FOOD COMPOSITION HARMONISATION

IN INTERNATIONAL NUTRITION

PROGRAMME MANAGEMENT

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ABSTRACT

Food Composition Harmonisation in International Nutrition Programme Management

Food composition data underpin some of the most fundamental activities in nutrition. Yet these data are being generated, compiled, disseminated and used without a consistent approach, cohesive framework or proper management guidelines. The International Network of Food Data Systems (INFOODS) was established to address these problems.

The aim of this thesis was to examine the concept of the international food composition programme management framework, and extend that concept specifically as it relates to harmonisation issues, into the next stages of elaboration. The research focus was to identify the issues, analyse the problems, and propose solutions.

The management challenges identified and analysed included technical harmonisation issues, inter-sectoral coordination of activities, infrastructural capacity-building, and establishing broad inter- and intra-agency affiliations.

The two technical harmonisation issues most critical to achieving success were identification of foods, including development of standards and guidelines for food nomenclature, terminology, descriptions, images, and associated documentation; and identification of food components, including all the methodological and documentation considerations. The development of these standards required coordination at the international level, and implementation regionally and nationally.

The significant sectors involved in food composition activities included health, agriculture and trade. Each had its own dominant area but the overlaps were significant, and in many cases, coordination of the sectors was not achieved, even at the national level. This led to inefficient use of resources and the production of data that was not suitable for all required purposes. Pursuing greater coordination between sectors led to better allocation of funds for all the activities, and ultimately addressed some of the significant infrastructural problems which were largely related to resource restriction. Trade was shown to be the sector presenting the most demanding of the harmonisation requirements.

Affiliation required liaison and agreements with international agencies involved in different — or the same — aspects of food composition work. For food composition harmonisation issues, the Codex Alimentarius Commission, the World Trade Organization, and AOAC International were identified as being most relevant for INFOODS to pursue on behalf of the food composition community. Many other aspects of affiliation were identified at the regional and national levels.

The INFOODS concept was endorsed as the appropriate framework; with national food composition programmes contributing to and cooperating with regional data centres, which facilitated a coordinated approach to food composition activities for a group of countries; and with a global secretariat undertaking the work of international coordination. Although the concept was endorsed, the framework and the activities required more development.

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I would also like to thank the INFOODS Regional Data Centre Coordinators from 18 regions and subregions, and the many people working in national food composition programmes around the world, for participating in focus groups sessions and responding to questionnaires.

Acknowledgment and thanks is due to the members of New Zealand's national Food Composition Steering Committee who, over the ten years of my involvement as the programme leader for New Zealand's food composition programme, have provided advice and guidance for the programme's effective operation; to Professor Mary Earle, who has been an inspiration and role model for me and many women in science in New Zealand, for her encouragement both in her capacity as professor of food technology and as a director for Crop & Food Research; and to Dr Fred Potter, biometrician with Crop & Food Research, for some of the statistical analyses and interpretation.

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PREFACE

When contemplating pursuing a PhD, I was faced with the dilemma of seeking further qualifications in the scientific discipline in which I was already academically trained and practising (nutrition science), or developing new and formal skills in a field in which I was working (science management) but for which I had no academic training. I chose the latter. In order to ready myself to pursue this doctorate degree in the Department of Management, I undertook course work in Massey's business faculty, taking one postgraduate level paper a year for six years since 1988. The first five papers were in marketing, organisational behaviour, accountancy, public policy and food law, and for these I earned a postgraduate diploma in business and administration. The next year I took an additional postgraduate paper in organisations and management, and upon completion, I began preparing this thesis in earnest.

Being more familiar with experimental research as a nutrition scientist, I found the research methodologies in management unfamiliar. I decided to use several techniques in my research approach: interviews, focus groups, case studies, surveys, and analysis of many official, governmental, and legal documents.

The approach of this thesis is to examine the concept of the international food composition programme management framework, and extend that concept specifically as it relates to harmonisation issues, into the next stages of elaboration. The research focus is to identify the issues, analyse the problems, and propose solutions.

Chapter 1, *Issues and context*, provides the basis of the thesis by identifying the pervasive and most commonly perceived difficulties in managing food composition programmes, and then classifying the activities and sectors to establish the framework for engaging and improving harmonisation.

Chapter 2, *Managing New Zealand's food composition programme,* addresses inter-agency disharmony with data generators and legislators, regional disharmony with our food composition partners in the region, and international disharmony with other nations, and non-government regulatory and policy agencies. Parts of this chapter were used in the presentation of invited papers at the 3rd Asia Pacific Food Analysis Network Conference in Manila in 1995 and New Zealand's annual Institute of Food Science and Technology Conference in Lincoln in 1996.

