates were in fact present, with their higher group ADI (30 μg/kg body weight/day) then the estimated dietary exposure would be ten fold lower, at only 1.3% of the ADI for a young male.

It should also be borne in mind that some commodities, such as brassicas (cabbage, broccoli, cauliflower) contain natural compounds which can produce carbon disulphide under the conditions used for dithiocarbamate analysis. As carbon disulphide is the chemical species determined in the dithiocarbamate analysis, this can lead to an overestimation of the dithiocarbamate content of these products (MAFF, 1997). Dithiocarbamates detected on brassicas account for approximately 20% of the estimated exposure to dithiocarbamate fungicides in the 1997/98 NZTDS.

Recommendation 9:

> *That emerging methodologies for the determination of individual dithiocarbamate fungicides be implemented in New Zealand in order to develop a more accurate estimate of the potential risk posed by these fungicides. That the contribution from naturally occurring sulphur compounds be assessed by analysing untreated samples.*

Chlorothalonil exposure (0.01% of ADI for YM) was due entirely to consumption of vegetables and principally (75% of estimated exposure) due to residues detected on celery.

Dicloran exposure (0.05% of ADI for YM) resulted from residues on three crops (kumara, pears, nectarines), with the fruit crops contributing approximately 75% of the exposure.

Diphenylamine exposure (0.3% of ADI for YM) was largely (>90%) due to treatment of pome fruit (apples, pears) with this fungicide.

Iprodione exposure (1% of ADI for YM) was predominantly (approximately 60%) due to residues in canned apricots.

Procymidone exposure (0.01% of ADI for YM) was largely (approximately 90%) due to the presence of residues of this pesticide on frozen beans.

Vinclozolin exposure (0.03% of ADI for YM) was largely due to the presence of residues of this pesticide on tomatoes (approximately 75% of total exposure).

3.5.2 Trends in estimated dietary exposure to fungicides

Considerable effort has been put in by sectors of the fruit and vegetable industries to decrease pesticide usage (NZ Vegetable and Potato Growers Federation, 1997). Table 7 compares the estimates of daily dietary exposure for the YM age-sex group from the 1987/88, 1990/91 and 1997/98 NZTDSs.

These trends are generally encouraging with exposures to three fungicides (chorothalonil, procymidone, vinclozolin) apparently decreasing steadily with time. The exposure to iprodione indicates an increase with time. This may be because iprodione is being substituted for other fungicides, such as chlorothalonil, procymidone and vinclozolin.

The estimated exposure to dithiocarbamate fungicides seems to be at a comparable level to 1990/91. It should be noted that the limit of reporting for dithiocarbamates has decreased significantly from 0.95 mg/kg in the 1990/91 NZTDS to 0.02 mg/kg in the 1997/98 NZTDS, resulting in an improved level in confidence in the corresponding exposure estimate.

Table 7 Estimated daily dietary exposure to fungicides for a young male in the 1997/98 NZTDS compared to previous NZTDSs

	Estimated daily dietary exposure (as a % of current ADI)		
	1987/88 NZTDS	**1990/91 NZTDS**	**1997/98 NZTDS**
Chlorothalonil	0.3	0.1	0.009
Dithiocarbamates	NA	12	13
Iprodione	0.2	0.4	1.0
Procymidone	0.2	0.08	0.007
Vinclozolin	2.3	1.7	0.03

NA Not analysed

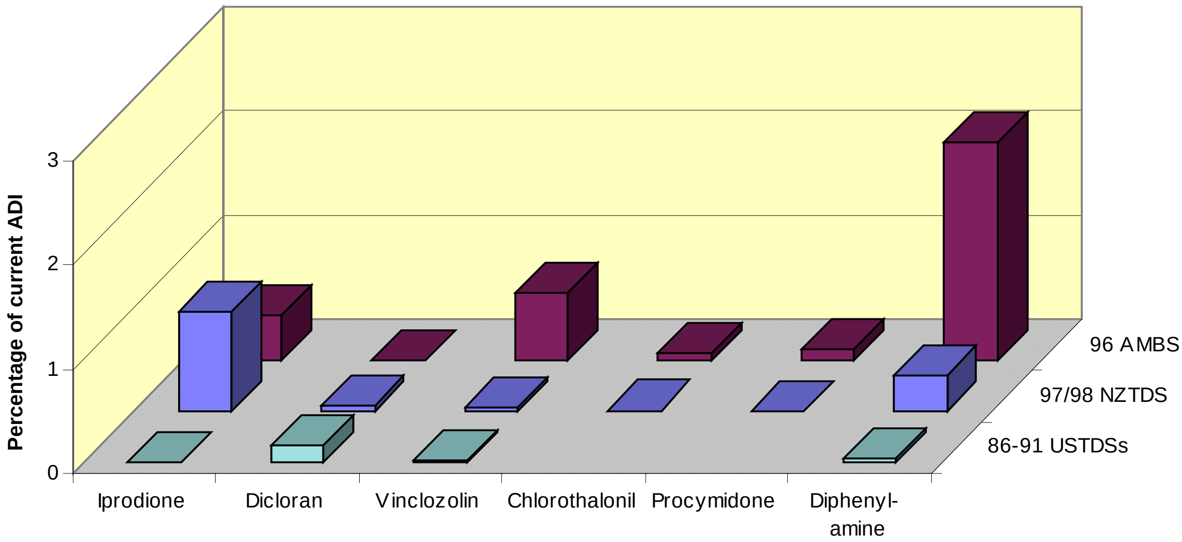
3.5.3 International comparisons of estimated dietary exposure to fungicides

Figure 7 compares the estimated daily dietary exposure to detected fungicides for a YM in the 1997/98 NZTDS with similar overseas estimates. Details of reference studies and description of age-sex groups is given in section 3.1.4.

Exposure estimates for chlorothalonil and procymidone were not reported for the USTDS. Dithiocarbamates were not included in this comparison, as neither of the comparison studies included estimates of dithiocarbamate exposure.

Estimated daily dietary exposure to fungicides in New Zealand generally compares favourably to estimates from other studies considered. Only iprodione exposure is greater than reported exposure levels in both Australia and the US, but is still at an extremely low level relative to the ADI.

Figure 7 Comparison of estimated daily dietary exposure to fungicides for a young male in the 1997/98 NZTDS with overseas total diet surveys



AMBS	Australian Market Basket Survey
NZTDS	New Zealand Total Diet Survey
USTDSs	United States Total Diet Surveys

3.6 Other Pesticide Residues

As the name suggests the category of other pesticides contains an assortment of generally unrelated pesticides, including herbicides, insecticides, post-harvest sprouting inhibitors and synergists (compounds which increase the effectiveness of other pesticides, which they are applied in conjunction with).

Levels of other pesticides detected in individual foods in the 1997/98 NZTDS have been detailed previously (Vannoort et al, 1997a; 1998a,b,c) and are consolidated in this report in Appendix 5. Residues of three other pesticides (bromopropylate, piperonyl butoxide, and propham) were detected in the 1997/98 NZTDS. No residues of the remaining 13 other pesticides included in the screen were detected in any food in the 1997/98 NZTDS. Residues of other pesticides accounted for 11% of all residues detected (42 out of a total of 397).

Bromopropylate is a contact acaricide (controls mites and ticks; Tomlin, 1994), which was detected in 1/2 jam composites, and in 1/12 samples of raisins/sultanas. This is consistent with its registered use on a variety of fruits.

Piperonyl butoxide was detected on a number of grain products and 2/12 samples of raisins/sultanas. Piperonyl butoxide is a synergist usually used in conjunction with pyrethroid pesticides, such as permethrin and cypermethrin (Tomlin, 1994). Piperonyl butoxide is mixed with the pyrethroid at ratios ranging from 5:1 to 20:1. This is a probable explanation of the fact that, while low levels of piperonyl butoxide were observed in a number of samples, no residues of any pyrethroid pesticide were detected.

Propham was found exclusively on potatoes and potato products. This is consistent with its registered use as a post-harvest sprouting inhibitor (Tomlin, 1994).

No residues of the herbicides screened for were detected in any food (alachlor, bromacil, linuron, pendamethalin, propyzamide).

3.6.1 Estimated dietary exposure to other pesticides

Estimated daily dietary exposures to other pesticides for each of the age-sex groups considered in the 1997/98 NZTDS are given in Appendix 8. Results are presented as exposures expressed as µg/kg body weight/day, and as a percentage of the relevant Acceptable Daily Intake (ADI), because ADIs differ between other pesticides.

Figure 8 Estimated daily dietary exposures to other pesticides detected in the 1997/98 NZTDS for a young male

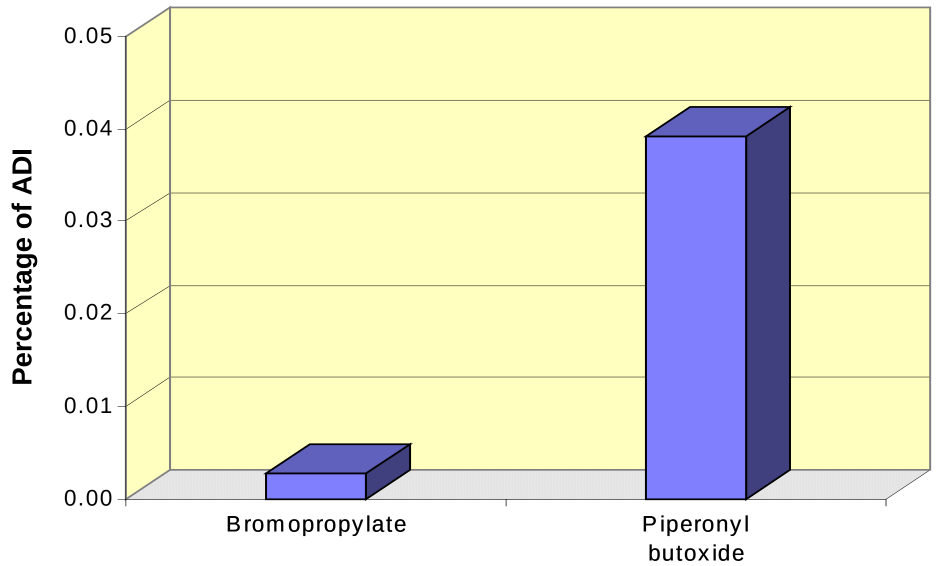


Figure 8 presents the estimated daily dietary exposures for the other pesticides bromopropylate and piperonyl butoxide based on the YM age-sex group and expressed as a percentage of the relevant ADIs. Note that the scale in this figure has been greatly expanded. The post-harvest sprout inhibitor, propham, was also detected on potatoes, however, no ADI has been established for this compound at present.

