

CONSULTATIONS AND WORKSHOPS

GEMS/Food Total Diet Studies

**Report of the 2nd International
Workshop on Total Diet Studies
Brisbane, Australia
4 – 15 February 2002**



**FOOD SAFETY PROGRAMME
DEPARTMENT OF PROTECTION OF THE HUMAN ENVIRONMENT
WORLD HEALTH ORGANIZATION**

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Report on the 2nd International Workshop on Total Diet Studies February 4-15 2002, Brisbane, Australia

1. INTRODUCTION

Research over the past number of years shows that toxic and nutritionally important chemicals exert a far greater influence over human health than previously thought. Toxic chemicals may affect all major organs of the body, causing serious health outcomes like cancer, birth defects, and brain damage. The relationship between nutrients, especially micronutrients, and health is well established.

Despite this, little attention has been given to assessing the actual dietary intake of these chemicals by humans. One reason is that most of the potential effects of these chemicals are chronic in nature, appearing often years after exposure, and thus cannot be traced to individual foods or food companies. In many cases, some of these effects are caused by exposure to groups of different chemicals. In such situations, the concentrations of each individual chemical in the group may be quite low and within current safety limits. However, when the group as a whole is assessed, exposure may be significant. Thus, it is becoming increasingly important to assess human exposure to background concentrations of a large number of chemicals. The responsibility and obligation to make these assessments usually rests with national health authorities.

For national authorities to ensure that toxic chemicals, such as pesticides, heavy metals, environmental contaminants and naturally occurring toxins, are not present in foods at levels that adversely affect the health of consumers, two complementary approaches are used. The first is to monitor individual foods for compliance with national and international regulatory standards. However, monitoring data of this type are focused on individual chemicals in raw commodities, and may not provide a direct link to the health assessment of the population.

The second approach is to measure the actual dietary consumption of these chemicals by the population, and compare these intakes with toxicological reference points, such as the Acceptable Daily Intake (ADI) or Provisional Tolerable Weekly Intake (PTWI). These comparisons provide a direct link to the health of the population, and total diet studies are the most reliable way to estimate the dietary intake of toxicants by large population groups. Therefore, total diet studies are essential to answer the fundamental question of whether or not the national diet is safe.

A total diet study consists of purchasing foods commonly consumed, processing them as for consumption, combining the foods into food composites or aggregates, homogenizing them, and analyzing them for toxic chemicals. The analytical results are then combined with food intake information for different population groups, and the dietary intakes of the chemicals by the groups are estimated.

Thus, the accuracy of total diet studies depends on two fundamental data components: the quantity of each prepared food consumed by individuals, usually collected in national surveys, and the background concentration of toxic chemicals in the foods as ready for consumption. In order to not overestimate the dietary intakes, the analytical methods used to measure toxicant levels should have appropriately low detection limits. Often, such methods are complex and require advanced instrumentation. Thus, total diet studies are expensive, particularly for developing countries. However, the cost of total diet studies and the laboratory infrastructure built around them is minuscule compared with their value in

supporting good health and active trade. For example, dioxin contamination of food in Belgium is estimated to have cost over US\$2 billion.

The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) of the World Trade Organization (WTO) requires that health and safety requirements related to food be based on scientific risk assessments. Risk assessments are based on both toxicological information and estimates of exposure of the population to the chemical. As mentioned above, the latter is most accurately obtained for large population groups using total diet studies. The SPS Agreement has referenced the standards, guidelines and other recommendations of the FAO/WHO Codex Alimentarius Commission as representing the international benchmark for health and safety requirements. However, countries may implement stricter standards if the need for such standards can be demonstrated based on sound scientific risk assessment. Thus, at a minimum, total diet studies in developing and industrialized countries are necessary to perform risk assessments and ensure that their food safety systems are effective in protecting the public health.

Internationally, the importance of conducting total diet studies is gradually being recognized, and more and more countries are initiating and expanding their total diet studies. However, the organization of these studies is complex and many different areas of expertise are required. Consequently, there is a need for a periodic forum to exchange information and experiences in conducting total diet studies.

2. THE WORKSHOP

The workshop was sponsored by the Australia New Zealand Food Authority, the New Zealand Ministry of Health and the World Health Organization (WHO) in cooperation with the Asia Pacific Food Analysis Network (APFAN) and the Food and Agricultural Organization of the United Nations (FAO). Over 60 representatives from 27 countries were present (see Annex II for a list of participants). The first week of the workshop consisted of presentations by experts on total diet studies that had been conducted in different countries. The second week focused on detailed training of national representatives in order to initiate or expand total diet studies in these countries. The agenda for the two week workshop is given in Annex I. The objectives of the workshop were to:

- promote and support total diet studies in all member countries;
- help prepare new people to conduct total diet studies;
- update recent developments in the field of total diet studies;
- promote reliable and comparable total diet studies through harmonized approaches and exchange of international best practices and expertise;
- establish a network of national counterparts for undertaking regional total diet study projects; and
- promote electronic submission to and use of total diet study data from the WHO Global Environmental Monitoring System/Food Contamination Monitoring and Assessment Programme (GEMS/Food).

The workshop participants elected Dr Richard Vannoort, ESR, Christchurch, New Zealand to be the Chairman of the workshop and appointed Dr Robert Dabeka, Health Canada, Ottawa, Canada and Ms Tracy Hambridge, ANZFA, Canberra, Australia to be the Rapporteurs.

Opening Remarks

On behalf of Dr Gro Harlem Brundtland, Director-General of the World Health Organization, Dr Gerald Moy welcomed the participants to the workshop and expressed his appreciation to the Australia New Zealand Food Authority and the New Zealand Ministry of Health for cosponsoring the workshop with WHO. He also commended the Food and Agriculture Organization of the United Nations and the Asia Pacific Food Analysis Network for their cooperation. He also thanked the Queensland Health Scientific Services (QHSS) for providing the excellent facilities and local support. He took the opportunity to again thank the US Food and Drug Administration for hosting the First International Total Diet Study, which many of the participants had attended and which had set the stage for the present workshop.

Welcome Address

Pieter Scheelings, QHSS, Brisbane, Australia stated that as the host agency for the workshop, and on behalf of the Director Professor Michael Moore and staff at Queensland Health Scientific Services (QHSS), it was a privilege and pleasure to welcome participants to Brisbane and to their laboratory campus at Coopers Plains. He noted that QHSS has important linkages with universities and organizations, such as the Asia Pacific Food Analysis Network (APFAN), which is cooperating in this workshop. APFAN provides a valuable link between food scientists in the Asia-Pacific region and can assist in the promotion and development of total diet study programmes particularly through its training workshops on analytical methods and quality control. He hoped that WHO and APFAN can work in partnership to improve the technical knowledge and skills of food scientists and assist in the development of total diet studies in the region.

Chairman's Opening Address

Dr Richard Vannoort noted that in an age where the risks in life are increasingly highlighted, food also has associated risks to public health and trade, and may become major political, legal and financial issues. To get a more sound, objective and transparent picture of the risks, the risk analysis approach is being used by international bodies such as WHO, FAO, Codex Alimentarius Commission, government agencies (such as Ministries of Health, Agriculture, Food Safety and Environment) and food producers/companies.

Total diet studies are a key public health risk assessment tool. They provide a snapshot of the safety and quality of the food supply. A key characteristic of such studies is that foods are prepared 'table ready', so this provides the best means of assessing the risk to consumers in contrast to commodity based surveys, which analyse agricultural products as produced e.g. whole unpeeled bananas. Total diet studies help to monitor pesticides, contaminants (and nutrients) present in food, and to estimate dietary exposures and characterize any associated risk to public health. Total diet studies can also help identify possible risk management and risk communication options.

Workshop Overview

Various topics were presented by participants over the two week workshop. Summaries of many of these are presented in Annex III. During the intensive discussions, the workshop addressed many of methodological and technical issues related to total diet studies. Among its activities, the workshop:

- reviewed the status of ongoing total diet studies in different countries;
- addressed technical points associated with them;

- reached consensus on issues of harmonization;
- focused on the urgent need for conducting total diet studies in all countries, especially developing countries;
- illustrated that even with cooperatively sharing of resources among countries, there is a world-wide shortage of laboratories capable of performing the technically demanding analyses. This impacts on food safety, trade and ability to react to food safety emergencies, including terrorist threats;
- promoted the reporting of monitoring data and total diet study results using GEMS/Food OPAL I, II, and III to the WHO SIGHT databases;
- promoted the importance of such studies for assessment of nutrient intakes;
- presented the inherent linkages of the studies with the assessment, management and communication of risks; and
- recommended actions for national and international health authorities.

Chairman's Closing Remarks

The Chairman noted that 27 countries were represented at the total diet studies workshop, and its international status was thus well justified. The cost of undertaking a total diet studies is, however, such that there are generally only a few experts per country. With 60 delegates present, the workshop provided a real opportunity to get to know everyone, and to help foster a warm, friendly, relaxed and supportive environment of learning and information exchange.

He drew particular attention to France, which had completed its first total diet studies since the inaugural international total diet studies workshop two years ago, South Africa, which had nearly completed its food consumption survey, and Ireland, which had committed to undertake its first total diet studies and was well advanced with its planning. The challenge for participants, especially those from developing countries, is to be in a position for the next total diet studies workshop to present progress on planning a total diet studies in their own country, or better, to be able to report their preliminary results.

He felt that all objectives of the workshop had been achieved, and that the critical next stages were the development of a Regional total diet studies proposal and securing funding, initially for a pilot Regional total diet studies.

Closing Remarks

On behalf of WHO, Dr Moy thanked the participants for their enthusiasm and contributions during the two week workshop. In recognizing the excellent local arrangements, he acknowledged the efforts of Dr Pieter Scheelings and the staff of the Queensland Health Scientific Services in making the workshop run smoothly, efficiently and pleasantly. He also gave a special note of thanks to Dr Richard Vannoort for his tireless and capable leadership as Chair of the workshop and looked forward to working with ESR in the follow-up to the workshop. He expressed the hope that the workshop had established a strong foundation for future collaboration among all of the organizations present as well as among participants.

3. CONCLUSIONS AND RECOMMENDATIONS

Toxic chemicals and nutritional imbalances may affect every aspect of human health, causing birth deformities, mental deficiencies, renal and reproductive dysfunction and cancer. The economic, trade and health burden in the world from these effects totals many billions of dollars annually. For this reason, it is essential to have realistic background information on

actual dietary exposure of humans to these chemicals to assess the safety of the food supply. Total diet studies are the primary sources of information on the residue status of foods as prepared for consumption rather than on agricultural commodities. In addition, total diet study results can be an indicator of environmental contamination by certain chemicals, such as Persistent Organic Pollutants (POPs), and can be used over time to assess the effectiveness of specific risk management measures over time.

Workshop participants, after intensive discussion adopted the following recommendations for consideration by national and international health authorities:

3.1 Total diet studies in each country.

Scientific risk assessments are the fundamental basis of decisions dealing with both health and trade aspects of food. For scientific risk assessment it is essential to know background concentrations of chemicals in foods so that the actual dietary exposure to these chemicals can be assessed. In every country, the diet and dietary customs are different.