Chapter 3, *Harmonisation issues in identification of food*, involves analysis of the information management strategies currently in use, the problems encountered by various sectors of information users, and recommendations for practical and immediate means of dealing with the problems of food identification. The issues are food nomenclature and terminology systems, and imaging systems to complement these. Parts of this chapter were presented as an invited papers at the First International Food Data Conference, held in Sydney in 1993, and subsequently peer-reviewed and published by AOAC International; at the National Nutrient Databank Conference in St Louis in 1994; and, integrated with part of Chapter 5, at the 16^{th} International Congress of Nutrition in 1997.

Chapter 4, *Harmonisation issues in identification of food components*, involves a critical assessment of the systems currently in use, qualification and quantification of the problems created by lack of harmonisation using carbohydrates as the model food component, and recommendations for implementation of procedures for adopting the INFOODS standard. Much of this chapter was published in mid-1996 as original research in the international refereed Journal of Food Composition and Analysis.

Chapter 5, *Harmonisation for food legislation and food trade regulations*, examines international and other multi-lateral and bilateral trade agreements with implications for food composition information, identifying areas of disharmony and incompatibility, and assessing the impact of the disharmony where it remains unaddressed. Part of this chapter, integrated with part of chapter 3, was presented at the 16^{th} International Congress of Nutrition, and at a EUROFOODS technical workshop, both in 1997.

Chapter 6, *Tying it all together*, consolidates the issues and the problems and brings them into a management framework for an overall pragmatic solution.

This thesis is based on research I have undertaken in several capacities: the global INFOODS Coordinator (1994-present); regional data centre coordinator for OCEANIAFOODS, the INFOODS Regional Data Centre which includes New Zealand (1989-1992), as well as an OCEANIAFOODS member (1987-present); and national food composition programme leader for New Zealand (1987-present).

ACRONYMS AND ABBREVIATIONS

AACC	American Association for Clinical Chemistry
ANSI	The American National Standards Institute
ANZFA	Australia New Zealand Food Authority
AOAC	formerly, Association of Official Analytical Chemists
AOCS	American Oil Chemists' Society
ARev	Advanced Revelation
ASEAN	Association of South East Asian Nations
ASEANFOODS	INFOODS Regional Data Centre for ASEAN Countries
Austr	Australia
CAB	Commonwealth Agricultural Bureau
CAId	Component Aspect Identifier
CARKFOODS	INFOODS Regional Data Centre for Central Asian Republics and Kazakstan
CCITT	Consultative Committee on International Telegraph & Telephone
CCMAS	Codex Committee on Methods of Analysis and Sampling
CD	Compact Disk
CD-ROM	Compact Disk-Read Only Memory
CEECFOODS	INFOODS Regional Data Centre for Central and Eastern Europe
CER	Closer Economic Relations
CFR	Code of the Federal Regulations (USA)
cmt	Comment
COST	Cooperation in Science and Technology (Europe)
CRI	Crown Research Institute (New Zealand)
DCT	Discrete Cosine Transform
DF	Degrees of Freedom
DMSO	Dimethylsulfoxide
dpi	Dots per inch
DSIR	Department of Scientific and Industrial Research (NZ)
DV	Daily Reference Values (USA)
EC	European Community
EDTA	Ethylenediaminetetraacetate
ep	Edible portion
ESR	Institute of Environmental Science & Research (NZ)
EU	European Union
EUROFOODS	INFOODS Regional Data Centre for Western Europe
EuroNIMS	Proprietary name for the food composition data management software developed in the EUROFOODS Region

FAO	The Food and Agriculture Organization of the United Nations
FBS	Food Balance Sheets
FDA	Food and Drug Administration (USA)
FRST	Foundation for Research, Science and Technology (NZ)
g	Grams
GATT	General Agreement on Tariffs and Trade
GC	Gas chromatography
GEMS	Global Environmental Monitoring System
GIF	Graphics Interchange Format
GLC	Gas liquid chromatography
GULFOODS	INFOODS Regional Data Centre for the Arab Gulf States
HACCP	Hazard Analysis Critical Control Point
HEW	Health, Education and Welfare
HPLC	High performance liquid chromatography
HTML	Hypertext Markup Language
INCAP	Institute of Nutrition for Central America and Panama
INFOODS	The International Network of Food Data Systems
INT	INFOODS Nomenclature and Terminology
IP	Intellectual property
ISO	International Standards Organization
IU	International Units
IUNS	International Union of Nutritional Sciences
IUPAC	International Union of Pure and Applied Chemistry
JAOAC	Journal of the Association of Official Analytical Chemists
JPEG	Joint Photographic Experts Group
KB	Kilobytes
kcal	Kilocalories
kg	Kilograms
kJ	Kilojoules
K-W	Kruskal-Wallis One Way Analysis of Variance
LATINFOODS	INFOODS Regional Data Centre for Central and South America
LINZ	Life in New Zealand
MAF	Ministry of Agriculture and Fisheries (NZ)
MAFF	Ministry of Agriculture, Fisheries and Food (UK)
MASIAFOODS	INFOODS Regional Data Centre for Middle Asia
MB	Megabytes
mcg	Microgram (also μg)
ME	Monosaccharide equivalents
MEFOODS	INFOODS Regional Data Centre for the Middle East