Bromopropylate exposure was due largely (approximately 80%) to the presence of residues of this pesticide in jam.

Patterns of exposure for piperonyl butoxide are similar to those for the organophosphorus pesticides chlorpyriphos-methyl, fenitrothion, and pirimiphos-methyl, with all sources of exposure being grain products or foods containing grain products.

3.6.2 Trends in estimated dietary exposure to other pesticides

Table 8 compares the exposure estimates derived for three other pesticides in the current survey with those derived in the 1987/88 and 1990/91 NZTDSs. It should be noted that the scale in this figure is expressed in terms of µg/kg body weight/day, rather than as a percentage of the ADI. This is due to the fact that no ADI has been established for the sprout inhibitor, propham.

Table 8 Estimated daily dietary exposure to the pesticides bromopropylate, piperonyl butoxide, and propham for a young male in the 1997/98 NZTDS compared to previous NZTDSs

	Estimated daily dietary exposure (µg/kg body weight/day)		
	1987/88 NZTDS	**1990/91 NZTDS**	**1997/98 NZTDS**
Propham	1.6	1.2	0.6
Bromopropylate	ND	0.007	0.003
Piperonyl butoxide	NA	0.003	0.04

ND Not detected in any food analysed in this survey
NA Not analysed for in this survey

Estimates of exposure to propham have decreased steadily across the last three NZTDSs.

There appears to have been a small increase in the estimated exposure to piperonyl butoxide. It is possible that this may reflect a move from the use of organophosphorus pesticides for the fumigation of grain to the use of the short-lived synthetic pyrethroids in conjunction with piperonyl butoxide. This is consistent with the findings of Holland and Rahman (1999), who report a significant increase in the use of pyrethroid insecticides in New Zealand agriculture.

3.6.3 International comparisons of estimated dietary exposure to other pesticides

Little comparative information was found concerning the other pesticides detected in the 1990/91 NZTDS.

3.7 Health Implications of Pesticide Residues Found

Only twenty of the 90 pesticide residues screened for in the 1997/98 NZTDS were detected in any of the food samples analysed. The pesticide residue levels found in the 1997/98 NZTDS result in dietary exposure estimates that are well within internationally established health standards and are therefore considered safe.

The highest estimated dietary exposure was for the dithiocarbamate fungicides which were potentially less than or equal to 14% of the ADI for adults and less than 23% for children. However, the dithiocarbamate methodology used means these are worst case estimates, possibly by as much as three to ten fold.

All other estimated dietary exposures to pesticide residues from the six age-sex group simulated typical diets were less than 3% of the level of their Acceptable Daily Intake (ADI).

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APPENDIX 1 Details of food preparation in the 1997/98 NZTDS

Glossary of terms

For foods to be prepared in a consistent and unambiguous manner, terms used in this section have been clearly defined.

Homogenise

Samples are put into the appropriate sized food processor or blender and chopped or blended until an homogeneous mixture is attained - usually 6-8 minutes depending on the moisture content of the sample.

Mix

When the preparation instructions state 'mix' or 'mix thoroughly' then the following procedures are to be followed:

For dry foods (such as flour) or semi-dry foods (such as cooked chopped meat):

- form the food into a cone or pile
- flatten the cone slightly and separate into four equal segments
- pull the segments apart so that four separate piles are formed
- combine diagonally opposite piles and mix together thoroughly
- this process should be repeated until thorough mixing of the foods has been achieved

For foods containing juice (eg. nectarines)

- if possible, the food being prepared should be chopped in a large glass or stainless steel bowl so that all the juice is collected.
- mixing of the chopped pieces is then carried out in the bowl using gloved hands or stainless steel cutlery and should be mixed as thoroughly as possible.
- unless cooking instructions state that the food must be drained, any juice must be regarded as an integral part of the food being prepared for analysis. A proportional amount of juice and seeds must be included in all sample containers

For liquid samples (eg. oils and beer)

- liquids are to be measured into a large receptacle such as a bowl or jug made of stainless steel or Pyrex. Plastic containers are to be avoided.
- the total volume added to the receptacle should be thoroughly stirred with a stainless steel utensil before being poured into the sample containers

Composite

Compositing involves thorough mixing/homogenising of equal weights of the indicated samples.

Food preparation equipment

Selection of appropriate food preparation equipment is a vital component of the contamination control procedures.

Gloves

Gloves are to be worn whenever the food being prepared could come into contact with hands. Non-lubricated surgical-style gloves should be used.

Utensils

- stainless steel knives
- wooden (good quality, smooth, crack free) or glass chopping boards
- stainless steel or teflon-coated utensils. Glass equipment can also be used provided it is Pyrex.
- large stainless steel or Pyrex receptacle (jug or bowl) for mixing liquids

Ceramic and enamelware should be avoided at all times, as these may leach traces of lead or cadmium.

Equipment

- domestic oven, with hotplates (electric)
- blenders, glass with stainless steel blades
- food processors, high density plastic with stainless steel blades
- fry-pans (Teflon-coated)
- large stainless steel pots

Food preparation procedures

The following table summarises the procedures used to prepare food samples received by the food preparation laboratory. Full details of food preparation methods are contained in the 1997/98 NZTDS Procedures Manual (Vannoort et al, 1997). All water used in food preparation was distilled.

'Type' indicates whether a food is considered to be national (N) or regional (R).

'No. of samplings' refers to the number of discrete combinations of 5 brands and 2 seasons (National foods) , or 4 regions and 2 seasons (Regional foods). Details of the sampling procedures are described in section 2.4.

'Total weight taken' gives the total weight of each particular food which was processed by the food preparation laboratory.

Food	Type	No. of samplings[a]	Total weight taken (kg)	Food preparation instructions
GRAINS (G) - 19 foods				
Biscuits, chocolate	N	10	17.7	Homogenised and mixed
Biscuits, cracker	N	10	6.2	Homogenised and mixed
Biscuits, plain sweet	N	10	6.5	Homogenised and mixed
Bran cereal	N	10	16.6	Homogenised and mixed
Bread, mixed grain	R	8	23.0	Homogenised and mixed
Bread, wheatmeal	R	8	22.5	Homogenised and mixed
Bread, white	R	8	22.5	Homogenised and mixed
Cake, plain	R	8	9.2	Homogenised and mixed
Corn snacks, cheese-flavoured	N	10	6.0	Homogenised and mixed
Cornflakes	N	10	7.0	Homogenised and mixed
Flour, white	N	10	15.0	Mixed
Muesli	N	10	17.8	Equal weight of water added, homogenised and mixed
Noodles, instant	N	10	4.2	Cooked according to instructions, homogenised and mixed
Oats, rolled	N	10	9.9	Mixed and cooked in water
Rice, white	N	10	7.5	Boiled in water, homogenised and mixed
Spaghetti in sauce, canned	N	10	8.3	Homogenised and mixed
Spaghetti, dried	N	10	5.0	Boiled in water, homogenised and mixed
Tortilla chips (corn)	N	10	6.4	Homogenised and mixed
Wheatbix	N	4	7.7	Homogenised and mixed
DAIRY (D) - 7 foods				
Butter	N	10	20.0	Homogenised and mixed
Cheese	N	10	12.0	Homogenised and mixed
Dairy dessert	N	10	5.5	Mixed
Ice cream	N	10	10.1	Mixed
Milk, trim	R	8	16.0L	Mixed
Milk, whole	R	8	16.0L	Mixed
Yoghurt	N	10	6.2	Mixed
OILS & FATS (O) - 3 foods				
Margarine	N	10	5.0	Homogenised and mixed
Oil, olive	N	10	5.0L	Mixed
Oil, salad and cooking	N	10	8.0L	Mixed