Thus, it is recommended that all countries conduct total diet studies to assess actual dietary intake of toxic and nutritionally important chemicals. This is particularly relevant for institutions already participating in GEMS/Food (see Annex IV). In addition, it is recommended that the WHO prepare a booklet describing and promoting total diet studies.

3.2 Support for total diet studies in developing countries.

For various reasons, in many developing countries, there is little or no monitoring of the food supply for toxic chemicals. As a result, information about the safety of foods is, more often than not, non-existent. With global trade, however, a food safety problem in one country may become a trade and health problem for many countries.

Thus, it is recommended that each developing country be given international assistance to conduct its own total diet study. This may be considered on a regional basis to reduce costs and promote regional cooperation.

3.3 Laboratory capacity.

Knowledge of background levels of toxic chemicals in foods is critical for knowing whether or not foods are safe. The number of laboratories capable of measuring background concentrations of toxic chemicals in foods are few and the costs of these analyses are relatively high. As a result, there is a paucity of background monitoring data. The costs for building up laboratory capacity, however, are minor compared with the health and economic consequences of not being able to deal with crises. For example, the economic consequences of the Belgium dioxin incident totalled \$2 billion, most of which was borne by the food industry, both in Belgium and internationally. Obviously, consumer confidence in the food supply also suffered.

It is recommended that all countries provide additional funding to health departments to substantially strengthen laboratory capacity to establish and monitor baseline levels of toxic chemicals in foods.

3.4 Emergency preparedness.

Food safety emergencies have occurred periodically, often with enormous health and economic costs. In addition, the food supply is a key target for terrorism, and without the ability to monitor for chemical toxicants, the populations of countries and world trade are at risk.

It is recommended that an inventory of laboratory capacities by chemical, matrix and detection limit be prepared by GEMS/Food. In addition, WHO

Collaborating Centres for Food Contamination Monitoring should consider expanding their terms of reference to address this issue.

3.5 WHO food safety databases.

With the globalization of trade and harmonization of food safety standards, it is critical that global food safety databases be maintained. These should include background concentration data for chemicals in individual foods and food groups, and dietary intake estimates from total diet studies conducted in individual countries.

It is recommended that:

- 1. existing GEMS/Food databases OPAL I, II and III, and SIGHT should continue to be supported and refined; and**
- 2. individual countries should support GEMS/Food databases by regularly submitting data in the OPAL format.**

3.6 Analytical training.

The chemical analyses required for total diet studies are among the most difficult of all food analyses because of the low detection limits which must be obtained.

It is recommended that, wherever possible, training be provided by more experienced laboratories for those analysts with less experience. Special emphasis should be placed on providing support and training to analysts in developing countries.

3.7 Persistent organic pollutants in breast milk.

Humans accumulate persistent organic pollutants in their stores of fat. Some of these are transferred into the fat portion of breast milk of mothers. Thus, breast milk is one of the few and least expensive mechanisms of assessing human exposure to these chemicals and monitoring this exposure with time can provide information on trends. Breast milk surveys can also be used to identify environmental sources of these chemicals and to monitor the effectiveness of risk management measures.

It is recommended that:

- 1. in light of the Stockholm Convention on POPs, countries should endeavour to participate in the ongoing 3rd WHO coordinated study of PCBs, PCDDs and PCDFs in breast milk; and**
- 2. countries should as a matter of balanced risk communication strongly emphasize the benefits of breast feeding whenever reporting the results of studies of this type.**

3.8 Risk assessment.

The primary user of total diet study results is the risk assessor. Internationally and in individual countries, there is an urgent need for risk assessments on many chemicals. For example, the Codex Committee on Food Additives and Contaminants had requested data to decide whether to set the maximum limit for patulin in apple juice at 50 or 25 ppm.

It is recommended that risk assessors and statisticians be consulted when a total diet study is designed so that the study results can be directly used in making scientifically valid risk assessments for at-risk population groups. Thus, it is important to be able to, as a minimum, estimate both average and upper percentile intakes of chemicals for each target population group. For nutrients, the ability to estimate lower percentile intakes is also critical.

3.9 Design and structure of total diet studies.

Numerous aspects of total diet studies can and should be harmonized if the results are to be comparable. However, it is important to also recognize that each study should reflect the health concerns and resources of the country in which it is conducted. The following recommendations deal with these aspects:

- 1. All countries should cooperate and coordinate their activities in the development and harmonization of standard protocols for total diet studies.**
- 2. A team approach should be used when conducting total diet studies, with all team members, including those recognizable for sample collection, sample processing, risk assessment, statistics and laboratory analysis, involved at the planning stage.**
- 3. Each total diet study should be documented in detail when it is reported. As a result of resource limitations or for strategic reasons, there will always be differences, such as analytical detection limits or choice of samples, in the design of studies in each country. These can have a major impact on the dietary intake results obtained for the survey and their interpretation.**
- 4. When comparing results of total diet studies from different countries, due care should be taken to ensure that the most recent data are used and to consider potential impact of individual differences in the design and implementation of the compared studies. Factors, such as different foods, age-sex groups, climates, agricultural practices, limits of detection / reporting and quality assurance and control practices, can affect results.**
- 5. Drinking water, taken as water, should be included in each total diet study except where resources do not allow for this. This should include bottled water and tap water taken from the sample pick-up areas. Thus, it is important that drinking water be included when food intake surveys are conducted.**
- 6. Where possible, distilled water should be used for sample preparation. Otherwise, the water used should be separately analyzed.**
- 7. There are some chemicals which, because of their nature, limited distribution or homogeneity, are better assessed in commodity surveys rather than total diet studies. Some mycotoxins, for example, are not homogeneously distributed in foods, and it would take a very large sample size to obtain a reasonable estimate of their concentration.**
- 8. Analytes for total diet studies should focus on those recommended for in the GEMS/Food Core, Intermediate and Comprehensive Lists of Contaminant / Commodity Combinations (see Annex V). Countries should consider including in their own total diet studies the following groups of chemicals: persistent organic pollutants (PCBs, dioxins, dibenzofurans); toxic elements (Pb, Hg, Cd, As, Cr); mycotoxins (such as aflatoxin, patulin and deoxynivalenol); specific chemical species (such as organotin compounds, methylmercury, nitrate, nitrite and nitrosamines), volatile organic compounds and nutrients such as vitamins, minerals and essential fatty acids.**
- 9. Prioritization when selecting analytes should be based on a) information available (has the analyte been included recently in a total diet study), b)**

toxicity (could the analyte act by itself or additively with other toxic chemicals to cause harm at low concentrations), c) susceptibility to technology changes, and d) potential for adventitious or deliberate contamination. Among the chemicals considered important enough for monitoring with every total diet study are pesticides, dioxins, PCBs, and the heavy metals Pb, Hg and Cd.

10. When selecting chemicals for total diet studies, countries should consider less common chemicals which may pose a significant health risk to their population.
11. Managers of total diet studies should define the limit of reporting required of the laboratory performing the analyses so that the exposure results will be meaningful and cost-effective.
12. Dietary exposures can vary widely depending on how results at or below the limit of reporting are handled. Regardless of the approach taken, it should be clearly described when the total diet study results are reported. Managers of total diet studies should define how results below the limit of reporting are to be used in risk assessment. The technique used should be practical, logical, scientifically valid and consistently applied. While there is still no general agreement about how this should be done, the workshop drew attention to the GEMS/Food EURO workshop recommendations that appear as Appendix V to the GEMS/Food Instructions for Electronic Submission of Data on Chemical Contaminants in Food, available at the WHO Website www.who.int/fsf.
13. Food consumption data used for total diet studies should be as recent as possible and maintained current. Because local dietary patterns may change quickly, the date and basis of the consumption data should be defined in each study.
14. While national consumption data are critical for the highest accuracy of total diet study results, GEMS/Food Regional Diets are a useful starting alternative for countries without their own food intake information.
15. Appropriate quality assurance and control at all stages of a total diet study are critical and cannot be overemphasized.
16. In addition to estimating exposure for adults or the general population, it is critical to estimate dietary intakes for infants and children who face the greatest risk due to their high consumption/body weight ratio. In addition, countries should conduct exposure estimates on other population sub-groups, such as ethnic populations, if their diet patterns are expected to be different.
17. Foods should be prepared “as normally consumed” and concentration data recorded as such. If not so, moisture content should be included in the data submitted.
18. Total diet studies should be planned so that food composites are analyzed shortly after they are prepared. Even if the foods are kept frozen, some chemicals may gradually decompose over time or become bound to the food matrix.
19. When dealing with the possibility of terrorist threats or other food safety emergency, each total diet study should contain an annex to deal with

highly contaminated samples quickly, so that the source of contamination can be identified and managed.

3.10 Risk communication.

It is recognized that information on concentrations of chemicals in foods and the dietary intake of these chemicals can be misinterpreted by the public, and thus discourage the public from eating foods which are nutritionally beneficial.

It is recommended that:

- 1. total diet study results be fully and openly reported immediately after they are analytically validated;**
- 2. individuals reporting these results be scientists from government and academia with closest knowledge of the study;**
- 3. total diet study results be reported in a way that is easily understood by the public, such as providing a direct comparison of the intake with the PTWI or ADI of the chemical; and**
- 4. when reporting results to the public, emphasis be on the risk rather than the hazard, and putting the risk into perspective and that it be presented in a format easily understandable to the public.**

3.11 International total diet workshops.

Total diet studies are complex and require expertise from many different areas, including management, analytical chemistry, nutrition, food consumption patterns, food preparation, and statistics. Transfer of this expertise to countries starting their own total diet studies, exchange of information among scientists already conducting studies, and sharing of resources are critical.

It is recommended that another international total diet workshop be held focusing on:

- 1. progress of total diet studies, particularly in developing countries;**
- 2. results of new total diet studies;**
- 3. international dietary risk assessment issues;**
- 4. techniques of food analysis, consumption studies, and exposure estimates; and**
- 5. training for less developed countries.**

It is also recommended that regional total diet workshops be held, especially where groups of developing countries are interested in initiating new total diet studies.