MFAT	Ministry of Foreign Affairs and Trade (NZ)
mg	milligrams
MoH	Ministry of Health (NZ)
N	Nitrogen
NAFTA	North American Free Trade Agreement
NFA	National Food Authority (Australia)
NGO	Non-government organisation
NLEA	Nutrition Labeling and Education Act (USA)
NORAMFOODS	INFOODS Regional Data Centre for North America
NSP	Non-starch polysaccharides
NZ	New Zealand
NZICFR	New Zealand Institute for Crop & Food Research Ltd
OCEANIAFOODS	INFOODS Regional Data Centre for Australia, New Zealand and 22 Pacific Island countries
P	Probability
PCX	IBM PC Paintbrush Picture File
PGSF	Public Good Science Fund
PKZIP	Compression format by PKWare
RDI	Recommended Dietary Intakes
RE	Retinol equivalents
S	Friedman Statistic
SAARC	South Asian Association for Regional Cooperation
SAARCFOODS	INFOODS Regional Data Centre for SAARC Countries
SCI	Statement of Corporate Intent
SGML	Standard Generalized Markup Language
SPS	Sanitary and Phytosanitary
SRA	Social Responsibility Accounting
SVGA	Super Video Graphics Adaptor
TAS	Technical Assessment Systems Inc.
TBT	Technical Barriers to Trade
TFA	Total fatty acids
TIFF	Tag Image File Format
UNU	United Nations University
USDA	United States Department of Agriculture
VGA	Video Graphics Adapter
WCO	World Customs Organization
WHO	The World Health Organization
WTO	The World Trade Organization

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1. IDENTIFYING THE ISSUES AND ESTABLISHING THE CONTEXT

1.1 INTRODUCTION

Food composition activities are being undertaken by a variety of agencies, programmes/projects and people, for an ever-increasing number of reasons, without a cohesive framework or proper management guidelines. Many national, regional and international agencies acknowledge the importance of food composition data and the need to interchange information that is unambiguous and useful to all those who need it (Rand & Young, 1984; Rand *et al*., 1985; West, 1985; Lupien, 1994). Nevertheless, the majority of food composition data is inadequate, unreliable and cannot be interpreted properly (Rand *et al*., 1987; Burlingame, 1993a).

The International Network of Food Data Systems (INFOODS) was created in 1983 and has established itself with an organisational framework and international management structure that includes a global secretariat and regional data centres. Its goal is "to improve data on the nutrient composition of foods from all parts of the world, with the goal of ensuring that eventually adequate and reliable data can be obtained and interpreted properly worldwide" (Rand *et al*., 1987, 1991). Implied within the phrase "interpreted properly" is ***harmonisation*** and all its attendant issues.

Fundamental to INFOODS mission was to establish a network of coordinating centres in different parts of the world. Currently there are 17 centres in operation, including some which were created in the mid to late 1980's with well established and effective coordination (e.g. LATINFOODS, ASEANFOODS, OCEANIAFOODS, EUROFOODS); some which are relatively new, yet making progress (e.g. SAARCFOODS); and a few which have been newly created and are trying to establish their regional/national priorities and capabilities (CARKFOODS). The Regional Data Centres and the countries they represent are shown in Appendix 1.

It seems reasonable to expect that a certain amount of disharmony will exist between countries/regions, where different cultures, languages, and food composition priorities exist. However, disharmony and incompatibility in food composition programmes often exist to a surprisingly great extent within a single country, and even within a single organisation (Burlingame, 1996a).

Food composition harmonisation is a management problem for the INFOODS secretariat, for regional data centre coordinators and for national programme/project managers. There is also the important issue of the quality of the results from research projects, and getting the best value for investments made in food composition projects; and for this reason it is a management issue for funding agencies and users of food composition data. Before harmonisation can result in effective and useful information that can be widely utilised, it is necessary to identify the important management issues and establish a context for providing solutions.

1.2 METHODS

Eight different types of information resources were used to determine the food composition management issues of greatest concern for those involved in food composition activities. These covered national, regional, and international issues. The instruments included four types of facilitated discussions, focus group sessions, international conference programmes, minutes of food composition steering committee meetings, and a literature review. A summary of the types of information resources used, the number of events per resource, and the time period covered for each, is presented in Table 1.1.

The first type of facilitated discussion focussed on issues of national concern for New Zealand and covered the period from 1987-1996. It involved ten presentations (six with published papers or abstracts) followed by discussion sessions, given to major users of food composition data at the Nutrition Society of New Zealand's annual conference (Shields *et al.*, 1988; Burlingame *et al.*, 1990; Milligan & Burlingame, 1991; Cook *et al.*, 1992; Burlingame *et al.*, 1995a) and the New Zealand Dietetics Association's annual conference (Burlingame, 1989). After each presentation, the discussion was undertaken, and points were recorded and evaluated.