Food	Type	No. of samplings[a]	Total weight taken (kg)	Food preparation instructions
CHICKEN, EGGS, FISH & MEAT (CEFM) - 17 foods				
Bacon	R	8	18.0	Rind and most of fat removed, grilled on each side, homogenised and mixed
Beef, mince	R	8	12.9	Dry fried, homogenised and mixed
Beef, rump	R	8	17.8	Fat removed, grilled on each side, homogenised and mixed
Chicken	N	6	17.0	Lean meat cut from breast, leg and thigh, dry fried, homogenised and mixed
Egg, boiled	R	8	13.4	Boiled in water, peeled, homogenised and mixed
Fish fingers	N	10	9.3	Oven baked as per instructions, homogenised and mixed
Fish, terakihi	R	8	12.7	Grilled on each side, homogenised and mixed.
Lamb/mutton, leg	R	8	11.2	Dry fried, homogenised and mixed
Lamb/mutton, shoulder	R	8	11.2	Dry fried, homogenised and mixed
Lamb's liver	R	8	9.4	Sliced and dry fried on each side, homogenised and mixed
Luncheon sausage	R	8	22.0	Homogenised and mixed
Mussels	R	6	1.8	Flesh scooped out, homogenised and mixed
Oysters	R	6	1.0	Flesh scooped out, homogenised and mixed
Pork pieces	R	8	14.3	Dry fried, homogenised and mixed
Salmon, canned	N	10	13.0	Drained, homogenised and mixed
Sausages, beef	R	8	12.8	Boiled, grilled on each side, homogenised and mixed
Soup, chicken	N	10	8.6	Diluted and cooked as per instructions, mixed
VEGETABLE (V) - 28 foods				
Beans	N	10	10.3	Boiled in water, homogenised and mixed
Beans, baked, canned	N	10	8.4	Homogenised and mixed
Beetroot, canned	N	10	12.6	Drained, homogenised and mixed
Broccoli/Cauliflower	R	8	33.5	Cut into florets, boiled in water, homogenised and mixed
Cabbage	R	8	27.2	Shredded, homogenised and mixed
Capsicum	R	8	24.6	Stem and seeds removed, homogenised and mixed
Carrots	R	8	21.4	Peeled, sliced and boiled in water, homogenised and mixed
Celery	R	8	22.4	Homogenised and mixed
Corn, creamed, canned	N	10	8.4	Homogenised and mixed
Courgette	R	8	29.0	Ends removed, homogenised and mixed
Cucumber	R	8	18.4	Ends removed, homogenised and mixed

Food	Type	No. of samplings[a]	Total weight taken (kg)	Food preparation instructions
VEGETABLE (V) – Continued				
Hummus	N	10	5.9	Homogenised and mixed
Kumara	R	8	19.2	Peeled, boiled in water, homogenised and mixed
Lettuce	R	8	24.7	Homogenised and mixed
Mushrooms	R	8	17.2	Homogenised and mixed
Onions	R	8	18.9	Peeled, boiled in water, homogenised and mixed
Peas	N	10	10.0	Boiled in water, homogenised and mixed
Potato crisps	N	10	7.5	Homogenised and mixed
Potatoes with skin	R	8	31.4	Washed, baked in microwave, homogenised and mixed
Potatoes, peeled	R	8	31.4	Peeled, boiled in water, homogenised and mixed
Pumpkin	R	8	25.0	Peeled, boiled in water, homogenised and mixed
Silverbeet	R	8	19.2	Washed, boiled in water, homogenised and mixed
Soya milk	N	10	6.5L	Mixed
Tofu	N	10	6.6	Homogenised and mixed
Tomato	R	8	25.1	Stalk removed, homogenised and mixed
Tomato pasta sauce, canned	N	10	10.2	Mixed
Tomato sauce, canned	N	10	11.7	Mixed
Tomatoes in juice, canned	N	10	11.8	Homogenised and mixed
FRUIT (F) - 13 foods				
Apple-based juice	N	10	10.0L	Mixed
Apples	R	8	32.1	Cores removed, homogenised with skins left on and mixed
Apricots, canned	N	10	8.4	Drained, homogenised and mixed
Bananas	N	2	6.4	Skin removed, homogenised and mixed
Dates	N	10	8.1	Homogenised and mixed
Kiwifruit	R	8	25.1	Cut in half, flesh scooped out, homogenised and mixed
Nectarines	R	8	17.9	Stones removed, homogenised and mixed
Orange juice	N	10	30.0L	Mixed
Oranges	R	8	25.8	Skin removed, homogenised and mixed
Peaches, canned	N	10	12.7	Drained, homogenised and mixed
Pears	R	8	29.0	Cores removed, homogenised with skins left on and mixed
Pineapple, canned	N	10	13.4	Drained, homogenised and mixed
Raisins/Sultanas	N	10	21.9	Equal weight of water added, homogenised and mixed

Food	Type	No. of samplings[a]	Total weight taken (kg)	Food preparation instructions
SPREADS & SWEETS (S&S) - 7 foods				
Chocolate, plain milk	N	10	6.6	Homogenised and mixed
Confectionery	N	10	4.4	Homogenised and mixed
Honey	N	10	7.3	Mixed
Jam	N	10	8.6	Mixed
Jelly dessert	N	10	1.4	Made up with water according to instructions, homogenised and mixed
Marmalade	N	10	8.8	Mixed
Yeast extract	N	4	4.0	Mixed
ALCOHOLIC Beverages (AL) - 4 foods				
Beer, draught	N	10	7.5L	Mixed
Beer, lager	N	10	6.7L	Mixed
Wine, still red	N	10	21.0L	Mixed
Wine, still white	N	10	21.0L	Mixed
TAKEAWAYS (TA) - 7 foods				
Chicken nuggets	R	8	6.2	Homogenised and mixed
Chinese dish, chicken chow mein	R	8	13.0	Homogenised and mixed
Fish in batter	R	8	7.6	Homogenised and mixed
Hamburger, plain	R	8	6.9	Homogenised and mixed
Pie, meat	R	8	5.9	Homogenised and mixed
Pizza	R	8	9.7	Heated ready to eat, homogenised and mixed
Potato, hot chips	R	8	8.5	Homogenised and mixed
NUTS (N) - 2 foods				
Peanut butter	N	10	7.5	Homogenised and mixed
Peanuts, whole	N	10	8.5	Homogenised and mixed
BEVERAGES, Non-alcoholic (B) - 7 foods				
Breakfast powdered drink	N	10	1.3	Made up with water according to instructions, mixed
Carbonated cola	N	10	14.4L	Mixed
Carbonated lemonade	N	10	14.4L	Mixed
Chocolate beverage	N	10	3.1	Made up with water according to instructions, mixed
Coffee, instant	N	10	1.0	Made up with boiling water, mixed
Tea	N	10	1.2	Made up with boiling water, mixed
Water	R	8	16.0L	Mixed

a 'No. of samplings' refers to the number of discrete combinations of 5 brands and 2 seasons (national foods), or 4 regions and 2 seasons (regional foods). Details of sampling procedures are described in section 2.4.

APPENDIX 2 Weights of food consumed in the 1997/98 NZTDS simulated typical fortnightly diets for each age-sex group

Food	Type	Weight of food in 1997/98 NZTDS diets (g/14 days)					
		YM	M	F	VF	C	YC
GRAINS (G) - 19 foods							
Biscuits, chocolate	N	280	250	175	108	240	195
Biscuits, cracker	N	296	270	135	230	85	55
Biscuits, plain sweet	N	140	155	85	90	210	145
Bran cereal	N	20	20	20	85	10	10
Bread, mixed grain	R	400	350	240	870	280	160
Bread, wheatmeal	R	320	385	180	890	180	110
Bread, white	R	1937	1405	1055	1120	1160	665
Cake, plain	R	481	380	355	200	210	150
Corn snacks, cheese-flavoured	N	0	0	0	0	90	55
Cornflakes	N	61	40	60	60	50	50
Flour, white	N	75	80	75	145	45	40
Muesli	N	30	25	25	90	25	25
Noodles, instant	N	30	30	60	100	50	40
Oats, rolled	N	50	50	50	170	30	25
Rice, white	N	60	100	60	270	50	40
Spaghetti in sauce, canned	N	100	80	60	60	70	35
Spaghetti, dried	N	80	80	60	330	50	40
Tortilla chips (corn)	N	0	0	0	0	45	30
Wheatbix	N	182	150	75	270	100	75
DAIRY (D) - 7 foods							
Butter	N	265	223	144	168	129	86
Cheese	N	418	280	265	460	185	145
Dairy dessert	N	160	110	60	150	150	80
Ice cream	N	270	160	140	170	155	135
Milk, trim	R	520	685	790	1150	600	350
Milk, whole	R	4590	2610	1630	1090	6100	5465
Yoghurt	N	205	133	100	395	350	190
OILS & FATS (O) - 3 foods							
Margarine	N	174	146	87	124	67	44
Oil, olive	N	22	9	19	80	9	8
Oil, salad and cooking	N	27	18	25	65	11	6

Food	Type	Weight of food in 1997/98 NZTDS diets (g/14 days)					
		YM	M	F	VF	C	YC
CHICKEN, EGGS, FISH & MEAT (CEFM) - 17 foods							
Bacon	R	60	70	50	0	35	20
Beef, mince	R	190	180	110	0	50	40
Beef, rump	R	180	180	110	0	55	20
Chicken	N	170	180	140	0	55	35
Egg, boiled	R	231	305	194	318	185	170
Fish fingers	N	0	0	0	0	40	20
Fish, terakihi	R	70	120	60	0	30	20
Lamb/mutton, leg	R	190	180	130	0	55	25
Lamb/mutton, shoulder	R	370	360	200	0	80	50
Lamb's liver	R	35	30	25	0	20	10
Luncheon sausage	R	150	140	105	0	55	35
Mussels	R	35	35	35	0	0	0
Oysters	R	35	35	35	0	0	0
Pork pieces	R	200	160	120	0	37	35
Salmon, canned	N	72	75	70	0	25	25
Sausages, beef	R	180	180	85	0	50	30
Soup, chicken	N	200	200	180	0	80	100
VEGETABLE (V) - 28 foods							
Beans	N	160	225	160	80	95	90
Beans, baked, canned	N	210	180	150	270	35	35
Beetroot, canned	N	45	40	55	45	25	25
Broccoli/Cauliflower	R	123	143	130	143	60	45
Cabbage	R	250	310	380	213	115	70
Capsicum	R	40	40	40	40	15	10
Carrots	R	293	495	260	423	155	120
Celery	R	40	40	70	40	30	25
Corn, creamed, canned	N	73	73	80	200	45	40
Courgette	R	30	30	30	60	20	15
Cucumber	R	90	80	90	120	20	20
Hummus	N	0	0	0	295	0	0
Kumara	R	63	63	65	303	40	40
Lettuce	R	50	47	45	40	12	10
Mushrooms	R	25	25	25	75	10	10
Onions	R	40	40	40	90	15	12
Peas	N	258	395	325	348	140	120