Second International Total Diet Workshop

4 – 15 February 2002, Brisbane, Australia

Cosponsored by the Australia New Zealand Food Authority, the New Zealand Ministry of Health and the World Health Organization in cooperation with the Asia Pacific Food Analysis Network and the Food and Agriculture Organization of the United Nations

Agenda for Week 1 (4 – 8 February 2002)

Monday, 4 February

09:00 – 10:00 Registration

10:00 – 10:30 Welcome and Opening

Australia New Zealand Food Authority

Dr Marion Healy

New Zealand Ministry of Health

Ms Jenny Reid

Asia Pacific Food Analysis Network

Dr Pieter Scheelings

Food and Agriculture Organization of the United Nations

Dr Barbara Burlingame

World Health Organization

Dr Gerald Moy

10:30 – 10:40 Appointment of Chair, Vice-Chair and Rapporteur

10:40 – 11:00 Objectives and Structure of Workshop
Chair – Dr Richard Vannoort

11:00 – 11:30 **Risk Analysis Framework in Protecting Human Health**
Dr Marion Healy

11:30 – 12:00 **International Risk Assessment for Contaminants**
Ms Katie Egan

12:00 – 14:00 Lunch

14:00 – 14:45 **Emerging Issues in Exposure Assessment Related to Codex**
Dr Luba Tomaska

- 14:45 – 15:15 **Current Status of GEMS/Food**
Dr Gerald Moy
- 15:15 – 15:45 Break
- 15:45 – 16:15 **GEMS/Food-EURO**
Dr Cristina Tirado
- 16:15 – 16:45 **Environmental Issues and Food Contamination Monitoring:
Dioxins**
Dr Piet van Zoonen
- 16:45 – 17:15 **Linking Nutrition Surveys with Total Diet Studies**
Dr Chen Junshi
- 17:15 – 17:30 **General Discussion**

Tuesday, 5 February

- 09:00 – 12:00 **National experiences with studies on chemical contaminants in
food and total diet**

Australia – Mr Steve Crossley

Canada – Dr Bob Dabeka

China – Dr Junshi Chen

Czech Republic – Dr Jiri Ruprich

Finland – Dr Jorma Kumpulainen

- 12:00 – 13:30 Lunch

- 13:30 – 17:00 **National experiences with studies on chemical contaminants in
food and total diet (continued)**

France – Dr Jean-Charles Leblanc

New Zealand – Dr Richard Vannoort

Pacific Islands – Prof. Bill Aalbersberg

South Africa – Ms Annette Casey

United States of America – Ms Katie Egan

Wednesday, 6 February

- 09:00 – 09:30 **Food Systems**
Dr Barbara Burlingame

- 09:30 – 10:00 **GEMS/Food International Dietary Consumption Patterns**
Dr Barbara Petersen
- 10:00 – 10:30 **Generating, Compiling and Using Food Composition Data in Developing Countries**
Dr Barbara Burlingame
- 10:30 – 11:00 Break
- 11:00 – 11:30 **Development of Food Lists, Diets and Design in New Zealand Total Diet Survey**
Ms Jenny Reid
- 11:30 – 12:30 **FAO's Risk Activities: Food Consumption Surveys**
Dr Barbara Burlingame
- 12:30 – 13:30 Lunch
- Food Consumption Survey Protocol for Developing Countries - ad hoc Working Group**
- Field Visit

Thursday, 7 February

- 09:00 – 09:30 **Analytical Issues Related to Organics**
Mr Chris Sack
- 09:30 – 10:00 **Analytical Issues Related to Elements**
Mr Duane Hughes
- 10:00 – 10:30 **An Expert System for the Evaluation of Quality of Analytical Results**
Dr Pieter Scheelings
- 10:30 – 11:00 Break
- 11:00 – 11:30 **Questionnaire to Assess Quality Assurance and Control of Sampling and Analysis of Submitted Data**
Dr Samuel Page (presented by Dr Gerald Moy)
- 11:30 – 12:00 **Electronic Reporting of Data to GEMS/Food**
Mr Peter Cressey
- 12:00 – 13:30 Lunch

- 13:30 – 14:30 **GEMS/Food Global Databases**
Mr Lawrence Grant
- 14:30 – 15:00 **Data Structure for Individual Contaminant/Commodity Database (OPAL III)**
Mr Lawrence Grant
- 15:00 – 15:30 **WHO SIGHT (Summary Information on Global Health Trends)**
Mr Lawrence Grant
- 15:30 – 16:00 Break
- 16:00 – 16:30 **Dietary Intake Assessment Modelling**
Ms Tracy Hambridge
- 16:30 – 17:15 **Risk Communication Issues Related to Total Diet Studies**
Prof. Ian Shaw

Friday, 8 February

- 09:00 – 09:30 **Development of a Food Consumption Survey Protocol for Developing Countries**
- 09:30 – 10:00 **Manual for Total Diet Studies**
- 10:00 – 10:30 **Proposal for a Regional Total Diet Study**
- 10:30 – 11:00 **Break**
- 11:00 – 12:00 **Summary and Conclusions**
Dr Richard Vannoort
- 12:00 – 12:30 **Closing Remarks**

Second International Total Diet Workshop

4 – 15 February 2002, Brisbane, Australia

Cosponsored by the Australia New Zealand Food Authority, the New Zealand Ministry of Health and the World Health Organization in cooperation with the Asia Pacific Food Analysis Network and the Food and Agriculture Organization of the United Nations

Training Agenda for Week 2 (11 – 15 February 2002)

Monday, 11 February

- 09:00 – 09:15 **Welcome & Introductions**
Dr Pieter Scheelings
- 09:15 – 10:15 **Planning a Total Diet Study**
Dr Richard Vannoort
- 10:15 – 10:30 Discussion
- 10:30 – 11:00 Morning break
- 11:00 – 11:30 **The Decision-making Process in Starting a Total Diet Study in Ireland**
Ms Christina Tlustos
- 11:30 – 12:15 **Preparing a Total Diet Study Project Timeline (Tutorial)**
Dr Richard Vannoort
- 12:15 – 12:30 **Discussion**
- 12:30 – 13:45 Lunch
- 13:45 – 14:45 **Standard Operation Procedures for a Total Diet Study**
Dr Richard Vannoort
- 14:45 – 15:00 **Discussion**
- 15:00 – 15:30 Afternoon break
- 15:30 – 16:30 **US FDA Standard Operating Procedures for a Total Diet Study**
Messrs Chris Sack and Duane Hughes
- 16:30 – 17:00 **Discussion**

Tuesday, 12 February

- 08:30 – 09:15 **Assessing the Food Supply**
Dr Barbara Burlingame

- 09:15 – 09:30 **Discussion**
- 09:30 – 10:15 **Food Consumption Data Using WHO GEMS/Food Diets**
Dr Gerald Moy
- 10:15 – 10:30 **Discussion**
- 10:30 – 11:00 Morning break
- 11:00 – 11:45 **Developing a Food List for a Total Diet Study**
Mr Rob Keane
- 11:45 – 12:15 **Food List Exercise**
Mr Rob Keane
- 12:15 – 12:30 **Panel Discussion**
Mr Rob Keane
Dr Barbara Burlingame
Dr Gerald Moy
- 12.30 – 13.45 Lunch
- 13:45 – 14:30 **Sampling – Introduction to General Issues**
Dr Richard Vannoort
- 14:30 – 15:00 **Interactive Sampling Plan (Tutorial)**
Dr Richard Vannoort
- 15:00 – 15:30 Afternoon break
- 15:30 – 16:30 **Food Sampling in the Marketplace**
Mr Mark Hansen
- 16:30 – 17:00 **Discussion**

Wednesday, 13 February

- 08.30 – 09.15 **Sample Preparation – General Issues**
Dr Richard Vannoort
- 09:15 – 09:30 **Discussion**
- 09.30 – 10.15 **Sampling and Sample Preparation for Pesticide Analysis**
Mrs Mary Hodge
- 10:15 – 10:30 **Discussion**
- 10.30 – 11.00 Morning break

- 11.00 – 11.45 **Internet and Other Information Resources**
Dr Jorma Kumpulainen
- 11.45 – 12.00 **Discussion**
- 13.00 – 17.00 **Personal Consultations with total diet studies Experts**

Thursday, 14 February

- 08:30 – 09.15 **Quality Assurance and Key Issues in Analyses of Pesticides**
Mr Chris Sack
- 09:15 – 09:30 **Discussion Panel on Quality Assurance**
Mr Chris Sack
Dr Richard Vannoort
Dr Pieter Scheelings
- 09.30 – 10.15 **Quality Assurance and Key Issues in Analyses of Inorganics**
Mr Duane Hughes
- 10.15 – 10.30 **Discussion Panel**
Mr Duane Hughes
Mr Richard Vannoort
Dr Jorma Kumpulainen
- 10.30 – 11:00 Morning break
- 11.00 – 11.30 **Exposure Estimates – Introduction to Options**
Mr Peter Cressey
- 11.30 –12.15 **Exposure Estimates (Tutorial Using Spreadsheets)**
Mr Peter Cressey
- 12:15 – 12:30 **Discussion**
- 12:30 – 13:45 Lunch
- 13:45 – 14:30 **Demonstration of sample handling and preparation for inorganic
and organic analyses at Queensland Health Scientific Services**
Mrs Mary Hodge
- 16.30 – 17:00 **Discussion**

Friday, 15 February

- 08.30 – 10.30 **Data Collection and Collation Using the GEMS/Food Programs
– Hands-on Tutorial of OPAL I, OPAL II and SIGHT**
Mr Lawrence Grant
Dr Jean-Charles Leblanc
Mr Peter Cressey
- 10.30 – 11.00 Morning break
- 11.00 – 12.00 **Hands-on Tutorial OPAL I, OPAL II and SIGHT (continued)**
- 12.00 – 13.00 **Review of Further Recommendations**
Dr Richard Vannoort
- 13.00 – 13.30 **Course Evaluation by Participants**
- 13.30 – 14.00 **Closing Remarks**
Dr Gerald Moy
Dr Pieter Scheelings
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SUMMARY OF SELECTED PRESENTATIONS

1. The Risk Analysis Framework in Protecting Human Health

Dr Marion J. Healy, ANZFA, Canberra, Australia

The most important objective in regulating the food supply is the protection of human health. Regulatory decisions about the safety and nutritional adequacy of the food supply utilize a risk and evidence based approach that is embodied within the risk analysis framework. This framework has been adopted by the Codex Alimentarius Commission, which has responsibility for developing international benchmarks for food safety and nutritional adequacy.

The risk analysis is defined as having three components: risk assessment, risk management and risk communication. Risk assessment draws on scientific information to determine the risk to human health posed by a defined food hazard; it draws together information about the likely exposure to the hazard via the diet and likely health impact at various levels of exposure. Total diet surveys provide the most accurate information on the dietary exposure of the population to food hazards, particularly chemical hazards.

The risk management measures implemented to address risks associated with the food supply should be based on the outcome of the risk assessment. However, the measures chosen to mitigate identified risks may be influenced by a number of factors including the level of safety demanded by the community, the severity and frequency of the adverse health outcome, national government policies, enforceability and feasibility. The most effective application of the risk analysis framework also utilizes risk communication strategies to explain the decision making process, the decision taken and the underpinning evidence.

The risk analysis framework therefore provides the regulatory context in which total diet surveys should be designed and implemented. The information from such surveys is critical to accurately characterize the risks from food hazards and, conversely, the surveys also provide a mechanism to evaluate the effectiveness of risk mitigation measures.

2. International Risk Assessment for Contaminants

Ms Katie Egan, US FDA, Washington D.C., USA

With the tremendous increase in international trade, there is a greater need for establishing international food safety standards. The Codex Alimentarius Commission has a pivotal role in this process and Codex standards are the references used by the WTO in resolving trade disputes. The SPS Agreement specifies that these standards must be based on an appropriate assessment of risks to human health. The Codex Committees elaborate standards based on the risk assessments conducted by two independent scientific bodies – Joint Expert Committee on Food Additives (JECFA) and Joint Meeting on Pesticide Residues (JMPPR). JECFA conducts risk assessments for food additives, contaminants and residues of veterinary drugs in food. The outcome of these risk assessments are used by the Codex Committee on Food Additives and Contaminants to determine whether risk management options should be considered for specific commodities. These risk assessments rely on data submitted by member countries. In order to conduct reliable assessments for contaminants at the international level, it is critical that the data be representative of contamination world wide and that the data be of high quality. Data quality criteria proposed by a Joint FAO/WHO workshop on estimating dietary exposure to contaminants suggest that data are to be generated by an accredited laboratory or equivalent using validated analytical methods, and that the samples be selected using a statistically based sampling technique. In addition, it was recommended that the data be fully documented, recent (within the last 10 years), random vs. targeted, and reported as individual values rather than aggregated.