The second type of facilitated discussion focussed on national issues of relevance to Americans. These discussions took place at the annual National Nutrient Databank Conference, which is the forum where American food composition data users and providers meet. Each conference has one session or more for provider/user discussion. Notes from seven conferences held between 1989-1996 have been compiled and evaluated (Burlingame, 1994a, 1995a).

The third type of facilitated discussion targeted the regional food composition programme management issues relevant to New Zealand. These were determined through documented facilitated discussion during an OCEANIAFOODS training workshop (Burlingame, 1994b), and OCEANIAFOODS Conferences in 1987 (English & Lester, 1987), 1989 (Badcock, 1991), 1991 (Burlingame & Monro, 1993), and 1995 (Aalbersberg, 1996). The 1991 conference programme was constructed for the explicit purpose of determining the harmonisation issues for the Oceania region.

The fourth type of facilitated discussion was held during INFOODS organisational meetings for Middle Asia (Burlingame, 1995b), Africa (Burlingame, 1994c), North Africa (Burlingame, 1994d), South Asia (Burlingame, 1996b), North America (Burlingame, 1996c), Central and Eastern Europe, and the Middle East (Burlingame, 1997). These discussions targeted the management issues at national, regional and international levels.

Regional issues for other parts of the world were identified through formal focus group sessions held in Manila (Burlingame, 1995c), Santiago (Burlingame, 1996d) and

Wageningen (Burlingame, 1996e). Each focus group session included people who were, or were hoping to be, active in food composition work in their countries. Participants in the Manila focus group were mainly from developing countries (Papua New Guinea, Pakistan, Sri Lanka and Philippines), with one exception (Australia). Each participant signed a consent form explaining the nature of their participation and their privacy rights. The session was tape recorded, transcribed and evaluated. Participants in the Santiago focus group were eight people from six different developing Latin American countries. The six participants in the Wageningen focus group were from countries categorised as developed (e.g. Canada), countries in transition (e.g. Poland, Portugal), and developing countries (e.g. Kazakstan, Jamaica).

For both the focus groups and the facilitated discussions, the questions were related to assessments of strengths and weakness in the management of their national programmes; effectiveness of the regional data centres as a functioning organisational structure; roles and responsibilities for international and regional coordination of the efforts, including development of standards and guidelines for harmonisation. A copy of the Question Guide is included as Appendix 2.

Three international food data conferences[1] have been held, where issues of relevance to managing food composition work were addressed. The conference programmes have been used to assess the dominant issues (Greenfield, 1995; Finglas, 1996; Sevenhuysen & Beecher, 1997) as they relate to harmonisation.

The biannual National Food Composition Steering Committee meeting has been the forum for a small group of New Zealand data users and data generators to discuss the more technical issues and to review the organisational structure and management of food composition programmes. Thirty-six sets of minutes of these meetings, from 1980 through

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1 The 3rd International Food Database Conference scheduled for July 1997 was cancelled. A four-paper session was included in the IUNS conference instead.

1997, have been evaluated.

A thorough literature search was conducted using CAB Abstracts on CD-ROM, covering a 13 year period.

Instrument	Number of events	Years covered	Issues & Context Identified in Priority Order
New Zealand Conferences	10	1987-1997	Sector roles, technical issues
USA Conferences	7	1989-1996	Sector roles, technical issues
OCEANIAFOODS Meetings/Workshop	5	1987-1995	Technical issues, infrastructural issues, sector roles
Focus Groups	3	1994-1996	Infrastructural issues, technical issues, sector roles
Regional Data Centre Meetings	7	1993-1997	Technical issues, infrastructural issues, sector roles
International Conferences	3	1993-1997	Technical issues, affiliations, sector roles
New Zealand Steering Committee Meetings	34	1980-1997	Technical issues, sector roles
Literature review	Not applicable	1983-1997	Sectors and users

Table 1.1 Information resources, number of events for each, and years of coverage to determine food composition management issues of significance to the professional community. The results listed in order of importance, represents the work of this author.

1.3 RESULTS AND DISCUSSION

1.3.1 Management Challenges

The findings show that in most countries, data are still generated, compiled and disseminated without any attempt at standardisation or harmonisation, or liaison with other active groups. The reasons for this were complex and took many forms in the management of food composition programmes. Analysis of the information obtained from all of the sources mentioned above has shown that the management challenges for food composition work can be compartmentalised into four categories. These will be discussed individually in greater detail but, briefly, they are:

- **Technical**: specialist detail in information technology, nutrition and analytical chemistry;
- **Sectoral**: economic and government sectors, NGOs[2] and charitable organisations involved in food composition activities;
- **Infrastructural**: the organisational framework and resources at national, regional and international levels; and
- **Affiliation**: liaison and agreements with external international agencies involved in different — or the same — aspects of food composition work.