Food	Type	Weight of food in 1997/98 NZTDS diets (g/14 days)					
		YM	M	F	VF	C	YC
VEGETABLE (V) - Continued							
Potato crisps	N	50	65	35	100	45	35
Potatoes with skin	R	530	380	240	896	230	130
Potatoes, peeled	R	1240	860	440	560	415	265
Pumpkin	R	70	80	65	110	105	135
Silverbeet	R	160	145	155	30	35	35
Soya milk	N	0	0	0	740	0	0
Tofu	N	0	0	0	265	0	0
Tomato	R	180	195	255	320	65	65
Tomato pasta sauce, canned	N	70	50	50	80	60	40
Tomato sauce, canned	N	70	80	70	60	80	70
Tomatoes in juice, canned	N	200	200	150	180	80	80
FRUIT (F) - 13 foods							
Apple-based juice	N	900	390	350	690	260	130
Apples	R	700	550	450	360	250	170
Apricots, canned	N	420	365	370	600	240	200
Bananas	N	500	350	300	360	200	200
Dates	N	20	20	15	70	15	10
Kiwifruit	R	100	100	100	200	70	60
Nectarines	R	130	110	110	230	60	60
Orange juice	N	380	270	210	300	200	160
Oranges	R	220	210	150	230	140	130
Peaches, canned	N	230	190	225	240	130	120
Pears	R	100	80	60	100	90	60
Pineapple, canned	N	30	50	50	60	30	30
Raisins/Sultanas	N	25	15	20	50	20	10
SPREADS & SWEETS (S&S) - 7 foods							
Chocolate, plain milk	N	40	40	25	40	25	25
Confectionery	N	30	20	20	20	20	20
Honey	N	10	15	10	15	7	7
Jam	N	45	48	65	58	15	10
Jelly dessert	N	300	300	300	150	220	180
Marmalade	N	25	17	25	20	5	5
Yeast extract	N	17	17	22	17	15	15

Food	Type	Weight of food in 1997/98 NZTDS diets (g/14 days)					
		YM	M	F	VF	C	YC
ALCOHOLIC Beverages (AL) - 4 foods							
Beer, draught	N	1600	1900	120	200	0	0
Beer, lager	N	1002	1900	150	200	0	0
Wine, still red	N	120	270	170	160	0	0
Wine, still white	N	150	220	300	330	0	0
TAKEAWAYS (TA) - 7 foods							
Chicken nuggets	R	110	100	60	0	45	30
Chinese dish, chicken chow mein	R	200	150	120	0	80	40
Fish in batter	R	145	180	60	0	40	25
Hamburger, plain	R	270	225	225	0	150	60
Pie, meat	R	160	160	120	0	120	40
Pizza	R	250	225	200	0	100	80
Potato, hot chips	R	360	250	80	0	50	30
NUTS (N) - 2 foods							
Peanut butter	N	45	35	40	85	17	10
Peanuts, whole	N	36	30	24	76	7	0
BEVERAGES, Non-alcoholic (B) - 7 foods							
Breakfast powdered drink	N	420	300	350	150	1200	920
Carbonated cola	N	925	655	225	225	100	100
Carbonated lemonade	N	484	360	120	234	400	240
Chocolate beverage	N	440	440	440	660	520	450
Coffee, instant	N	1790	3370	3900	3080	0	0
Tea	N	1130	2720	3570	2205	0	0
Water [a]	R	7653	7580	12281	12410	9073	6035
Total Weight of Diet per fortnight (g)		**39433**	**39162**	**36516**	**39209**	**27449**	**20293**
Total Weight Diet per day (g)		2817	2797	2608	2801	1961	1450

a Additional water, excludes water to make tea, coffee, chocolate beverage or breakfast powdered drink

YM - young male, 19-24 years, 70 kg bw
M - adult male, 25+ years, 80 kg bw
F - adult female, 25+ years, 65 kg bw
VF - lacto-ovo vegetarian female, 19-40 years, 65 bw
C - child, 4-6 years, 20 kg bw
YC - young child, 1-3 years, 13 kg bw
N - National food
R - Regional food

APPENDIX 3 Summary of the number of samples taken and analytical samples prepared in the 1997/98 NZTDS

Compositing: where the number of samples 'Analysed' is the same as the 'No. of samplings' foods were analysed as the individual brand (national foods) or region (regional foods). Where the number of samples 'Analysed' is less than the 'No. of samplings' then foods have been composited to form seasonal composites.

Food	Type	No. of samplings[a]	Multi-residue pesticides No. of samples		Dithiocarbamate fungicides No. of samples	
			Analysed[b]	*Containing residues*	*Analysed*	*Containing residues*
GRAINS (G) - 19 foods						
Biscuits, chocolate	N	10	10	9	na	na
Biscuits, cracker	N	10	2	2	na	na
Biscuits, plain sweet	N	10	2	2	na	na
Bran cereal	N	10	10	10	na	na
Bread, mixed grain	R	8	8	8	na	na
Bread, wheatmeal	R	8	8	8	na	na
Bread, white	R	8	8	8	na	na
Cake, plain	R	8	2	2	na	na
Corn snacks, cheese-flavoured	N	10	2	2	na	na
Cornflakes	N	10	2	0	na	na
Flour, white	N	10	2	2	na	na
Muesli	N	10	10	9	na	na
Noodles, instant	N	10	2	2	na	na
Oats, rolled	N	10	2	0	na	na
Rice, white	N	10	2	0	na	na
Spaghetti in sauce, canned	N	10	2	0	na	na
Spaghetti, dried	N	10	2	2	na	na
Tortilla chips (corn)	N	8	2	2	na	na
Wheatbix	N	4	2	2	na	na
DAIRY (D) - 7 foods						
Butter	N	10	10	10	na	na
Cheese	N	10	2	2	na	na
Dairy dessert	N	10	2	0	na	na
Ice cream	N	10	2	0	na	na
Milk, trim	R	8	2	0	na	na
Milk, whole	R	8	2	1	na	na
Yoghurt	N	10	2	2	na	na
OILS & FATS (O) - 3 foods						

Food	Type	No. of samplings[a]	Multi-residue pesticides		Dithiocarbamate fungicides	
			No. of samples		No. of samples	
			Analysed[b]	*Containing residues*	*Analysed*	*Containing residues*
Margarine	N	10	2	0	na	na
Oil, olive	N	10	2	0	na	na
Oil, salad and cooking	N	10	2	0	na	na
CHICKEN, EGGS, FISH & MEAT (CEFM) – 17 foods						
Bacon	R	8	2	2	na	na
Beef, mince	R	8	2	2	na	na
Beef, rump	R	8	2	2	na	na
Chicken	N	6	2	1	na	na
Egg, boiled	R	8	2	2	na	na
Fish fingers	N	10	2	1	na	na
Fish, terakihi	R	8	2	2	na	na
Lamb/mutton, leg	R	8	2	2	na	na
Lamb/mutton, shoulder	R	8	2	2	na	na
Lamb's liver	R	8	2	1	na	na
Luncheon sausage	R	8	8	8	na	na
Mussels	R	6	na	na	na	na
Oysters	R	6	na	na	na	na
Pork pieces	R	8	2	2	na	na
Salmon, canned	N	10	2	0	na	na
Sausages, beef	R	8	2	2	na	na
Soup, chicken	N	10	2	0	na	na
VEGETABLES (V) - 28 foods						
Beans	N	10	2	2	na	na
Beans, baked, canned	N	10	2	0	na	na
Beetroot, canned	N	10	2	0	na	na
Broccoli/Cauliflower	R	8	2	0	8	8
Cabbage	R	8	2	0	8	8
Capsicum	R	8	2	2	8	2
Carrots	R	8	2	0	na	na
Celery	R	8	2	2	8	7
Corn, creamed, canned	N	10	2	0	na	na
Courgette	R	8	2	1	8	4
Cucumber	R	8	2	1	8	7
VEGETABLES (V) – Continued						

Food	Type	No. of samplings[a]	Multi-residue pesticides		Dithiocarbamate fungicides	
			No. of samples		No. of samples	
			Analysed[b]	*Containing residues*	*Analysed*	*Containing residues*
Hummus	N	10	2	0	na	na
Kumara	R	8	2	2	8	3
Lettuce	R	8	8	2	8	5
Mushrooms	R	8	2	0	8	5
Onions	R	8	2	0	8	8
Peas	N	10	2	0	na	na
Potato crisps	N	10	2	1	na	na
Potatoes with skin	R	8	2	1	8	4
Potatoes, peeled	R	8	2	1	na	na
Pumpkin	R	8	2	0	na	na
Silverbeet	R	8	2	1	na	na
Soya milk	N	10	2	0	na	na
Tofu	N	10	2	0	na	na
Tomato	R	8	8	4	8	8
Tomato pasta sauce, canned	N	10	2	0	na	na
Tomato sauce, canned	N	10	2	0	na	na
Tomatoes in juice, canned	N	10	2	0	na	na
FRUIT (F) - 13 foods						
Apple-based juice	N	10	2	0	na	na
Apples	R	8	8	7	8	4
Apricots, canned	N	10	2	2	na	na
Bananas	N	2	2	1	2	1
Dates	N	10	2	0	na	na
Kiwifruit	R	8	2	0	8	2
Nectarines	R	8	2	2	8	3
Orange juice	N	10	2	0	na	na
Oranges	R	8	2	0	8	4
Peaches, canned	N	10	2	1	na	na
Pears	R	8	8	7	8	3
Pineapple, canned	N	10	2	0	na	na
Raisins/Sultanas	N	12	12	6	na	na
SWEETS & SPREADS (S&S) - 7 foods						
Chocolate, plain milk	N	10	2	0	na	na
Confectionery	N	10	2	0	na	na
SWEETS & SPREADS (S&S) - Continued						