3. *Emerging issues in Exposure Assessment Related to Codex*

Dr Luba Tomaska, ANZFA, Canberra, Australia

International standard setting process performed by the Codex Alimentarius Commission uses a risk and evidence based approach. Health-based Codex standards may only be developed on the basis of a sound risk assessment and serve to protect public health and safety. World Trade Organization agreement binds its members to the application of food standards that need to be justified on basis of protecting public health, thereby prevent non-tariff trade barriers.

The risk assessment therefore has become the underpinning tool in a health-based standard setting process, both at the national and international levels. Exposure assessment is often the neglected component in a risk assessment process, because national and global data is very limited for specific chemicals or microbiological agents in food. Adequate data about food consumption and concentrations of chemical and microbiological agents in food at the national level is vital in obtaining the best estimate of exposure for a population. Sound scientific exposure estimates resulting in accurate risk assessments provide defensible basis for the setting and enforcement of food standards that protect health of people. National dietary intake and food contamination data also inform regional and global risk assessment done by JECFA and used by Codex to set international standards.

Countries that lack this exposure data are unable to prioritize risks posed by contaminants in food, may not be able to set realistic and defensible food standards for imported and domestic food and may be disadvantaged when international food standards don't represent their needs.

4. *Current Status of GEMS/Food*

Dr Gerald Moy, WHO, Geneva, Switzerland

The current status of GEMS/Food, including recent developments, was presented. GEMS/Food was established in 1976 to compile data on food contamination and human exposure for global synthesis, evaluation and presentation. The focus of GEMS/Food is on health-oriented population-based dietary exposure to major food contaminants rather than trade-oriented targeted sampling and analysis programmes. GEMS/Food currently includes institutions located in over 70 countries around the world. GEMS/Food is interested in levels of contaminants in individual foods and in the total diet as reflected in the software programs OPAL I and II, which have been developed expressly to collect and manage such data. More recently, SIGHT (Summary Information on Global Health Trends) was developed as a dissemination tool that offers the public and other specified users access to the GEMS/Food database. Among the users, JECFA and JMPR receive GEMS/Food data on chemicals that are scheduled for evaluation by these bodies. GEMS/Food is also involved in the collection and evaluation of chemicals in breast milk and is sponsoring countries to participate in the Third Round of WHO Coordinated Studies of Dioxins, Dibenzofurans and Polychlorinated Biphenyls in Breast Milk. As a result of the signing of the Stockholm Convention on Persistent Organic Pollutants (POPs) in May 2001, GEMS/Food is supporting the analyses of breast milk samples to include other POPs in order to establish baselines, which will be used to assess the effectiveness of the treaty in reducing emissions of POPs. Countries interested in participating in the breast milk study should contact the GEMS/Food Manager for further details. Finally, GEMS/Food is responding to the potential terrorist threats by collaborating in the preparation of an annex on potential sabotage of water, food and other products, which will be attached to the WHO publication "Health Aspects of Biological and Chemical Weapons". GEMS/Food is also considering the development of an inventory of monitoring capabilities of GEMS/Food and other food laboratories in order to provide support in the event of terrorists incidents or other food safety emergencies.

5. *Environmental Issues and Food Contamination Monitoring: Dioxins*

Dr Piet van Zoonen, RIVM, Bilthoven, The Netherlands

A survey was carried out in 1998/1999 to estimate the dietary intake of dioxins and dioxin-like PCBs in foodstuffs in The Netherlands. In this programme dioxins (PCDDs and PCDFs) and dioxin-like PCBs (non-ortho PCBs and mono-ortho PCBs) were analysed in composite food samples. The dietary intake was estimated taking into account the food consumption patterns in the population as obtained in the 1998 food consumption survey. Dioxins and dioxin-like PCBs tend to accumulate in the body, hence evaluation of the data was focused on long-term intake.

The database of food consumption from the Dutch National Food Consumption Survey (DNFCS) performed in 1998 was consulted for the selection of foods based on their relative importance in the total fat consumption, resulting in a sample plan covering 98% of the fat-intake. The dioxin levels found in these samples were used as input in the database of the DNFCS.

A two-step approach was used to estimate the long-term intake in the population. First, for 6 250 individuals personal daily-averaged intake was calculated for two consecutive days, using the food consumption data and concentrations in consumed products (12500 data points). Next, the relationship of long-term intake with age in the population was determined using regression analysis and nested variance analysis. The regression analysis was used to quantify the intake as a function of age. From this relationship the lifelong-averaged (70 yrs.) intake was calculated. Nested variance analysis served to unravel the between-subject and the within-subject components of the total variation of daily-averaged intake in the population.

The estimated median lifelong-averaged intake of dioxins in the population is 0.65 pg WHO-TEQ/kg bw per day. The estimate for the sum of dioxins and dioxin-like PCBs is 1.2 pg WHO-TEQ per/kg bw per day. The 90th percentile of intake in the population is 1.6 times higher than the median intake. The contribution of different food groups to the total intake of TEQ (dioxins and dioxin-like PCBs) is fairly uniformly distributed over the foods consumed: meat products (23%), dairy products (27%), fish (16%), eggs (4%), vegetable products (13%), and industrial oils and fats (17%). A comparison was made between these results and those of the 1990/91 survey. An average reduction in intake of 50% for dioxins and 60% for non-ortho PCBs was estimated. This substantial reduction is related to the decrease in the concentrations of dioxins and dioxin-like PCBs in the majority of foodstuffs. Nevertheless, 8% of the population is exposed to intake levels above the Tolerable Daily Intake of 2 pg TEQ/kg bw per day, as recently derived by the Scientific Committee on Food (SCF) of the European Commission.

6. *Linking Nutrition Surveys with Total Diet Studies in China*

Dr Junshi Chen, INFH, Beijing, China

Three national total diet studies have been conducted in China by the Institute of Nutrition and Food Hygiene (INFH), Chinese Academy of Preventive Medicine, in 1990, 1992 and 2000. This paper reports on the nutritional assessment of the Chinese diet in the 1990 and 1992 total diet studies.

The total diet studies was carried out in 12 provinces using the food composite approach. Based on geographical distribution, each regional market basket was comprised of 12 cooked food group composites, e.g., cereals, meats, vegetables, etc. from each of the 3 closest provinces. Macronutrients, micronutrients fatty acids and amino acids were analyzed. Some of the results are reported below.

- Comparing the nutrient intakes between the conventional dietary survey (weighing and recording) and the total diet studies, the intakes energy, protein, fat and carbohydrates and minerals were comparable between the two types of study. However, the intakes of ascorbic acid, which is heat-labile, were

significantly lower in the total diet studies (4.7 mg/person/day) than in the conventional dietary survey (86.6 mg/person/day).

- Dietary fat and cholesterol intakes were significantly lower in rural areas than in urban areas.
- Dietary fatty acid profiles were significantly different between the 2 southern regions and the 2 northern regions, characterized by the high proportion of monounsaturated fatty acid in the southern regions. Palmitic acid (16:0), oleic acid (18:1) and linoleic acid (18:2) were the 3 predominant fatty acids in the Chinese diet.
- The analysis of food sources of fat showed that meats (about 90%) and vegetables (about 30%) were the major source of dietary fat. The increased use of cooking oil in the preparation of vegetable dishes accounted for the high fat contribution by vegetables.
- Only 30% of the dietary iron intake was heme iron, and the bioavailable iron in the Chinese diet was only about 10% of the total dietary iron intake.

In conclusion, nutritional assessment of the diet using the total diet studies provides important information on nutrient intake that is not available in conventional dietary surveys.

7. *The 19th Australian Total Diet Survey*

Mr Steve J. Crossley, ANZFA, Canberra, Australia

Australia has been conducting total diet surveys, formerly known as market basket surveys, since 1970. The aim of Australia's total diet surveys is to monitor pesticide residues and contaminants in the food supply and to estimate the overall dietary exposure of these chemicals to the Australian consumer. Retail samples are taken from Australia's States and Territories and these are prepared to a 'table ready' state prior to analysis, for example, potatoes were cooked.

Australian total diet surveys have used the *representative food approach*, whereby individual foods are analysed and the results extrapolated to other similar foods e.g. peaches are taken to be representative of all stone fruit. Dietary exposure assessments are then conducted using Australia's own dietary modelling software, known as DIAMOND. This software utilizes detailed food consumption data, taken from a large nationwide nutritional survey conducted in 1995, to estimate exposure for six population sub-groups: men, women, boys, girls, toddlers and infants.

The 19th total diet survey¹ was published in March 2001 and a full report can be found at www.anzfa.gov.au. The results of the 19th survey, demonstrate that the levels of pesticide residues and contaminants in the Australian food supply are very low, and in all cases they were within acceptable safety limits (e.g. acceptable daily intake – ADI) where reliable dietary exposure assessments could be calculated. The survey did though highlight the need to obtain lower levels of reporting for mercury and antimony in food and to refine the dietary exposure models for dithiocarbamate fungicides.

In undertaking total diet surveys, Australia recognizes that they have inherent limitations. In particular, they are expensive, are not generally truly statistically representative of the food chosen, and do not take into account the potential acute dietary risk arising from residue variability between individual commodity units. Nevertheless, total diet surveys provide useful information for risk managers and the wider community, in

¹ Acknowledgements: Rob Keane, Janis Baines, Steve Fynmore, Brigid Hardy, Annette Learmonth and Narelle Marro.

that they represent the most realistic estimate of dietary exposure to chemical residues and contaminants in the food supply.

8. *Canadian Total Diet Study*

Dr Robert Dabeka, Health Canada, Ottawa, Canada

The total diet study programme in Canada has been ongoing for over 25 years. It currently involves collection of 850 foods from one city each year. The foods are processed as for consumption at Kemptville Community College, combined into 140 different food composites, and homogenized. The bottled composites are analysed for dioxins, 60 pesticides, PCB congeners and trace elements. Recently, nitrate, nitrite, nitrosamines, brominated diphenyl ethers (fire retardants) and mercury have been added to the list of analytes. Past targeted cities include Toronto (1992), Montreal (1993), Halifax and Winnipeg (1994), Vancouver and Ottawa (1995), Toronto (1996), Whitehorse (1998), Calgary (1999), Ottawa (2000), and St. Johns (2001).

The key focus of the analytical methods used was obtaining detection limits low enough so that the results would be valid for risk assessments. Details of the methods can be obtained from the following sources: trace elements: (Ref. Bob_Dabeka@HC-SC.GC.CA); dioxins, furans, brominated diphenyl ethers: (Ref. Jake_Ryan@HC-SC.GC.CA); pesticides: (Ref. Thea_Rawn@hc-sc.gc.ca), PCBs: (Ref. Sheryl_Tittlemier@hc-sc.gc.ca); and iodine (Ref. Mary_L'Abbe@HC-SC.GC.CA). Analyses for pesticides and PCBs are several years behind schedule due to loss of technical staff. As some pesticides decompose with storage, the results will be less useful in making risk assessments.