For the **technical** issues, the most prevalent reasons for lack of harmonisation were ignorance of existing standards, the perception that adoption of the standard would be too difficult, and the absence of some needed standards. Other significant but less common reasons included disregard for standards already developed after wide consultation, and the creation and implementation of new, competing standards. For **sectoral** issues, the reasons included having no knowledge of other people or groups working in the area, national/regional disagreement and/or unwillingness of the parties to cooperate in

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2 Non-Government Organisations

establishing standardised approaches, financial/resource considerations that prevented collaboration with other groups and/or created a competitive environment, and the perception that different sectors had different food composition data requirements and harmonisation would lead to less useful information for some sectors.

Infrastructure emerged as a highly significant management issue, but it was only indirectly associated with harmonisation. **Affiliation** was perceived as the least significant of the management issues in all of the measured events, in spite of it being seen as the most significant of the issues by the INFOODS secretariat (Burlingame & Scrimshaw, 1997).

1.3.2 *Technical* issues in food composition

Results of the focus group studies and facilitated discussions have shown that technical issues are the most significant for people working in national programmes in most countries. When asked, "What kind of intervention, advice, resources, etc., are needed?" there was unanimous agreement from all members of the Manila, Santiago and Wageningen focus groups that technical guidance and guidelines are needed for data generation and data compilation. It was felt that this would lead to the most effective use of their food composition programme budgets, and facilitate international sharing of food composition data. This same conclusion emerged in a different form from the national studies in New Zealand and the United States. In New Zealand, the technical liabilities became apparent when composition activities were being undertaken by more than a single organisation. This happened in two documented ways: (1) when the Ministry of Health contracted work from another Crown Research Institute, with the requirement that the data generated should be able to be included in the New Zealand Food Composition Database, and (2) when Crop & Food Research subcontracted some of its analyses to outside laboratories. Details of this will be presented in Chapter 2 of this thesis, *Managing New Zealand's food composition programme*. It is also the experience in the United States where budget restriction at the United States Department of Agriculture has required that most data now come from industry, the scientific and trade literature, or through interchange with other national and regional data centres. The only events where technical issues were not significant were those undertaken with countries that did not have national programmes. This was the case for most of the people participating in the OCEANIAFOODS workshop session in Suva (Burlingame, 1994b).

International attempts have been made to address the most serious of the technical issues affecting the management of food composition programmes. For example, INFOODS' leadership has been effective in identifying many issues, and resolving some of the very problematic ones. Without prompting, specific technical issues were only identified by participants from countries with a long history of food composition activities (USA, New Zealand, Australia, Thailand, Slovakia, Chile). Others identified the significant technical issues *only after prompting*. The most frequently mentioned included the following:

- methods of component analysis and/or expression,
- food component (e.g. nutrients) identification,
- sample documentation procedures,
- food identification,
- representations of data quality, and
- international interchange protocols.

International harmonisation has been most successfully attempted and achieved in the area of food component identification. INFOODS international food component identifiers (tagnames) provide the basic nomenclature for differentiating components and presenting them in data files (Klensin *et al.*, 1989). Nevertheless, universal adoption has not yet taken place because of ignorance of the existence of this standard, or disregard for the standard because it was believed that its adoption would be too difficult. This technical issue will be addressed in detail in Chapter 4 of this thesis, *Harmonisation issues in identification of food components.*

A worthy attempt has been made to address the area of food identification, but success is still a long way off. This technical issue will be addressed in detail in Chapter 3 of this thesis, *Harmonisation issues in identification of foods*. International interchange of food composition data and harmonisation of methods of analysis and modes of expression of food composition data still require more attention internationally. Nevertheless, INFOODS has assisted some nations' food composition programmes to standardise the way data are generated, compiled and disseminated for their region, thereby harmonising with other regions (Burlingame, 1993b, 1993c, 1996f). Examination of the conference topics from the International Food Data Base Conferences revealed that technical issues were the most significant of the issues addressed in that international context (Greenfield, 1995; Finglas, 1996; Sevenhuysen & Beecher, 1997).

1.3.3 *Sectors* and their data uses

The sectors involved in food composition activities were most clearly identified within the context of national meetings (USA and New Zealand), during workshops held in Suva, Chile and Wageningen, and by literature review.

The use of food composition data is widespread throughout different government and economic sectors, because food composition data underpin many diverse activities. The challenges related to the involvement of many different sectors, and the management strategies to improve the situation, have not been effectively examined previously.