Food	Type	No. of samplings[a]	Multi-residue pesticides		Dithiocarbamate fungicides	
			No. of samples		No. of samples	
			Analysed[b]	*Containing residues*	*Analysed*	*Containing residues*
Honey	N	10	2	0	na	na
Jam	N	10	2	1	na	na
Jelly dessert	N	10	2	0	na	na
Marmalade	N	10	2	0	na	na
Yeast extract	N	4	2	0	na	na
ALCOHOLIC Beverages (AL) - 4 foods						
Beer, draught	N	10	2	0	na	na
Beer, lager	N	10	2	0	na	na
Wine, still red	N	10	2	2	na	na
Wine, still white	N	10	10	10	na	na
TAKEAWAYS (TA) - 7 foods						
Chicken nuggets	R	8	2	2	na	na
Chinese dish, chicken chow mein	R	8	2	0	na	na
Fish in batter	R	8	2	2	na	na
Hamburger, plain	R	8	2	2	na	na
Pie, meat	R	8	2	2	na	na
Pizza	R	8	2	2	na	na
Potato, hot chips	R	8	2	1	na	na
NUTS (N) - 2 foods						
Peanut butter	N	10	2	1	na	na
Peanuts, whole	N	10	2	1	na	na
BEVERAGES, non-alcoholic (B) - 7 foods						
Breakfast powdered drink	N	10	2	0	na	na
Carbonated cola	N	10	2	0	na	na
Carbonated lemonade	N	10	2	0	na	na
Chocolate beverage	N	2	2	0	na	na
Coffee instant	N	10	2	0	na	na
Tea	N	10	2	0	na	na
Water	R	8	2	0	na	na
Total		**1008**	**322**	**186**	**138**	**86**

a ‘No. of samplings’ refers to the number of discrete combinations of 5 brands and 2 seasons, (national foods) or 4 regions and 2 seasons (regional foods). Details of sampling procedures are described in section 2.4.

b This may differ from the ‘No of samplings’ because of compositing, described in Sections 2.4.1 and 2.4.2.

N National food R Regional food na Not analysed

APPENDIX 4 Analytical methodologies and quality assurance for pesticides analysed in the 1997/98 NZTDS

ANALYTICAL METHODOLOGIES

Multi-residue pesticide screen

The MULTI-RESIDUE PESTICIDES screen is an ESR in-house method based on Var Foda (1986). Samples (12.5g - 100g) were exhaustively extracted with acetone (varying amounts of water were added, depending on the moisture content of the sample), vacuum filtered and evaporated until only the aqueous extract remained. The aqueous extract was partitioned three times with dichloromethane and the combined dichloromethane extracts were evaporated to just dryness. The residue was made to a final volume with ethyl acetate/hexane and an aliquot was cleaned up using Gel Permeation Chromatography (GPC).

Variations to the above method were necessary due to the wide range of food matrices involved in the survey. Generally those samples containing more than 5% fat were extracted with an ethanol/hexane mixture, instead of acetone. These fatty samples also required further clean up prior to Gel Permeation Chromatography. The residue obtained from the dichloromethane extractions was made to a final volume with hexane and an aliquot containing less than 3g of fat was taken through a hexane/acetonitrile partitioning step to remove most of the fat. Liquid samples were extracted three times with dichloromethane. Centrifuging was often required because of emulsion problems. The dichloromethane extracts were concentrated and cleaned up using Gel Permeation Chromatography. Other anomalies were analysed by using a combination of the methods and variations described.

The Gel Permeation Column was calibrated with standards to determine the elution volume of the pesticides. This fraction was then collected for each sample and made to a final volume in hexane/acetone 3:1.

These sample extracts were analysed in the beginning of the study through a gas chromatography system utilising a variety of specific detectors such as flame photometric, electron capture and nitrogen/phosphorus. During the latter stages, pesticides were identified and quantification was carried out using a mass selective detection (MSD) system operating in full scan mode.

This system was capable of detecting 90 different pesticides residues. The limits of reporting for most of the pesticides detected by this analytical system were generally within the range 0.003 – 0.5 mg/kg.

Dithiocarbamate fungicide screen

DITHIOCARBAMATE residues on foods were decomposed by refluxing the food with boiling dilute acid. The carbon disulphide evolved was carried by a stream of gas through a trap (trap 1) to remove hydrogen sulphide and other volatile interferences. The carbon disulphide was then carried to a second trap where it reacted with the colour reagent to form a yellow complex - the cupric salt of N, N-bis (2-hydroxyethyl) dithiocarbamic acid. The resultant yellow solution was measured spectrophotometrically and compared with a standard calibration graph. This method was unable to differentiate between individual dithiocarbamate compounds where more than one was present on the crop. In addition, the method does not distinguish between dithiocarbamate residues and carbon disulphide from naturally occurring sulphur compounds in brassicas and reports these as pesticide residues (MAFF, 1997). The limit of reporting was 0.01 mg carbon disulphide per kg of food. (Keppel, 1971; Cullen, 1964; Lowen, 1951), which is equivalent to 0.02 mg of parent dithiocarbamate per kg of food, based on ziram.

QUALITY CONTROL PRACTICES FOR PESTICIDE ANALYSES

For robust concentration data to be produced, appropriate quality control procedures must be in place. The general principles employed in the 1997/98 NZTDS are explained below. Fuller details are to be presented elsewhere (paper in preparation).

Accuracy of pesticide analyses

Analysis of surrogate spike recovery

A known amount of surrogate standard was added to all samples prior to extraction. The surrogate is a pesticide which is unlikely to be present in sample. The amount of the surrogate measured into the final clean extract can be expressed as a percentage of the amount added, and provides an estimate of the efficiency of the extraction and clean up procedures, as well as a screen for analytical problems.

Surrogate used for the multi-residue screen: methyl 2,4,5-T

Target surrogate recovery 70-125%, exceptions considered on a case by case basis.

Analysis of pesticide spike recovery

Matrix Spikes

The full range of pesticides and metabolites included in the multi-residue screen were spiked into a control food matrix (mashed potato) and the matrix analysed through the full multi-residue system. The amount of each pesticide determined was compared to the amount originally added to give a percentage recovery. This recovery provides a measure of the efficiency of the multi-residue system for each individual pesticide.

Target matrix spike recovery 70-125%, exceptions considered on a case by case basis.

Laboratory control samples

A narrower range of pesticides (6-8) were spiked into the laboratory control matrix to produce a laboratory control sample. A sub-sample of this control sample was included in each analytical batch. Recoveries for each pesticide were compared between batches to determine the consistency of the multi-residue procedure over time.

Target laboratory control recovery 70-125%, exceptions considered on a case by case basis.

Precision of analytical results

Planned duplicates

Approximately 5% of samples analysed by the analytical laboratory were analysed in duplicate to give an indication of the precision of the multi-residue system.

Blind duplicates

A further selection of samples were prepared as duplicates, but presented to the analytical laboratory not identified as duplicates. Results from these samples were used as a further check on the precision of the multi-residue system.

Agreement between duplicates is dependent on concentration found in the sample, and how close this is to the limit of reporting.

APPENDIX 5 Pesticides screened for and foods in which they were detected in the 1997/98 NZTDS

Pesticide	Food	No. of Samplings[a]	No. of samples		Mean[b] (mg/kg)	Max (mg/kg)	Min (mg/kg)
			Analysed	*Containing residues*			
Organochlorine Pesticides (OC) - 14 Compounds or groups of related compounds*							
Aldrin	*Not detected in any food*						
BHC, alpha	*Not detected in any food*						
BHC, beta	*Not detected in any food*						
BHC, gamma (Lindane)	*Not detected in any food*						
Chlordane, total	*Not detected in any food*						
DDT, total	Bacon	8	2	2	0.0055	0.008	0.003
	Beef, mince	8	2	2	0.0075	0.009	0.006
	Beef, rump	8	2	2	0.0023	0.003	0.002
	Biscuits, chocolate	10	10	1	0.0003	0.003	*Not detected*
	Butter	10	10	10	0.0186	0.040	0.003
	Cheese	10	2	2	0.0075	0.009	0.006
	Chicken	6	2	1	0.0015	0.003	*Not detected*
	Chicken nuggets	8	2	2	0.0030	0.003	0.003
	Egg, boiled	8	2	2	0.0060	0.009	0.003
	Fish in batter	8	2	2	0.0060	0.009	0.003
	Fish, terakihi	8	2	2	0.0030	0.003	0.003
	Hamburger, plain	8	2	2	0.0060	0.009	0.003
	Lamb/mutton, leg	8	2	2	0.0080	0.010	0.006
	Lamb/mutton, shoulder	8	2	2	0.0095	0.010	0.009
	Lamb's liver	8	2	1	0.0050	0.010	*Not detected*
	Luncheon sausage	8	8	8	0.0077	0.020	0.003
	Milk, whole	8	2	1	0.0015	0.003	*Not detected*
	Pie, meat	8	2	2	0.0060	0.009	0.003
	Pizza	8	2	2	0.0045	0.006	0.003
	Pork pieces	8	2	2	0.0045	0.006	0.003
	Raisins/Sultanas	12	12	2	0.0005	0.003	*Not detected*
	Sausages, beef	8	2	2	0.0150	0.020	0.010
Dicofol	Nectarines	8	2	2	0.0550	0.10	0.01
	Pears	8	8	1	0.0075	0.06	*Not detected*
	Raisins/Sultanas	12	12	4	0.0192	0.07	*Not detected*
Dieldrin	*Not detected in any food*						
Endosulfan, total	Tomato	8	8	1	0.0038	0.03	*Not detected*
	Cucumber	8	2	1	0.0100	0.02	*Not detected*