Food intakes used were obtained by the Nutrition Research Division in a Nutrition Canada Survey in 1970. New food intake information for adults has recently been collected and will be incorporated into the study this coming year. No new Canadian food intake information exists for infants and younger children. Such information is important because the dietary intake of chemicals by infants can vary significantly between birth and 1 year old, and because the developing body of infants is more susceptible to the toxic effects of many chemicals.

Total diet study results for recent years have revealed that only one of the samples (strawberries) contained a level of pesticide (6.9 ppm captan) higher than the maximum residue limit of 5 ppm. The greatest dietary source of ingested PCBs was fish. For two cities, Whitehorse and Calgary, fish contributed 51% and 95%, respectively, to the dietary intake of PCBs. The freshwater fish composites generally contained the highest concentrations of PCBs. For the saltwater fish composite, there appeared to be a gradual decrease in total PCB concentrations between 1992 and 1999.

9. *The 2000 Chinese Total Diet Study - Methodology and Preliminary Results*

Dr Junshi Chen, INFH, Beijing, China

The Chinese total diet studies has undergone gradual improvements. The first total diet study conducted in 1990 used the food composite approach for a single population group - adult males. There were 4 regional market baskets and about 100 contaminants and nutrients were analysed. The total diet studies in 1992 increased the number of age/sex groups to 5. The 3rd total diet study in 2002 increased the number of age/sex groups to 12. In addition, in order to fully take advantage of individual food samples without giving up the food composite approach, all 662 individual food samples collected from each of the 12 provinces were stored, in addition to preparing these into composites for each of 4 regions. This new method has the advantage of the food composite approach (fewer samples for laboratory analysis), while the individual samples are available to trace any contamination to its source. Some examples are presented.

- A high cadmium concentration (149 µg/kg) was found in the aquatic food composite from the North 1 Region. Further analysis revealed a high cadmium level (594 µg/kg) in the aquatic food composite from Liashing province (one of the 3 provinces that comprised the North 1 Region). Analysis of the 7 individual samples from the province revealed 1498 µg/kg cadmium in one sea crab sample.
- High hexachlorohexane (HCH) in the fish composites of North 1 and South 2 regions were found. Analysis of HCH isomers found that gamma-HCH was the residue of concern. The gamma-HCH was traced to a carp fish from Heilongjiang Province containing about 300 µg/kg, and to a Wu-Chang fish from Hubei Province with a level of about 500 µg/kg.
- The ratio of inorganic to total arsenic was studied in the 12 food group composites in the 4 regions, and found to vary in the food groups with a range of 15-50%.

10. Total Diet Study in the Czech Republic

Dr Jiri Ruprich, NIPH, Brno, Czech Republic

One of the realized changes in food safety strategy in the Czech Republic during 90's – an independent total diet study – has been organized by the National Institute of Public Health since 1994. Total diet studies is not involved in the food inspection system and it is conducted as a part of Environment and Health Monitoring System in the health sector. QA/QC system has been introduced as the condition for funding of total diet studies by the government. All important procedures are described in SOPs. QA/QC system is assessed by two independent bodies – the Czech Institute for Accreditation and the QA/QC team of the monitoring system. Quality is regularly checked externally by proficiency testing (FAPAS, WEPAL, etc.) and internally (QA/QC manager, repeated sample analyses, etc.). Based on the national food consumption survey (HBS) – 196 food items were selected which represent more than 95 % of weight of the typical Czech diet. Additional selections have been done for specific chemical substances (e.g. mycotoxins, minerals, etc.). Selection of agents is influenced by the government, by NGOs and by food producers. Usually there is a good agreement with national and international recommendations; sometimes the selection is not a very high priority (problem of risk communication). If possible, all samples are analyzed for one analyte in one laboratory. Substances analyzed from 1994 until 2002 include organochlorine pesticides, indicator congener PCBs, substances with TCDD effects, polycyclic aromatic hydrocarbons, carbamate pesticides, mycotoxins, elements, anions and vitamins. Exposure assessment is based on the calculation exposure doses for non-cancer effects and for cancer effects. Cost of the total diet study programme depends on the cost of the main components – food consumption and analytical data. Solution is a tiered approach. Risk characterization for non-nutrients and non-cancer effects is done by comparison with ADI/RfD (PTWI, PMTDI, TDI, etc.), for cancer effect, when OSF is known (probability of cancer attributed to one year exposure), for macronutrients by comparison with RDA/RDI, for micronutrients by comparison with Basal Population Minimum / Normative Population Minimum. Risk Communication strategy and tactics used for presentation of total diet study results have been discussed also.

It is concluded that total diet studies shall be an integral part of the more complex monitoring system – possibility to validate results. Total diet studies can be realized with different levels of precision – the tiered approach. QA/QC system is the basic condition for realization of the long-time total diet study programme. Risk communication strategy has to be an integral part of the total diet studies management. Results from the total diet studies shall be comparable internationally.

11. Finnish Experiences in Total Diet Studies of Contaminants

Dr Jorma T. Kumpulainen, ARF, Jokioinen, Finland

The present paper summarizes results of nationwide average dietary intake studies conducted in Finland over a period of 1997 – 1998. The present study was the second nationally representative market basket study (MBS). The composed diet was based on the so called Finndiet food consumption survey carried out by the Finnish Public Health Institute in 1997. This comprehensive survey provided the necessary basic information upon which the collection of foods and preparation of the second market basket diet was based. Additional information was needed, however, to obtain data on market shares of the most important brands and certain special foods. Food items used for the MBS were aggregates of 1,087 food samples made of 3,988 subsamples collected from various sources in a representative way. Total weight of the collected subsamples was 2 529 kg. In addition, the alcoholic beverage group contained 16 alcoholic beverage types being aggregates of 54 samples and 156 sub-samples. Samples were collected and the diet composed during 1997-1999. The market basket was divided into 10 food groups and a separate alcohol group. The total diet prepared included 228 food items, i.e. all foods whose average consumption was more than 0.5 g/d/person. The results include toxic heavy metals lead and cadmium, polycyclic aromatic hydrocarbons (PAHs), PCBs and organochlorine pesticide residues, polychlorinated dibenzo-p-dioxins and -furans. In addition, many nutrient were also analyzed. The second national hospital diet study was conducted in 1996-1997 comprising the weekly diets of all 19 central or university hospitals. The results included essential mineral and trace elements, toxic heavy metals lead and cadmium and PCBs and PAH-compounds. The results of the project have demonstrated that average intakes of chemical contaminants studied are low. In particular, the total dietary intake of heavy metals, polychlorinated dibenzo-p-dioxins/furans, PCBs, organochlorine pesticide residues and PAH compounds were either very or relatively low when compared with the tolerance limits. The dietary pattern of the Finns has changed dramatically over the ten year period between the first and the second MBS. Finland joined the European Union in 1995 which has influenced the dietary pattern, number and type of foods on the market and origin of raw materials. Furthermore, the improved environmental control systems established in Finland over the past ten years have reduced the average intakes of lead, PCBs and PAH compound very significantly. Thus, the above two diet sets provide a useful way to make time-trend estimations of intakes of contaminants.

12. French Studies on Chemical Contaminants in Food and Total Diet

Dr Jean-Charles Leblanc, INRA, Paris, France

The presentation gave a brief overview of French monitoring and control plan for contaminants and toxins, which are addressed on a raw commodity basis by the Ministry of Agriculture and Fisheries and by the Ministry of Economy, Finances and Industry for animal and vegetable products. It also presented an overview of research basis conducted in the field of food risk analysis by the National Institute of Agronomical Research (INRA). INRA undertook in the frame of it's missions several studies on risk assessment of nutrients, chemicals and toxins in food and actually was responsible for conducting the first French Total Diet Study on exposure assessment to contaminants and toxins in food which is founded by the Ministry of Agriculture and has been implemented after the first international total diet study workshop held in Kansas City in 1999.

Food consumption data for total population and vegetarians was used to develop the food list of the total diet survey. The total diet was based on the last national survey on individuals food consumption for the total population (INRA, 1999) and another food consumption survey for vegetarians (Leblanc et al., 2000). The total diet included 342 foods items where all foods consumed on average more than 1g/day/person were taken into account in the food list. These criteria covered more than 90 percent of the total diet. Additional information concerning the mode of purchase and supply by household as a function of the percentage of the market share was obtain from national household database (SECODIP, 1996) to get the best representativeness in food list sampling. After sampling, foods were mixed and prepared as consumed by

a cook in a special kitchen at the French superior school of culinary arts. 1 132 composite samples will be analysed for 18 trace elements/sample including lead, cadmium, arsenic, mercury, aluminium, tin, selenium, calcium and iron with a ICP-MS at the National Laboratory of Reference for Traces Elements. Furthermore 456 composite samples will be analysed for different mycotoxins of interest (aflatoxin B, G, and M, ochratoxin A, patulin, zearalenone, fumonisins and about 10 tricothecenes of group A and B) with immunoaffinity HPLC and GC-MS by the laboratory of the National Institute of Beverages and Brewery Industry.

At this stage, sampling is completed and the analysis of trace elements has begun. Preliminary results of estimated intakes to ochratoxin A and deoxynivalenol from various foods in the French diet have given a best estimate of the total dietary exposure in the same range as other previous studies conducted on a 'not as consumed' basis (e.g. for ochratoxin A, estimate exposure in total diet studies is 3.3 ng/kg b.w/day vs. 3.6 ng/kg b.w/day in SCOOP task 3.2.7 1999.). Results will also be used to try to estimate exposure of at-risk groups like vegetarians.

This observation shows that the implementation of a total diet study provides a useful way to obtain best exposure estimates of a population to chemicals and toxins present in food. Total diet studies could confirm that the use of food consumption and monitoring data, even if analytical results are on a raw basis, can provide a good approach to get a preliminary picture of exposure of the population to some contaminants present in food.

13. New Zealand Total Diet Survey – A Public Health Risk Assessment Tool

Dr Richard Vannoort, ESR, Christchurch, New Zealand

There have been five New Zealand Total Diet Surveys thus far, and that these have been carried out on a periodic basis dating back to 1974. In the latest NZ total diet study, there were 114 foods, of which 48 were 'Regional' foods and 66 'National' foods. All were sampled over two seasons, with regional foods sampled from four regional sites, and national foods from one nationally representative site. In total some 2 440 food samples were purchased, and these were then prepared 'table ready' before analysis of 90 pesticide residues and metabolites, five contaminant elements (lead, cadmium, arsenic, mercury and tin) and three selected nutrients of relevance to NZ (iodine, selenium and zinc). In the 1997/98 NZ total diet study individual food types were analysed separately (i.e. white bread, wheatmeal bread, rice etc) although resource constraints meant that some of the multiple purchases of each food type were composited before analysis. Wherever possible, regional and/or seasonal sample information was retained. In total 460 samples were analysed for pesticides, and 530 for elements.

By combining the mean concentration data found in each of the individual foods with median consumption information from simulated fortnightly 'typical' diets for six different age-sex groups in the population, dietary exposures were estimated. Any potential risk to average consumers was characterized by comparing these dietary estimates to international health standards such as the acceptable daily intake (ADI) for pesticides, provisional tolerable weekly intake (PTWI) for contaminants or recommended dietary intake (RDI) for nutrient elements.

For pesticides, 94% of estimated dietary exposures were less than 1% of the ADI. Most pesticides dietary exposure estimates were trending down, and all were well within internationally established health standards.