Broadly, there are four sectors commonly generating, compiling, disseminating and/or using food composition data. They are health, agriculture, environment and trade. Each sector, with examples of food composition data activities, will be discussed later in this section. Historically, agriculture has been the dominant sector involved in food composition programme management. This is demonstrated most clearly in countries which have the longest history of formal food composition activities: the United States, where responsibility for food composition data lies with the United States Department of Agriculture, and the United Kingdom, where the Ministry of Agriculture, Fisheries and

Food have most of the responsibility. Nevertheless, most of the participants from the focus groups and facilitated discussions, and conferences in New Zealand and the USA, are health sector professionals. In New Zealand, it is the health sector that provides 70 percent of the funding for the work, and constitutes 80 percent of the users of the information (Burlingame, unpublished).

Involvement of the environment sector is becoming increasingly important as it relates to the composition of native foods for endangered or protected animal species, and the composition of indigenous plants as an ecological resource in their own right. This sector was identified without prompting during only two events, but all focus group and discussion participants agreed after prompting that it was emerging as an important sector. Trade has also gained more dominance in recent years. In many countries, people seeking to maintain or increase funding for food composition programmes are finding that highlighting the trade implications to funding decision-makers is more compelling in their advocacy than the more conventional implications related to health and agriculture. Trade was selected as the theme for the 3rd International Food Data Conference.

Food security[3], a relatively new term that is loaded with implication, is the single issue that impinges on all four sectors, compounding the disharmony but presenting the urgency of the case for proper international management of food composition activities. This topic will not be explicitly addressed in detail but all the harmonisation issues in food composition work have implications for food security assessment and policy development (Burlingame & Scrimshaw, 1997)

Some of the specific uses of food composition data to the four sectors, along with a few examples of their uses, are listed below.

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3 Food security is defined in its most basic form as access by all people at all times to the food needed for a healthy life. There are several levels in the management of food security, ranging from the individual and household level, through the community and national levels, to the international level.

No attempt was made to include a complete set of references for each of the examples; in CAB Abstracts Compact Disk for a single year (1996), a search for papers using food composition data yielded in excess of 1800 references.

➢ Health sector

Health protection

Food composition data are used in health protection activities in most countries in the world. "Food control" laboratories monitor mostly harmful components of foods on a continuing basis (Dogheim *et al*, 1996). Other health protection activities include total diet surveys (Pennington *et al*., 1995) or "market basket surveys" (Tsuda, 1995) designed to determine the risk to populations from intakes of selected nutrients, anti-nutrients and contaminants. All the sampling, sample preparation, sample handling, analyses and reporting requirements are virtually identical to the requirements of other food composition activities (Petersen & Barraj, 1996).

Health promotion

Health promotion activities include campaigns aimed at reducing or increasing the intake of certain nutrients in certain populations. An example is the Healthy Heart/Pick the Tick campaign run by the New Zealand Heart Foundation and supported by the New Zealand Ministry of Health. Here the nutrient focus is fat and the promotion aims to reduce the populations' intake of fat to reduce the incidence of heart disease.

Clinical research

Food composition data are central to many clinical research trials. Examples include amino acid digestibility in ileostomy patients (Rowan *et al*., 1994), vitamin A intake in breast fed infants (Groh-Wargo, 1996) and serum cholesterol levels in vegetarians (Appleby *et al.*, 1995). Knowledge of the composition of the test and control food(s)/diet(s) is fundamental to these studies.

Clinical care

Clinical dietitians must know the composition of foods to provide effective and therapeutic meals and diet planning in a clinical setting. Special diets for patients are often based on individual nutrients in the foods: low sodium for hypertensive patients, low saturated fats for heart patients, proper ratios of protein, fat and carbohydrate for diabetics, high protein for burn patients, and low phenylalanine for phenylketonuric patients, etc. (Shils & Olson, 1994).

Epidemiological research/Diet studies

Epidemiological studies and diet studies take many forms. Some address food intakes and relate these to nutrient content of the diet and incidences of diseases. In the interpretation of the findings of these studies, individual nutrients are often the focus. Recent examples of these types of studies include Dutch (Brandt *et al.*, 1993) and Finnish dietary antioxidants and lung cancer studies (Knekt *et al.*, 1991), and the Iowa women's vitamin E and colon cancer study (Bostick *et al.*, 1993). Studies of this type can also link diet quality with socio-economic status, age, and living arrangements (Murphy *et al.*, 1993). Much of our understanding of the relationship between nutrients and disease, and much of the controversy and conflict in nutrition, comes from epidemiological studies. Speculation that much of this conflict and controversy is due to the lack of standardisation and/or harmonisation in tools, terminology, etc., has been discussed in reference to both human and animal epidemiological studies (Moutou, 1992; Ahl *et al.*, 1993; Kushi, 1994).