Pesticide	Food	No. of Samplings[a]	No. of samples		Mean[b] (mg/kg)	Max (mg/kg)	Min (mg/kg)
			Analysed	*Containing residues*			
Organochlorine Pesticides (OC) – Continued							
Endrin	*Not detected in any food*						
HCB	*Not detected in any food*						
Heptachlor, total	*Not detected in any food*						
Kepone	*Not detected in any food*						
Mirex	*Not detected in any food*						
Organophosphorus pesticides (OP) - 28 Compounds or groups of related compounds*							
Bromophos	*Not detected in any food*						
Bromophos-ethyl	*Not detected in any food*						
Chlorpyriphos	Apples	8	8	7	0.0056	0.010	*Not detected*
	Apricots, canned	10	2	1	0.0015	0.003	*Not detected*
	Bananas	2	2	1	0.0015	0.003	*Not detected*
	Muesli	10	10	2	0.0012	0.009	*Not detected*
	Nectarines	8	2	2	0.0115	0.020	0.003
	Peanuts, whole	10	2	1	0.0040	0.008	*Not detected*
	Pears	8	8	4	0.0026	0.009	*Not detected*
	Pie, meat	8	2	1	0.0050	0.010	*Not detected*
	Raisins/Sultanas	12	12	1	0.0017	0.020	*Not detected*
	Silverbeet	8	2	1	0.0025	0.005	*Not detected*
Chlorpyriphos-methyl	Biscuits, chocolate	10	10	2	0.0160	0.100	*Not detected*
	Biscuits, cracker	10	2	2	0.0400	0.050	0.030
	Biscuits, plain sweet	10	2	2	0.0115	0.020	0.003
	Bran cereal	10	10	10	0.7450	2.700	0.010
	Bread, mixed grain	8	8	6	0.0114	0.050	*Not detected*
	Bread, wheatmeal	8	8	7	0.0104	0.030	*Not detected*
	Bread, white	8	8	4	0.0300	0.090	*Not detected*
	Cake, plain	8	2	2	0.0075	0.009	0.006
	Flour, white	10	2	1	0.0030	0.006	*Not detected*
	Hamburger, plain	8	2	1	0.0100	0.020	*Not detected*
	Instant noodles	10	2	2	0.0090	0.009	0.009
	Luncheon sausage	8	8	7	0.0261	0.090	*Not detected*
	Muesli	10	10	9	0.1686	0.400	*Not detected*
	Peanuts, whole	10	2	1	0.0008	0.002	*Not detected*
	Pie, meat	8	2	1	0.0045	0.009	*Not detected*
	Pizza	8	2	2	0.0230	0.040	0.006
	Sausages, beef	8	2	2	0.0600	0.100	0.020

Pesticide	Food	No. of Samplings[a]	No. of samples		Mean[b] (mg/kg)	Max (mg/kg)	Min (mg/kg)
			Analysed	*Containing residues*			
Organophosphorus pesticides (OP) – Continued							
Chlorpyriphos-methyl	Spaghetti, dried	10	2	2	0.0395	0.070	0.009
Diazinon	*Not detected in any food*						
Dichlorvos	*Not detected in any food*						
Dimethoate	Capsicum	8	2	1	0.1250	0.25	*Not detected*
	Courgette	8	2	1	0.3000	0.60	*Not detected*
	Tomato	8	8	1	0.0038	0.03	*Not detected*
Ethion	*Not detected in any food*						
Etrimphos	*Not detected in any food*						
Fenchlorphos	*Not detected in any food*						
Fenitrothion	Bran cereal	10	10	2	0.2000	1.00	*Not detected*
	Spaghetti, dried	10	2	1	0.0050	0.01	*Not detected*
Fenthion	*Not detected in any food*						
Heptenophos	*Not detected in any food*						
Isazophos	*Not detected in any food*						
Malathion	*Not detected in any food*						
Methidathion	*Not detected in any food*						
Mevinphos	*Not detected in any food*						
Naled	*Not detected in any food*						
Parathion	*Not detected in any food*						
Parathion-methyl	*Not detected in any food*						
Phorate, total	*Not detected in any food*						
Phosalone	*Not detected in any food*						
Phosmet	*Not detected in any food*						
Phosphamidon, total	*Not detected in any food*						
Pirimiphos-methyl	Biscuits, chocolate	10	10	6	0.0510	0.20	*Not detected*
	Biscuits, cracker	10	2	2	0.0550	0.06	0.05
	Biscuits, plain sweet	10	2	2	0.0450	0.05	0.04
	Bran cereal	10	10	3	0.0160	0.07	*Not detected*
	Bread, mixed grain	8	8	8	0.0894	0.20	0.03
	Bread, wheatmeal	8	8	8	0.1094	0.20	0.005
	Bread, white	8	8	7	0.0838	0.30	*Not detected*
	Capsicum	8	2	1	0.0100	0.02	*Not detected*
	Corn snacks, cheese-flavoured	10	2	2	0.0250	0.03	0.02
	Fish fingers	10	2	1	0.0100	0.02	*Not detected*
	Fish in batter	8	2	1	0.0050	0.01	*Not detected*

Pesticide	Food	No. of Samplings[a]	No. of samples		Mean[b] (mg/kg)	Max (mg/kg)	Min (mg/kg)
			Analysed	*Containing residues*			
Organophosphorus pesticides (OP) - Continued							
Pirimiphos-methyl	Flour, white	10	2	2	0.1500	0.2	0.1
	Hamburger, plain	8	2	2	0.0225	0.025	0.02
	Luncheon sausage	8	8	4	0.0075	0.02	*Not detected*
	Muesli	10	10	5	0.0270	0.1	*Not detected*
	Peanut butter	10	2	1	0.0050	0.01	*Not detected*
	Peanuts, whole	10	2	1	0.0125	0.025	*Not detected*
	Pie, meat	8	2	2	0.0200	0.02	0.02
	Pizza	8	2	2	0.0400	0.05	0.03
	Sausages, beef	8	2	1	0.0100	0.02	*Not detected*
	Tortilla chips (corn)	10	2	2	0.2250	0.25	0.20
	Wheatbix	4	2	2	0.0400	0.06	0.02
Prothiofos	*Not detected in any food*						
Pyrazophos	*Not detected in any food*						
Tolclofos-methyl	*Not detected in any food*						
Triazophos	*Not detected in any food*						
Fungicides (F) - 18 Compounds or groups of related compounds*							
Bromacil	*Not detected in any food*						
Captafol	*Not detected in any food*						
Captan	*Not detected in any food*						
Chlorothalonil	Celery	8	2	1	0.0500	0.10	*Not detected*
	Lettuce	8	8	2	0.0138	0.08	*Not detected*
Chlozolinate	*Not detected in any food*						
Dicloran	Kumara	8	2	2	0.0550	0.10	0.01
	Nectarines	8	2	1	0.0500	0.10	*Not detected*
	Pears	8	8	1	0.0375	0.30	*Not detected*
Diphenylamine	Apples	8	8	3	0.0663	0.40	*Not detected*
	Cucumber	8	2	1	0.0300	0.06	*Not detected*
	Pears	8	8	5	0.1713	0.60	*Not detected*
Dithiocarbamates	Apples	8	8	4	0.1150	0.26	*Not detected*
	Bananas	2	2	1	0.1300	0.26	*Not detected*
	Broccoli/Cauliflower	8	8	8	0.2675	0.56	0.10
	Cabbage	8	8	8	0.1800	0.46	0.02
	Capsicum	8	8	2	0.0200	0.12	*Not detected*
	Celery	8	8	7	0.3075	1.18	*Not detected*
	Courgette	8	8	4	0.0325	0.18	*Not detected*

Pesticide	Food	No. of Samplings[a]	No. of samples		Mean[b] (mg/kg)	Max (mg/kg)	Min (mg/kg)
			Analysed	*Containing residues*			
Fungicides (F) – Continued							
Dithiocarbamates	Cucumber	8	8	7	0.1275	0.26	*Not detected*
	Kiwifruit	8	8	2	0.0075	0.04	*Not detected*
	Kumara	8	8	3	0.0500	0.20	*Not detected*
	Lettuce	8	8	5	0.4850	3.50	*Not detected*
	Mushrooms	8	8	5	0.0550	0.24	*Not detected*
	Nectarines	8	8	3	0.0450	0.24	*Not detected*
	Onions	8	8	8	0.1100	0.26	0.04
	Oranges	8	8	4	0.0750	0.18	*Not detected*
	Pears	8	8	3	0.0175	0.06	*Not detected*
	Potatoes with skin	8	8	4	0.0675	0.20	*Not detected*
	Tomato	8	8	8	0.1625	0.38	0.02
Fenarimol	*Not detected in any food*						
Folpet	*Not detected in any food*						
Imazalil	*Not detected in any food*						
Iprodione	Apples	8	8	1	0.0125	0.10	*Not detected*
	Apricots, canned	10	2	2	0.8500	0.90	0.80
	Jam	10	2	1	0.0450	0.09	*Not detected*
	Muesli	10	10	2	0.0350	0.30	*Not detected*
	Nectarines	8	2	2	0.7500	0.90	0.60
	Peaches, canned	10	2	1	0.0250	0.05	*Not detected*
	Pears	8	8	1	0.0375	0.30	*Not detected*
	Wine, still red	10	2	2	0.1300	0.20	0.06
	Wine, still white	10	10	10	0.4050	0.80	0.10
	Yoghurt	10	2	2	0.0500	0.08	0.02
Metalaxyl	*Not detected in any food*						
Nitrothal isopropyl	*Not detected in any food*						
Procymidone	Beans	10	2	2	0.0375	0.04	0.035
	Celery	8	2	1	0.0050	0.01	*Not detected*
	Lettuce	8	8	1	0.0025	0.02	*Not detected*
	Raisins/Sultanas	12	12	1	0.0083	0.10	*Not detected*
Propiconazole	*Not detected in any food*						
Triadimefon	*Not detected in any food*						
Triadimenol	*Not detected in any food*						
Vinclozolin	Jam	10	2	1	0.0050	0.01	*Not detected*
	Tomato	8	8	2	0.0113	0.05	*Not detected*
	Wine, still white	10	10	1	0.0030	0.03	*Not detected*