For the five contaminant elements, the estimated dietary exposures were all well within the PTWI. Since the PTWI represents a level of tolerable risk for lifetime exposure, the contaminant dietary exposure in the 1997/98 NZ total diet studies were considered to be unlikely to have any adverse health implications for the general NZ population. The effectiveness of risk management strategies, such as discouraging use of lead

solder in canned foods, and phasing out of lead in petroleum products, was clearly evident in the downward trend of estimated lead dietary exposures found over successive NZ total diet studies.

For iodine, intakes are below the Australian RDI and the US RDA, but discretionary salt was not considered in the NZ total diet study, so intakes may be underestimated. Continued monitoring of iodine intake and status is considered imperative. Selenium intakes had increased since the last NZ total diet study and do not represent a risk to public health.

NZ total diet study reports can be found at: <http://www.moh.govt.nz>, then go to Online Publications, then to March 2000, then to 1997/98 New Zealand Total Diet Survey

14. Update on US FDA's Total Diet Study

Ms Katie Egan, US FDA, Washington D.C., USA

The US FDA has conducted its total diet study continuously since 1961. The current programme consists of 4 regional market baskets each year. In each market basket, samples of about 280 foods are collected in 3 cities within the region and 3 individual samples of each food are composited for analysis. The foods are analysed for a wide range of analytes: pesticide residues, industrial chemicals, radionuclides, elements, folate and dioxins. Dietary intakes are calculated for 14 age-gender groups based upon food consumption data collected by the US Departments of Agriculture and Health and Human Services. Results of the analyses are available on the total diet study website at www.cfsan.fda.gov (go to Programme Areas / Pesticides and Chemical Contaminants and Total Diet Study). Dietary intakes for elements have recently been published in "Food Additives and Contaminants" Vol. 19, No. 2, pp 103-125 (2002).

15. Food Classification Systems

Dr Barbara Burlingame, FAO, Rome, Italy

An important first step in ensuring that food data of all types can be compared is to have a common food classification and descriptor system. Several different and incompatible classification systems are in use. These include Codex classifications for additives, another for pesticide residues, the system used in Food Balance Sheets and the other agriculture statistical databases, various systems used by national and regional food composition database developers, and other systems for use with food intake surveys. Standards to facilitate international comparisons of food data sets have been developed and proposed to the international community. Among those systems are INFOODS Guidelines, Eurocode, Languag and others. No single system has received universal acceptance. FAO and United Nations University will convene an expert consultation involving experts from a number of speciality areas including total diet surveys, to re-examine the needs of data generators, data compilers and data users, and make recommendations on a single system or minimum set of guidelines which can be adopted by all.

Reference: www.fao.org/infoods/tech/nomen.htm

16. GEMS/FOODS International Dietary Consumption Patterns

Dr Barbara J Petersen², Novigen Sciences, Washington D.C., USA

The WHO GEMS/Food Regional Diets (WHO, 1989) are being revised as a result of recommendations of an FAO/WHO expert consultation (FAO/WHO, 1995) in order to develop more comparable food consumption data for countries throughout the world. Available data were reviewed and the FAOSTAT Food Balance Sheets (FBS) were determined to be the most widely available and comparable data on a worldwide

² With Dr Leila M Barra

basis (more than 125 countries provide information using similar methods). The FBS are based on the amount of food utilized and allow estimates, on a national basis, of per capita daily intake. However, intake by subgroups cannot be estimated.

New regional diets were created through a 3-step process. A standard statistical tool, (cluster analysis) was used to group countries according to the contribution of staples to their population's diets. Examples include countries with high fish, high corn, or high wheat intakes. The cluster analysis identified 9 major dietary patterns, based on the staple foods; the dietary patterns were not as similar when other chief components were evaluated. Therefore, the groups were further sub-divided based on geographical region, e.g. high corn Africa and high corn Latin America. Thirteen dietary patterns (cultural/regional groups) were identified at this stage.

The next step was to derive estimates of intake of the different food groups in each of the 13 cultural/regions diets based on a weighted average of the intakes of each food groups as reported in the FBS. These estimates were created by weighting each country's contribution by its population so that countries with the largest population have the largest contribution to the cultural/regional diet.

The revised diets were reviewed by national governments under the auspices of the Codex Committee on Pesticide Residues. The 13 cluster consumption diets provide an international tool for evaluating consumer intakes of nutrients, contaminants, pesticides, mycotoxins and other components of food.

17. Generating, Compiling and Using Food Composition Data in Developing Countries

Dr Barbara Burlingame, FAO, Rome, Italy

Reliable data on the composition of foods consumed are critical in many areas – health assessment, the formulation of appropriate institutional and therapeutic diets, nutrition labelling, food regulations, food safety, consumer protection and many other areas.

International Network of Food Data Systems (INFOODS) was established in 1984 on the basis of the recommendations of an international group convened under the auspices of the United Nations University (UNU). Its goal was to stimulate and coordinate efforts to improve the quality and availability of food analysis data worldwide and to ensure that anyone anywhere would be able to obtain adequate and reliable food composition data. In furtherance of these purposes INFOODS, now operating its secretariat from FAO, has provided leadership and administrative framework for the development of standards and guidelines for collection, compilation, and reporting of food component data. It is establishing and coordinating a global network of regional data centres directed toward the generation, compilation and dissemination of accurate and complete data on food composition. It is also the generator and repository of special international data bases and serves as a general and specific resource for persons and organizations interested in food composition data on a worldwide basis. The INFOODS effort is intrinsically interdisciplinary, depending on the efforts of food scientists, analytical chemists, and nutritionists working together with computer and information scientists. Reference: www.fao.org/infoods

18. Development of Food Lists, Diets and Design in the New Zealand Total Diet Survey.

Ms Jenny Reid, MoH, Wellington, New Zealand

New Zealand has undertaken periodic total diet surveys since the mid 1970's. A total of 5 surveys have been completed, with the sixth survey in its planning stages. The total diet study has been an essential component of monitoring the safety and adequacy of the average New Zealand diet.

Over the life of the total diet study a number of improvements have been made. These include:

- a move from composite foods to individual foods;

- increased number of foods and food groups;
- increased number of population groups evaluated; and
- combinations of common foods as well as high-risk foods.

Many of the improvements to the total diet studies have resulted from improvements in other data sets feeding into the total diet studies. These include robust food consumption data which enable the development of representative food lists (currently 114 foods) and food groups (currently 11 groups). The development of 14-day simulated diets for each of the population groups has provided a more realistic range of food intakes. These data have been based on national food consumption data wherever possible. The sixth total diet study is in its planning stages which will include a review of the food list and simulated diets to reflect the most recent food consumption data.

19. Food Consumption Surveys

Dr Barbara Burlingame, FAO, Rome, Italy

There are many reasons for conducting a food consumption survey, including:

- to assess the adequacy and safety of the food supply;
- to assess the intakes and exposures of groups or individuals;
- to establish policies in agriculture, trade and health; and
- to examine the relationship between diet and disease.

The same survey results can be used for more than one assessment, and multiple databases (e.g. nutrients, contaminants, pesticide residue) can be linked to the survey data. Choice of method is dictated by quality of the data required, and the available resources. FAO Statistical Databases (e.g. Food Supply and Food Balance Sheets), allow for a quick assessment of the consumption patterns and food intakes at the national level. In addition to providing a quick assessment, they are also useful in establishing food lists for more detailed surveys, such as Food Frequency Questionnaires (FFQ), and for establishing the key foods for chemical analysis. FFQ is an example of a retrospective survey method, and is among the least costly. The other common retrospective survey method is the 24-hour recall. Prospective surveys can also be used, but are typically more expensive. Diet histories, weighed inventory and duplicate diet involve recording intake quantitatively at the time of intake, and in the case of duplicate diet, the subsequent chemical analysis of the foods actually consumed.

20. Analytical Issues Related to Organics

Mr Chris A. Sack, US FDA, Sawnee Mission, Kansas, USA

Many issues surround the emerging development of international total diet studies. In this presentation three specific issues are targeted for consideration: scope of analytes, choice of analytical technology, and quality assurance procedures and controls. A total diet study analytical programme should include, at minimum, the analysis of Stockholm Convention's 12 persistent organic pollutants (POPs). Immediate analyte expansion would best include organohalogen and organophosphate pesticides by multiresidue methods. Organonitrogen pesticides might also be analyzed with minimal effort. Once multiresidue methods have been implemented selective residue methods may be employed including carbamates, volatile organic compounds, chlorophenoxy acid herbicides, phenylurea herbicides, sulfonylurea herbicides, benzimidazole fungicides, paraquat/diquat, glyphosate, volatile organic compounds, and new water-soluble pesticides. Additional analyses might include mycotoxins, radionuclides, vitamins, food additives, polybrominated diphenyl ethers, PAHs, fatty acids and total fat.

Technology is quickly evolving from selective detection on gas chromatographs (GCs) and high-pressure liquid chromatographs (HPLCs) hyphenated mass spectrometry (MS) determination. Currently, gas

chromatographers are using capillary columns with efficiencies upwards of 10^6 theoretical plates. Selective detectors are used to screen for specific heteroatoms included in analyte structures such as halogens for organohalogen compounds. Similarly, liquid chromatographers are using more efficient columns with selective detection, such as UV/Vis, fluorescence, and post-column derivitization. Multiple determinations using different chromatographic parameters are required for positive identification. Because MS detection includes spectral identification, analytes can be identified and quantitated in a single determination. However, a disadvantage of MS detection is its universal nature. At levels less than about 1 ppm, sample matrices interfere with the detection of targeted analytes. Programmed selective ion monitoring (SIM) is effective to eliminate undesirable matrix responses, but with the trade-off of selecting specific analytes for analysis. Using hyphenated MS techniques (GC/MS, GC/MS/MS, HPLC/MS, and HPLC/MS/MS) is more expensive and requires considerably greater operator skill.

ISO 17025 “General Requirements for the Competence of Testing and Calibration Laboratories” is the new quality standard required for laboratory accreditation. Two important issues addressed by the standard include method validation and the new “Uncertainty of Measurement” reporting requirement. The Joint FAO/WHO Codex Committee on Methods of Analysis and Sampling (CCMAS) agreed in March, 2001 that while collaborated methods are preferred, in light of the difficulty of collaboration of quickly advancing technology, within-laboratory validated and performance based procedures with QC charts (as required by ISO 17025) are acceptable. As written in ISO 17025 uncertainty of measurement must be calculated based upon the summed uncertainties of each component of a procedure (component approach). However, the CCMAS agreed in March 2001 that statistical evaluation of quality control data (QC approach) would be acceptable. Currently, accrediting bodies are devising acceptable procedures for determination and reporting of uncertainty of measurement by both approaches. Other QA issues include the selection of appropriate QCs, participation in proficiency samples testing programmes, international analyst training, and total diet studies data publication.

21. Analytical Issues Related to Elements

Mr Duane Hughes. US FDA, Sawnee Mission, Kansas, USA

Mr Hughes’ presentation was designed to assist scientists from developing countries with decisions relevant to initiating a total diet elemental analysis programme. Areas discussed included costs, maintenance expenditures, ancillary equipment purchases, and training considerations. Also presented were discussions relating to contamination control in the laboratory, difficulties encountered in sample homogenization, and sample mineralization.