Public health policies

Most of the noncommunicable disease public health policies in all countries of the world relate to food and food composition. Such policies include nutrition goals and guidelines and recommended dietary intakes. An example from goals and guidelines is "choose a diet low in fat, saturated fat and cholesterol" (USDA, 1995); and an example of an RDI is "women between the ages of 11 and 50 should get 15 mg of iron daily" (NRC, 1989). Recommendations of this nature require that health professionals and the public have access to data on the nutrient composition of foods. Figure 1.1 shows some examples of the health promotion campaigns and policies.

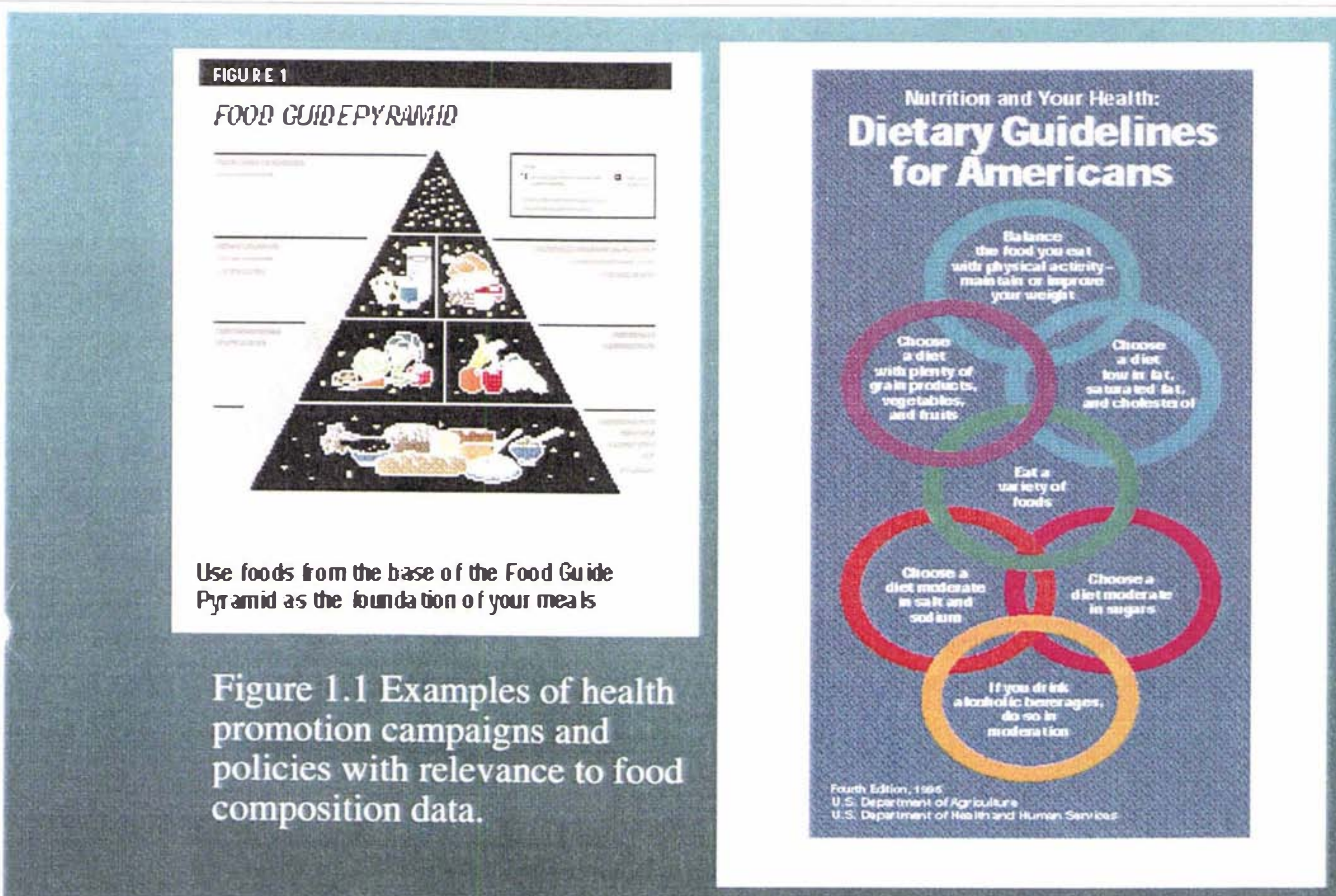

Figure 1.1 Examples of health promotion campaigns and policies with relevance to food composition data.

Nutrition intervention policies

Nutrition intervention typically takes the form of adding a nutrient to the food supply or large-scale administration of nutrients by injection. In New Zealand, nutrition intervention includes addition of fluoride to the water supply (Colquhoun, 1993) and addition of iodine to salt (Ministry of Health, 1995). In Guatemala, intervention includes the addition of vitamin A to sugar (Anleu, 1995). In the USA and Britain, intervention takes the form of certain minerals and B vitamins added to refined grain products (Code of the Federal Regulations, 1996). Interventions of this type are usually only implemented after an examination of the nutrients in the food and water supply of the country, and the baseline positions are usually carefully monitored over time. This is currently being undertaken in New Zealand for the purpose of devising a folate fortification programme (Elliot & Singh, 1997).