Pesticide	Food	No. of Samplings[a]	No. of samples		Mean[b] (mg/kg)	Max (mg/kg)	Min (mg/kg)
			Analysed	*Containing residues*			
Other pesticides (O) - 14 Compounds or groups of related compounds*							
Alachlor	*Not detected in any food*						
Bromopropylate	Jam	10	2	1	0.0150	0.03	*Not detected*
	Raisins/Sultanas	12	12	1	0.0067	0.08	*Not detected*
Cyfluthrin	*Not detected in any food*						
Cypermethrin, total	*Not detected in any food*						
Deltamethrin	*Not detected in any food*						
Fenvalerate	*Not detected in any food*						
Linuron	*Not detected in any food*						
Pendimethalin	*Not detected in any food*						
Permethrin, total	*Not detected in any food*						
Piperonyl Butoxide	Biscuits, chocolate	10	10	1	0.0040	0.04	*Not detected*
	Biscuits, cracker	10	2	2	0.0650	0.10	0.03
	Biscuits, plain sweet	10	2	2	0.0150	0.02	0.01
	Bran cereal	10	10	6	0.1590	1.10	*Not detected*
	Bread, wheatmeal	8	8	1	0.0013	0.01	*Not detected*
	Bread, white	8	8	2	0.0050	0.02	*Not detected*
	Cake, plain	8	2	2	0.0300	0.03	0.03
	Hamburger, plain	8	2	1	0.0100	0.02	*Not detected*
	Instant noodles	10	2	1	0.0200	0.04	*Not detected*
	Luncheon sausage	8	8	4	0.0188	0.10	*Not detected*
	Muesli	10	10	5	0.0170	0.05	*Not detected*
	Pie, meat	8	2	1	0.0050	0.01	*Not detected*
	Raisins/Sultanas	12	12	2	0.0150	0.10	*Not detected*
	Sausages, beef	8	2	2	0.0600	0.10	0.02
	Spaghetti, dried	10	2	2	0.1000	0.10	0.10
	Tortilla chips (corn)	10	2	1	0.0100	0.02	*Not detected*
Pirimicarb	*Not detected in any food*						
Propham	Potato crisps	10	2	1	0.3000	0.60	*Not detected*
	Potato, hot chips	8	2	2	0.3500	0.50	0.20
	Potatoes with skin	8	2	1	0.3000	0.60	*Not detected*
	Potatoes, peeled	8	2	1	0.2500	0.50	*Not detected*
Propyzamide	*Not detected in any food*						

a ‘No. of samplings’ refers to the number of discrete combinations of 5 brands and 2 seasons, (national foods) or 4 regions and 2 seasons (regional foods). Details of sampling procedures are described in section 2.4.

b the mean is an arithmetic mean. As this figure is an intermediate figure in the calculation of estimated dietary exposure, it has not been rounded.

* For some pesticides several different forms (isomers or metabolites) are able to be detected by the multi-residue pesticide screen. Amounts of these different forms are conventionally summed and expressed as, for example, ‘DDT, total’ indicating the sum of the amount of parent DDT and the amounts of the major metabolites. Where a particular form of the pesticide was not detected, its contribution to the ‘total’ determined was taken to be zero.

APPENDIX 6 Acceptable daily intakes (ADI) for pesticides analysed in the 1997/98 NZTDS

Reference: IPCS (1998)

Pesticide	ADI (µg/kg bw/day)	Pesticide	ADI (µg/kg bw/day)
Organochlorine Pesticides (OC) – 14 Compounds or groups of related compounds*			
Aldrin	0.1	Dieldrin	0.1
BHC, alpha	No ADI	Endosulfan, total	6
BHC, beta	No ADI	Endrin	0.2
BHC, gamma (Lindane)	1	HCB	0.6
Chlordane, total	0.5	Heptachlor, total	0.1
DDT, total	20	Kepone	No ADI
Dicofol	2	Mirex	No ADI
Organophosphorus Pesticides (OP) –29 Compounds or groups of related compounds*			
Bromophos	40	Methidathion	1
Bromophos-ethyl	3	Mevinphos	0.8
Chlorpyriphos	10	Naled	No ADI
Chlorpyriphos-methyl	10	Parathion	5
Diazinon	2	Parathion-methyl	3
Dichlorvos	4	Phorate, total	0.5
Dimethoate	2	Phosalone	10
Ethion	2	Phosmet	10
Etrimphos	3	Phosphamidon, total	0.5
Fenchlorphos	10	Pirimiphos-methyl	30
Fenitrothion	5	Prothiofos	0.1
Fenthion	7	Pyrazophos	4
Heptenophos	3	Tolclofos-methyl	70
Isazophos	No ADI	Triazophos	1
Malathion	300		
Fungicides (F) - 18 Compounds or groups of related compounds*			
Captafol	10	Iprodione	60
Captan	100	Metalaxyl	30
Chlozolinate	No ADI	Nitrothal isopropyl	No ADI
Chlorothalonil	30	Procymidone	100
Dicloran	30	Propiconazole	40
Diphenylamine	20	Triadimefon	30
Fenarimol	10	Triadimenol	50
Folpet	100	Vinclozolin	10
Imazalil	30		

Pesticide	ADI (μg/kg bw/day)	Pesticide	ADI (μg/kg bw/day)
Other Pesticide Residues (O) - 14 Compounds or groups of related compounds*			
Alachlor	No ADI	Linuron	2
Bromacil	130	Pendimethalin	No ADI
Bromopropylate	30	Permethrin, total	50
Cyfluthrin	20	Piperonyl butoxide	200
Cypermethrin, total	50	Pirimicarb	20
Deltamethrin	10	Propham	No ADI
Fenvalerate	20	Propyzamide	2.6

* For some pesticides, several different forms (isomers or metabolites) are able to be detected by the multi-residue pesticide screen. Amounts of these different forms are conventionally summed and expressed as, for example, 'DDT, total' indicating the sum of the amount of parent DDT and the amounts of the major metabolites. Where a particular form of the pesticide was not detected, its contribution to the 'total' determined was taken to be zero.

APPENDIX 7 Foods of the 1997/98 NZTDS with pesticide residue levels non-compliant with the New Zealand Food Regulations 1984

Pesticide residues above the Maximum Permissible Proportion (MPP) were found in the following foods:

No pesticide residues were detected which exceeded defined MPPs.

Pesticide residues above the default MPP (0.1 mg/kg) were found in the following foods (the default MPP is used when no MPP for the pesticide in the particular food is defined in the New Zealand Food Regulations 1984). Where no specific New Zealand MPP exists for the pesticide-food combination, but where a maximum residue limit (MRL) is reported by the Codex Alimentarius Commission (Codex, 1996), the Codex MRL is also reported here as a reference value. Under the New Zealand Food Regulations 1984, imported foods may contain proportions of pesticides not greater than the Codex MRLs:

- one sample of pears had a dicloran residue of 0.30 mg/kg (there is no MPP for dicloran in pome fruit and the default MPP of 0.1 mg/kg applies). Codex (1996) does not define a limit for dicloran in pears or any other pome fruit;

- three samples of pears had diphenylamine residues ranging from 0.20 to 0.60 mg/kg (there is no MPP for diphenylamine in pears and the default MPP of 0.1 mg/kg applies). Codex (1996) does not set a limit for diphenylamine in pears, but sets a limit of 5 mg/kg for diphenylamine in apples;

- three samples of New Zealand manufactured bran cereal had chlorpyriphos-methyl residues ranging from 0.40 to 2.60 mg/kg (there is no MPP for chlorpyriphos-methyl and the default MPP of 0.1 mg/kg applies). Codex (1996) set a limit of 20 mg/kg for chlorpyriphos-methyl in unprocessed wheat bran. All imported brands of bran cereal contained levels of chlorpyriphos-methyl well below the Codex limit;

- six samples of New Zealand manufactured muesli had chlorpyriphos-methyl residues ranging from 0.20 to 0.40 mg/kg (there is no MPP for chlorpyriphos-methyl and the default MPP of 0.1 mg/kg applies). Codex (1996) set a limit of 10 mg/kg for chlorpyriphos-methyl in whole wheat. All imported brands of muesli contained levels of chlorpyriphos-methyl well below the Codex limit

None of the technical non-compliances above represent an adverse public health risk. This was determined by multiplying pesticide residue levels found by consumption levels for each of the age-sex groups (see Appendix 2) and comparing the resultant exposure estimate with the Acceptable Daily Intake (ADI) for the particular pesticide residue.