A number of limitations and problems with differing instrument types were presented, along with suggestions for alleviation of the problems, most notably, those of interferences in GFAAS operations.

22. An Expert System for the Evaluation of Quality of Analytical Data

Mr Pieter Scheelings, QHSS, Brisbane, Australia

Analytical measurements not only underpin quality control in manufacture and industry but the analytical data often support an array of decisions relating to public health, international trade, environmental land and water remediation and occupational health and safety. At times these decisions are made by programme managers unaware of the scientific limitations of these measurements or are too far removed from laboratory operations to question the appropriateness of the technology. Consequently, analytical results are often accepted on trust or with only a sketchy understanding of the analytical processes or quality controls.

External accreditation schemes which measure laboratory compliance against international standards such as ISO/IEC 17025 and ISO 9000 Quality Systems have set benchmark operational standards for laboratories

whilst the increasing support for participation in inter-laboratory trials and proficiency studies provide objective performance measures for specific areas of analyses. It is generally acknowledged however that performance in external audits and proficiency studies is likely to represent the optimal performance of a laboratory or analyst. There is no guarantee however that this level of performance is maintained consistently by laboratories during routine operations. The submission of monitors, blind duplicates or split samples to several laboratories can provide clients with some additional assurance on laboratory reliability or analyst competence. Consistent and competent performance are therefore key indicators to a laboratory's quality reputation. This reputation together with price, capability range and responsiveness are the primary considerations for clients in the selecting of contract laboratories. There is however an inverse relationship between quality, price and sample turn-around time as, in most cases, the commercial laboratory needs to balance its financial performance with client expectations. Customers will use laboratories based on their quality perceptions of the laboratory and their understanding of the reliability of analytical data.

To ensure that only data of acceptable reliability is collated, compilers of food composition data at the US Department of Agriculture have addressed this 'tension' by developing an expert system to evaluate the quality of analytical data on nutrients in foods generated and supplied by different laboratories. This expert system is based on the application of a numerical rating system for each of the five key activities which make up the analytical process, viz., the analytical method, analytical quality control, number of samples, sample handling and the sampling plan. This presentation explores the potential for more general application of this system to analytical chemistry and specifically to programmes such as total diet studies where data may be provided by a number of laboratories with uncertain or unknown reputation.

23. Questionnaire to Assess Quality Assurance and Control of Sampling and Analysis of Submitted Data

Dr Samuel Page, WHO, Geneva, Switzerland (presented by Dr Gerald Moy)

The recognition by the World Trade Organization and its Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) of the health and safety requirements of the Codex Alimentarius Commission is based on the scientific risk assessments carried out by FAO/WHO expert advisory bodies, such as JECFA and JMPR. Recently, JECFA has evaluated the safety of certain mycotoxins, including risk assessment of various exposure scenarios. During this process, the reliability and comparability of data used by JECFA raised questions about the variability and uncertainty of the evaluations. In order to provide a better basis for considering the data used by JECFA, a questionnaire was developed, which attempts to ascertain details on both sampling procedures and analytical methods used to generate the data. The questionnaire, which is attached as an annex to the GEMS/Food document "Manual for the Electronic Reporting of Data on the Chemical Contamination of Food", is available on the WHO Web site (<http://who.int/fsf/>). The questionnaire will be used by JECFA experts to assess both aggregate and individual data submitted to JECFA.

24. Electronic Reporting of Data to GEMS/Food

Mr Peter J Cressey, ESR, Christchurch, New Zealand

Electronic media provide a convenient means for submitting data on contaminants in foods (OPAL I) and dietary exposure to contaminants (OPAL II). Submitted data in electronic form offers advantages with respect to accuracy, flexibility, consistency and convenience of the submission process.

OPAL data fields represent basic data which would normally be identified during food surveillance or total diet studies. However, some further clarification/discussion around fields related to representativity of samples, quality control, LOD/LOQ and study types appears desirable.

Data can be submitted through generation of export files from a local version of OPAL or in the form of spreadsheets or ASCII files.

25. GEMS/Food Global Databases

Mr Lawrence Grant, WHO Consultant, Geneva, Switzerland

Mr Grant presented the GEMS/Food global databases and the procedures and software to enable data collection and dissemination. GEMS/Food collects (a) aggregate data on contaminants in individual food commodities, (b) dietary intakes of contaminants from total diet studies, and (c) individual measurements of contaminants in food commodities. The structure and definition of these data collections were given. Emphasis was given to the harmonization between existing national databases and GEMS/Food to facilitate data transfer and promote data quality. Formal procedures for data transfer were presented and are given in the document GEMS/Food Data Collections Including Instructions for the Electronic Submission of Data. The OPAL (Operating Programmes for Analytical Laboratories) software was presented. This software provides a means for countries that have not automated their monitoring data systems to collect, collate, analyze and disseminate data at the national level. The suite of OPAL programmes consists of OPAL I for aggregate data on contaminants in foods, OPAL II for total diet studies and OPAL III, which is a prototype system for individual measurements of contaminants in foods. Mr Grant stressed the compatibility and inter-relationships of the three systems. Contributions from national databases are stored in a global GEMS/Food database at WHO, Geneva. Dissemination of these data is enabled through the Internet based tool WHO/SIGHT, which allows navigation over statistical databases and document collections. Several examples of accessing GEMS/Food data by WHO/SIGHT were given.

26. Dietary Exposure Assessment Modelling

Tracy Hambridge, ANZFA, Canberra, Australia

Dietary modelling is the process of combining food consumption data and food chemical concentration data to estimate dietary exposure to food chemicals. Estimated dietary exposures are compared to reference health standards to determine the risk to health of a population. Dietary modelling is used for a variety of areas at ANZFA, including food regulatory measures, monitoring and surveillance e.g. the Australian Total Diet Survey, food consumption data, and provision of information and dietary exposure assessments for international bodies, such as Codex and JECFA.

Dietary modelling is used for total diet surveys to estimate dietary exposure to food chemicals for the population, from table ready foods. A lot of data are required to conduct dietary modelling, and a lot of planning and manipulation of that data must be done before dietary modelling commences. For example, population groups to be assessed (based on age, gender, geographical region or dietary pattern) must be selected.

Representative food chemical concentrations for each commodity/chemical combination are determined from analytical results. The treatment of “not detected” results will affect the estimated dietary exposures. Model diets need to be prepared; the Australian total diet study uses individual dietary records from the 1995 National Nutrition Survey (NNS). Foods consumed in the nutrition survey are ‘mapped’ or matched to foods analysed for the total diet survey. NNS foods are given ‘food adjustment factors’ to convert them to the equivalent amount of the total diet study food analysed, e.g. raw rice to cooked. For NNS foods that cannot be directly mapped to an Australian total diet study food, such as mixed foods, recipes are developed. Estimated dietary exposures are compared to reference health standards. Results reported (e.g. all respondents versus consumers only, means, medians, high percentiles, and percent of total exposures for each food group) depend on the objectives of the survey.

DIAMOND (**DI**etary **M**odelling **O**f **N**utritional **D**ata) is a computer programme, developed by ANZFA, to conduct dietary exposure assessments. DIAMOND can run models for a range of food chemicals, including food additives, pesticide residues, contaminants, nutrients and food ingredients. There are a number of different models, based on different assumptions (budget method, high consumer, individual dietary records) that can be run, depending on the outcome required for the dietary exposure assessment.

The assumptions made during the process, and the limitations of the data and methodologies used must be considered when interpreting the estimated dietary exposure results.

27. Overview of Queensland Health Scientific Services (QHSS)

Dr Pieter Scheelings, QHSS, Brisbane, Australia

As the host for the Workshop, Director Professor Michael Moore and staff of Queensland Health Scientific Services (QHSS) are pleased to welcome participants to its Coopers Plain laboratory. QHSS operates within the Health portfolio of the state of Queensland. Its' primary role is to provide analytical, research and advisory support services in public health and forensic science. These services cover the broad range of scientific disciplines of chemistry, microbiology, virology, toxicology, forensic biology and pathology. A co-tenant of the laboratory is the National Research Centre for Environmental Toxicology which undertakes complementary research activities. QHSS has several links with WHO as a WHO/FAO/OIE Collaborating Centre for Leptospirosis and a WHO Centre for Arbovirus Reference and Research.

QHSS also has important linkages with universities and organizations such as the Asia Pacific Food Analysis Network (APFAN) which is a minor sponsor of this workshop. APFAN is a network of food analysts and scientists from the Asia-Pacific region although it has a number of members from the African continent. Its' objective is to promote reliable food analysis in developing countries thereby supporting food safety and good nutrition. APFAN provides a valuable link between food scientists in the asia-pacific region and can assist in the promotion and development of total diet study programmes particularly through its training workshops on analytical methods and quality control. It is hoped that WHO and APFAN can work in partnership to improve the technical knowledge and skills of food scientists and assist in the development of total diet studies in the region.

28. Planning a Total Diet Study

Dr Richard Vannoort, ESR, Christchurch, New Zealand

A basic approach to planning a total diet study was outlined. The presentation focused on three key aspects: objectives, management and components of a total diet study.

The objectives of a total diet study need to be clear and unambiguous, while also being realistic and achievable in the timeframe, with the resources and expertise available. The primary objective is to estimate dietary exposure to selected pesticides residues, contaminants and nutrients, and thus assess any associated health implications. Other objectives relate to use of food concentration data and exposure estimates, whether considering trends over time, between countries, or submitting them to WHO GEMS/Food, stakeholders, Codex or using them in the setting of food standards.

To manage a total diet study effectively, there should be one overall coordinator. All members should have their roles clearly defined, and lines of communication should be well understood. A total diet study is a large and complex project with many components. It very much involves a team approach, with the success of the overall project only being as good as the weakest link in the chain.

The many components of a total diet study were discussed, namely: planning, indicative budget, scoping the food list, scoping the organic and inorganic analyses and specific analytical considerations, such as the limit of detection being adequate to provide meaningful exposure estimates. The paramount importance of quality assurance and quality control was emphasized as another key component of a total diet study, as were the analytical plan (which foods for which analyses, which individually analysed and which composited), the sampling plan, sampling, sample preparation, sample containers and sample analyses. With such a large project, an effective risk minimization strategy suggested was to do a small pre-test of all systems for 2-3 foods for sampling, preparation, and analyses. Other key components of a total diet study identified were data evaluation, statistics, the possible need for re-analysis, consumption data, exposure/intake estimates, and risk characterization. Of course, interpretative reports need to be written, peer reviewed, and then effective risk communication (and possibly risk management) undertaken. Standard operating procedures were seen as an important and fundamental component of a successful total diet study.

29. Preparing a Total Diet Study Project Timeline (Tutorial)

Dr Richard Vannoort, ESR, Christchurch, New Zealand

While appreciating that the planning the component parts of a total diet study is important, its implementation must be coordinated to assure the overall project functions smoothly. The inter-dependence of components must be recognized (one cannot prepare samples until after they have been sampled, obviously). A total diet study timeline was organized in the form of a spreadsheet with the help of workshop participants.

A copy of the NZ total diet study procedures manual was provided to participants, and its key aspects highlighted. This is an invaluable resource for starting out in planning a total diet study. An example of a complete NZ total diet study timeline is contained on page 68 & 69 of the NZ total diet study procedures manual.

30. Sampling Introduction to General Issues

Dr Richard Vannoort, ESR, Christchurch, New Zealand

The varying components of sampling in a total diet study were considered in regards to the questions; which foods?; who samples?; when?; where?; how?; and budget? In regard to which foods to sample, it was pointed out that the food list should identify the most important foods to the general population, foods relevant to population sub groups, and those of specific concern for contaminant content (e.g. liver, shellfish). The numbers of foods in the list and whether the total diet study was based on an individual foods approach or food groups composite approach were discussed for New Zealand, Czech Republic, Australia, UK and USA. Possible food groupings/subgroupings were also detailed.

Sampling can be carried out by sampling officers or private contractors, but it is important they know how important they are to the success of the total diet studies project, and that they do their job effectively. Standard Operating Procedures (SOPs) are seen as an important part of helping all concerned fulfil their roles.

Sampling should be coordinated with sample preparation and analyses. It was suggested that sampling occurs over a number of weeks, as this is usually most effective for managing large volumes of food. Sampling should ideally be at the beginning of the week to allow sample preparation to occur later that same week. Sampling should consider regionally as well as nationally produced and distributed food.

Sampling should be as representative as possible. Weights of food samples to be purchased are worked back from amounts needed for analyses, whether foods are to be analysed individually or composited, and also considering extra amounts needed for duplicates, reserve samples, and processing losses. Sample details to

record were suggested, as were sample identification labels and purchasing check lists. Procedures for purchasing amounts, sample handling and transportation were also described.

The total diet studies budget must, of course, include purchase costs of foods and equipment, such as payment for samples, insulated containers and coolants and transportation costs. Sampling is a critical part of a successful total diet study and it must be planned and managed effectively.

31. Sampling Plan Tutorial

Dr Richard Vannoort, ESR, Christchurch, New Zealand

The previous lecture on sampling in a total diet study was put into practice when workshop delegates were given a food list and asked to identify which foods would need cooking or special analyses. They were then asked to organize a 4 week sampling schedule. They had to try to keep foods of a similar group together as much as possible, while also bearing in mind the need to keep a relatively uniform distribution of weights of foods to be sampled and transported each week. In addition, they had to also consider keeping the amount of subsequent food preparation relatively constant each week. It proved a thought provoking and useful exercise.

32. FAO's Role and Activities: Assessing the Food Supply

Dr Barbara Burlingame, FAO, Rome, Italy

The Food and Agriculture Organization of the United Nations (FAO) has a history of activities in assessing the food supply that goes back to its founding constitution. Article 1.1 says: "The Organization shall collect, analyse, interpret and disseminate information relating to nutrition, food and agriculture." This includes information on nutrients, additives, contaminants and pesticide residues, among other data sets. The roles and responsibilities of WHO and FAO are complementary. Important activities for effectively assessing the food supply include FAO's work in food consumption surveys, food composition under the auspices of INFOODS (International Network of Food Data Systems), and Food Supply and Food Balance Sheet databases. Enhancing collaboration between FAO and WHO will be important for the international community, and will ensure that standards are developed and all types of food data can be put to their most effective use to improve food security in the world. Further information is available at: www.fao.org

33. Food Consumption Data Using GEMS/Food Diets

Dr Gerald Moy, WHO, Geneva, Switzerland

Estimates of food consumption based on GEMS/Food diets are used at the international level by JECFA and JMPR in assessing exposure to contaminants and pesticide residues, respectively. GEMS/Food Regional Diets were initially developed to assess exposure to radionuclides following the Chernobyl disaster and have been used since 1989 to estimate long-term exposure to residues of pesticides that are considered by the Codex Alimentarius Commission. More recently, the JECFA and the Codex Committee on Food Additives and Contaminants have used GEMS/Food Regional Diets to assess exposure to selected mycotoxins and contaminants.

The five Regional Diets include Africa, Europe (including North America, Australia and New Zealand), Far East, Latin America and Middle East. The diets include about 350 primary and semi-processed agricultural commodities which are coded according to the Codex Classification System for Food and Animal Feed. In order to more accurately represent consumption patterns in Member States, GEMS/Food has undertaken the develop of 13 Consumption Cluster Diets based on a statistical approach for grouping countries based on consumption of 36 basic foods and food groups. The refinement of these diets is being undertaken to

included the approximately 350 foods in the current diets. These diets may be useful to countries which do not have detailed food consumption data for their countries.

In addition, GEMS/Food maintains a large portion food consumption database, which is comprised of the highest reported 97.5th percentile consumption (eaters only) of various food items for the general population and children ages 6 and under. This data is used to calculate the International Estimated Short-Term Intake (IESTI) for pesticide residues. To date, such data have only been reported from France, Japan, the Netherlands, United Kingdom and United States. All countries in possession of such data are requested to submit such data if the consumption of a food (expressed on a gram per kilogram body weight basis) exceeds the amount currently listed in the database. The database can be seen at <http://who.int/fsf>.

34. Sample Preparation – General Issues

Dr Richard Vannoort, ESR, Christchurch, New Zealand

The point was reiterated that total diet studies are set apart from agricultural commodity surveys, in that foods are prepared ready for consumption. Sample preparation is thus another critical link in the chain of success of a total diet study. To ensure consistency, Standard Operating Procedures (SOPs) are considered essential.

SOPs should address such issues as sample receipt procedures, sample receipt check lists, appropriate documentation that needs to be undertaken, pre-sorting samples and prioritizing foods on receipt for sample preparation. SOPs need to explain suitable equipment to be used for sample preparation, acceptable containers and labels for prepared samples, the need for reserve samples, contamination control and whether an individual foods or food group composite approach is being undertaken. SOPs should provide explicit instructions on how to prepare each food, whether to keep brands/regions/seasons separate or to composite them, and which foods are to go for which analyses. Prepared foods should be checked off when dispatched, and their receipt at the analytical laboratory confirmed.

35. Internet and Other Information Resources

Dr Jorma T. Kumpulainen, ARF, Jokioinen, Finland

Previously, scientific research databases have been available mainly as CD-ROM versions that a research centre must order from database providers. Recently, however, there has been a very rapid change towards Internet databases and scientific Web-publications. Furthermore, the so-called “selective dissemination of information” feature, lets an authorized user save a search and have it rerun automatically, with the results e-mailed to that user. Moreover, some of these information sources are available free of charge, such as titles and in some cases even abstracts of publications. In addition, the Web- editions of publications typically appear 1-2 months earlier than the same paper versions. This trend is going to increase in the future, thus making it faster and easier for scientists to obtain information on research results. The paper described the most important providers of Web-based databases and journals and gave examples on how to use them in the field of total diet research and food analytical chemistry.

ANNEX IV

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**GEMS/FOOD-EURO LISTS OF PRIORITY CONTAMINANTS AND FOODS
(AS REVISED AUGUST 2001)**

GEMS Core List

Contaminants	Food
aldrin, dieldrin, DDT (<i>p,p'</i> - and <i>o,p'</i> -), TDE (<i>p,p'</i> -), DDE (<i>p,p'</i> - and <i>p,o'</i> -), endosulfan (α , β and sulfate), endrin, hexachlorocyclohexane (α and β and γ), hexachlorobenzene, heptachlor, heptachlor epoxide and polychlorinated biphenyls	whole milk, butter, animal fats and oils, fish, cereals*, human milk
lead	milk, canned/fresh meat, kidney, cereals*, canned/fresh fruit, fruit juice, spices, infant food, drinking water
cadmium	kidney, molluscs, crustaceans, cereals*
mercury	fish
aflatoxins	milk, maize, groundnuts, other nuts, dried figs
diazinon, fenitrothion, malathion, parathion, methyl parathion, methyl pirimiphos	cereals*, fruit, vegetables
inorganic arsenic	drinking water

* or other staple foods

GEMS Intermediate List

Contaminants	Food
aldrin, dieldrin, DDT (<i>p,p'</i> - and <i>o,p'</i> -), TDE (<i>p,p'</i> -), DDE (<i>p,p'</i> - and <i>p,o'</i> -) endosulfan (α , β and sulfate), endrin, hexachlorocyclohexane (α and β and γ), hexachlorobenzene, heptachlor, heptachlor epoxide, chlordane and polychlorinated biphenyls (congeners No. 28, 52, 77, 101, 105, 114, 118, 123, 126, 138, 153, 156, 167, 169, 180 and 189)	whole milk, dried milk, butter, eggs, animal fats and oils, fish, cereals*, vegetable fats and oils, human milk, total diet
lead	milk, canned/fresh meat, kidney, fish, molluscs, crustaceans, cereals*, pulses, legumes, canned/fresh fruit, fruit juice, spices, infant food, total diet, drinking water
cadmium	kidney, molluscs, crustaceans, cereals*, flour, vegetables, total diet
mercury	fish, fish products, total diet
aflatoxins	milk, milk products, maize, cereals*, groundnuts, other nuts, spices, dried figs
diazinon, fenitrothion, malathion, parathion, methyl parathion, methyl pirimiphos, chlorpyrifos	cereals*, vegetables, fruit, total diet
aldicarb, captan, dimethoate, folpet, phosalone	cereals*, vegetables, fruit, total diet,
radionuclides (Cs-137, Sr-90, I-131, Pu-239)	cereals*, vegetables, milk, drinking water
nitrate/nitrite	leafy vegetables, drinking water
inorganic arsenic	drinking water

* or other staple foods

GEMS Comprehensive List

Contaminant	Food
aldrin, dieldrin, DDT (<i>p,p'</i> - and <i>o,p'</i> -), TDE (<i>p, p'</i> -), DDE (<i>p,p'</i> - and <i>p,o'</i> -) endosulfan (α , β and sulfate), endrin, hexachlorocyclohexane (α and β and γ), hexachlorobenzene, heptachlor, heptachlor epoxide, chlordane, polychlorinated biphenyls (congeners No. 28, 52, 77, 101, 105, 114, 118, 123, 126, 138, 153, 156, 167, 169, 180 and 189), and dioxins (PCDDs and PCDFs)	whole milk, dried milk, butter, eggs, animal fats and oils, fish, cereals*, vegetable fats and oils, human milk, total diet
lead	milk, canned/fresh meat, kidney, fish, molluscs, crustaceans, cereals*, pulses, legumes, canned/fresh fruit, fruit juice, spices, infant food, total diet, drinking water
cadmium	kidney, molluscs, crustaceans, cereals*, flour, vegetables, total diet
mercury	fish, fish products, mushrooms, total diet
Aflatoxins	milk, milk products, maize, cereals*, groundnuts, other nuts, spices, dried figs
Ochratoxin A	wheat, cereals, wine
Dioxynivalenol	wheat, cereals
Patulin	apple juice
Fumonisin	maize, wheat
diazinon, fenitrothion, malathion, parathion, methyl parathion, methyl pirimiphos, chlorpyrifos	cereals*, vegetables, fruit, total diet
aldicarb, captan, dimethoate, folpet, phosalone	cereals*, vegetables, fruit, total diet
Dithiocarbamates	cereals*, vegetables, fruit, total diet, drinking water
Radionuclides (Cs-137, Sr-90, I-131, Pu-239)	cereals*, vegetables, fruit, total diet, drinking water
nitrate/nitrite	leafy vegetables, drinking water
inorganic arsenic	drinking water

*or other staple food