APPENDIX 8 **Summary of estimated dietary exposures to pesticide residues by age-sex group and as a percentage of acceptable daily intake (ADI) in the 1997/98 NZTDS**

Pesticide	**ADI (µg/kg bw/day)**	**Estimated daily exposure for population age-sex group (µg/kg bw/day)**					
		YM	**M**	**F**	**VF**	**C**	**YC**
Organochlorine pesticides (OC) - 14 Compounds or groups of related compounds[a]							
Aldrin	0.1	*	*	*	*	*	*
% ADI							
BHC, alpha	No ADI	*	*	*	*	*	*
% ADI							
BHC, beta	No ADI	*	*	*	*	*	*
% ADI							
BHC, gamma (Lindane)	8	*	*	*	*	*	*
% ADI							
Chlordane, total	0.5	*	*	*	*	*	*
% ADI							
DDT, total	20	**0.035**	**0.026**	**0.021**	**0.011**	**0.072**	**0.084**
% ADI		**0.2**	**0.1**	**0.1**	**0.1**	**0.4**	**0.4**
Dicofol	2	**0.009**	**0.006**	**0.008**	**0.016**	**0.016**	**0.022**
% ADI		**0.4**	**0.3**	**0.4**	**0.8**	**0.8**	**1.1**
Dieldrin	0.1	*	*	*	*	*	*
% ADI							
Endosulfan, total	6	**0.002**	**0.001**	**0.002**	**0.003**	**0.002**	**0.002**
% ADI		**0.03**	**0.02**	**0.03**	**0.04**	**0.03**	**0.04**
Endrin	0.2	*	*	*	*	*	*
% ADI							
HCB	No ADI	*	*	*	*	*	*
% ADI							
Heptachlor, total	0.1	*	*	*	*	*	*
% ADI							
Kepone	No ADI	*	*	*	*	*	*
% ADI							
Mirex	No ADI	*	*	*	*	*	*
% ADI							

Pesticide	ADI (µg/kg bw/day)	Estimated daily exposure for population age-sex group (µg/kg bw/day)					
		YM	M	F	VF	C	YC
Organophosphorus pesticides (OP) - 29 Compounds or groups of related compounds[a]							
Bromophos	No ADI	*	*	*	*	*	*
% ADI							
Bromophos-ethyl	No ADI	*	*	*	*	*	*
% ADI							
Chlorpyriphos	10	**0.009**	**0.006**	**0.007**	**0.008**	**0.013**	**0.015**
% ADI		**0.09**	**0.06**	**0.07**	**0.08**	**0.13**	**0.15**
Chlorpyriphos-methyl	10	**0.138**	**0.103**	**0.094**	**0.175**	**0.265**	**0.275**
% ADI		**1.4**	**1.0**	**1.0**	**1.7**	**2.7**	**2.7**
Diazinon	2	*	*	*	*	*	*
% ADI							
Dichlorvos	4	*	*	*	*	*	*
% ADI							
Dimethoate	2	**0.015**	**0.013**	**0.016**	**0.027**	**0.029**	**0.033**
% ADI		**0.8**	**0.7**	**0.8**	**1.3**	**1.5**	**1.7**
Ethion	2	*	*	*	*	*	*
% ADI							
Etrimphos	3	*	*	*	*	*	*
% ADI							
Fenchlorphos	No ADI	*	*	*	*	*	*
% ADI							
Fenitrothion	5	**0.005**	**0.004**	**0.005**	**0.021**	**0.008**	**0.012**
% ADI		**0.09**	**0.08**	**0.09**	**0.4**	**0.2**	**0.2**
Fenthion	7	*	*	*	*	*	*
% ADI							
Heptenophos	No ADI	*	*	*	*	*	*
% ADI							
Isazophos	No ADI	*	*	*	*	*	*
% ADI							
Malathion	300	*	*	*	*	*	*
% ADI							
Methidathion	1	*	*	*	*	*	*
% ADI							
Mevinphos	0.8	*	*	*	*	*	*
% ADI							

Pesticide	ADI (µg/kg bw/day)	Estimated daily exposure for population age-sex group (µg/kg bw/day)					
		YM	M	F	VF	C	YC
Organophosphorus pesticides (OP) - Continued							
Naled	No ADI	*	*	*	*	*	*
% ADI							
Parathion	4	*	*	*	*	*	*
% ADI							
Parathion-methyl	3	*	*	*	*	*	*
% ADI							
Phorate, total	0.5	*	*	*	*	*	*
% ADI							
Phosalone	1	*	*	*	*	*	*
% ADI							
Phosmet	10	*	*	*	*	*	*
% ADI							
Phosphamidon, total	0.5	*	*	*	*	*	*
% ADI							
Pirimiphos-methyl	30	**0.320**	**0.238**	**0.201**	**0.362**	**0.728**	**0.692**
% ADI		**1.0**	**0.8**	**0.7**	**1.2**	**2.4**	**2.3**
Prothiofos	No ADI	*	*	*	*	*	*
% ADI							
Pyrazophos	4	*	*	*	*	*	*
% ADI							
Tolclofos-methyl	70	*	*	*	*	*	*
% ADI							
Triazophos	1	*	*	*	*	*	*
% ADI							

Pesticide	ADI (µg/kg bw/day)	Estimated daily exposure for population age-sex group (µg/kg bw/day)					
		YM	M	F	VF	C	YC
Fungicides (F) - 18 Compounds or groups of related compounds[a]							
Captafol	No ADI	*	*	*	*	*	*
% ADI							
Captan	100	*	*	*	*	*	*
% ADI							
Chlorothalonil	30	**0.003**	**0.002**	**0.005**	**0.003**	**0.006**	**0.008**
% ADI		**0.01**	**0.01**	**0.02**	**0.01**	**0.02**	**0.03**
Chlozolinate	No ADI	*	*	*	*	*	*
% ADI							
Dicloran	30	**0.014**	**0.011**	**0.012**	**0.035**	**0.031**	**0.041**
% ADI		**0.05**	**0.04**	**0.04**	**0.1**	**0.1**	**0.1**
Diphenylamine	20	**0.068**	**0.047**	**0.047**	**0.049**	**0.116**	**0.122**
% ADI		**0.3**	**0.2**	**0.2**	**0.2**	**0.6**	**0.6**
Dithiocarbamates	3	**0.380**	**0.304**	**0.370**	**0.427**	**0.556**	**0.677**
% ADI		**13**	**10**	**12**	**14**	**19**	**23**
Fenarimol	10	*	*	*	*	*	*
% ADI							
Folpet	100	*	*	*	*	*	*
% ADI							
Imazalil	30	*	*	*	*	*	*
% ADI							
Iprodione	60	**0.574**	**0.483**	**0.619**	**0.963**	**0.992**	**1.281**
% ADI		**1.0**	**0.8**	**1.0**	**1.6**	**1.7**	**2.1**
Metalaxyl	30	*	*	*	*	*	*
% ADI							
Nitrothal isopropyl	No ADI	*	*	*	*	*	*
% ADI							
Procymidone	100	**0.007**	**0.008**	**0.007**	**0.004**	**0.014**	**0.020**
% ADI		**0.01**	**0.01**	**0.01**	**0.00**	**0.01**	**0.02**
Propiconazole	40	*	*	*	*	*	*
% ADI							
Triadimefon	30	*	*	*	*	*	*
% ADI							
Triadimenol	50	*	*	*	*	*	*
% ADI							
Vinclozolin	70	**0.003**	**0.003**	**0.005**	**0.005**	**0.003**	**0.004**
% ADI		**0.03**	**0.03**	**0.05**	**0.05**	**0.03**	**0.04**

Pesticide	ADI (µg/kg bw/day)	Estimated daily exposure for population age-sex group (µg/kg bw/day)					
		YM	M	F	VF	C	YC
Other pesticides (O) - 14 Compounds or groups of related compounds[a]							
Alachlor	No ADI	*	*	*	*	*	*
% ADI							
Bromacil	No ADI	*	*	*	*	*	*
% ADI							
Bromopropylate	30	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**
% ADI		**0.003**	**0.002**	**0.004**	**0.004**	**0.004**	**0.004**
Cyfluthrin	20	*	*	*	*	*	*
% ADI							
Cypermethrin, total	50	*	*	*	*	*	*
% ADI							
Deltamethrin	10	*	*	*	*	*	*
% ADI							
Fenvalerate	20	*	*	*	*	*	*
% ADI							
Linuron	No ADI	*	*	*	*	*	*
% ADI							
Pendimethalin	No ADI	*	*	*	*	*	*
% ADI							
Permethrin, total	50	*	*	*	*	*	*
% ADI							
Piperonyl butoxide	200	**0.078**	**0.061**	**0.053**	**0.088**	**0.132**	**0.137**
% ADI		**0.04**	**0.03**	**0.03**	**0.04**	**0.07**	**0.07**
Pirimicarb	20	*	*	*	*	*	*
% ADI							
Propham	No ADI	**0.622**	**0.389**	**0.242**	**0.482**	**0.728**	**0.694**
% ADI							
Propyzamide	No ADI	*	*	*	*	*	*
% ADI							

a For some pesticides several different forms (isomers or metabolites) are able to be detected by the multi-residue pesticide screen. Amounts of these different forms are conventionally summed and expressed as, for example, 'DDT, total' indicating the sum of the amount of parent DDT and the amounts of the major metabolites.

* This pesticide was not detected in any food analysed in the 1997/98 NZTDS and estimated daily exposures are therefore considered to be zero.

YM - young male, 19-24 years, 70 kg bw
M - adult male, 25+ years, 80 kg bw
F - adult female, 25+ years, 65 kg bw
VF - lacto-ovo vegetarian female, 19-40 years, 65 kg bw
C - child, 4-6 years, 20 kg bw
YC - young child, 1-3 years, 13 kg bw

APPENDIX 9 Acknowledgements

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Sampling

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Bruce Butters, Health Care Hawke's Bay, Napier

Lynette Finnie, Healthcare Otago, Dunedin

Diane Floyd, formerly Auckland Healthcare, Auckland

Sample preparation

Elizabeth Reynolds, Crop and Food Research, Palmerston North

Grant Taylor, Crop and Food Research, Palmerston North

Analysis

Andrea Lister, ESR, Wellington

Henry McGrath, ESR, Wellington

Bob Symons, ESR, Wellington

Review of report

Steven Crossley, Australia New Zealand Food Authority, Canberra, Australia

Jefferson Fowles, ESR, Porirua

Ministry of Health Officials

Elizabeth Aitken, Ministry of Health, Wellington (Project leader)

Martin Edwards, formerly Ministry of Health, Wellington

Joe Manning, formerly Ministry of Health, Wellington

Jim Waters, Ministry of Health, Wellington