Household food security

Although food security is an issue that spans several sectors, **household** food security is usually considered to be a health sector issue (Nandi, 1994). Knowledge of the nutrient content of the foods consumed by household members is a precondition for assessing household food security (Burlingame & Scrimshaw, 1997).

➢ **Agriculture Sector**

Feed composition and animal performance

The intensive livestock industries (e.g. poultry and pig in New Zealand, but also sheep and cattle in other countries) require accurate nutrient composition data on the feeds used. The data are generally far more extensive than those required for human foods, and include many micronutrients and individual amino acids. "Performance" in these animals usually refers to weight at time of slaughter; muscle tissue to fat tissue ratios; and in the case of milk, an accurate profile of the proximate nutrients (protein, fat, lactose, water and ash) (Stern *et al.*, 1994).

Food security

National and global food security is generally considered an agriculture sector issue related to food production, rural development, irrigation, fertiliser and pesticide use, crop yields, etc. (Chen *et al.*, 1995). A common tool used to assess national and global food security are the food balance sheets that examine, at the commodity level, the amount of food available to a country (FAO, 1995). The amount of food is then converted into individual nutrients and reported as the amount of protein, carbohydrate and energy, etc., per caput food supply. This is done retrospectively annually in most countries. This topic is dealt with in detail in Chapter 2, *Managing New Zealand's Food Composition Programme.*

Export food industries

The agriculture sector is responsible for ensuring that food exports meet the regulatory requirements, including compositional information, of their intended market (Codex Alimentarius, 1997). This topic is treated in more detail as a trade sector issue, and in Chapter 5, Harmonisation for trade.

Domestic food production

Agriculturalists have long professed that malnutrition is not just a health problem, but it is also an agriculture problem. Increased consumption of imported food commodities has brought about changes in food patterns and diets that have contributed to the increase in food and nutrition-related health problems previously unheard of in certain parts of the world (Eusebio, no date). Agricultural extension workers are combatting the incidences of diet related diseases in the Pacific by using nutrient composition data in family food production, helping families in designing home garden projects to supply nutrients that would otherwise be consumed in insufficient quantities (Burlingame, 1994b).

Molecular and traditional food plant and animal breeding

Breeding has been done to modify certain nutrients in foods. Familiar examples include corn bred for higher lysine (Liu, 1994) and cattle bred for lower fat content of the carcass (Novelli *et al.*, 1993).

➢ Environment Sector

Endangered species

Knowledge of the nutrient composition of the native diet of endangered animal species is an important requirement for protecting them. In New Zealand, the Department of Conservation funded a study to determine the nutrient composition of the traditional diet of the kakapo in their native habitat, to ensure that the same nutrients in the same quantities and proportions were being supplied in their artificial offshore island sanctuaries and other protected, artificial habitats (James *et al.*, 1991).

Ozone depletion

Ozone depletion affects agriculture in terms of production, but also in terms of the nutrient content of crops and horticultural products (Anupa-Singh & Singh, 1996).

Global warming

Like ozone depletion, global warming affects agriculture in terms of production implications. Its other major effect is/will be creating the conditions for certain food products to be cultivated where temperature did not permit their cultivation previously (Jodha & Downing, 1995). This will alter the food supply, and therefore nutrients available, in certain countries. This is a subject of many current research projects (Lomas, 1996; Ruttan *et al.*, 1995).

Food security

Besides being both a health and agriculture issue, food security is also an environmental issue (Chen *et al.*, 1995). In a press statement issued in June 1997, the Food and Agriculture Organization's (FAO) Director-General Jacques Diouf told at the Nineteenth Special Session of the UN General Assembly on the overall review and appraisal of the implementation Agenda 21 (FAO ES, 1997) adopted at the Earth Summit in Rio in 1992, the environmental issues and food security were inseparable. Dr. Diouf went on to state that FAO is the task manager for key chapters of Agenda 21, including integrated land-use management and protection, preservation of the biodiversity, and sustainable agricultural (FAO Press Release, 1997). Each of these has implications for food composition programmes.

➢ **Trade Sector**

Trade has emerged in recent years as one of the more compelling of the sectors involved in food composition activities. Managers of national programmes and regional data centres have identified six trade sector issues, listed below:

- Trade agreements (NAFTA[4], SAARC[5], ASEAN[6])
- Food standards and food legislation
- Nutrition Labeling and Education Act, USA
- Joint Standards for New Zealand and Australia
- EC Directive
- Food security

This topic will be dealt with in detail in Chapter 5 of this thesis, *Harmonisation for food legislation and food trade regulations*, which examines international and other multilateral and bilateral trade agreements with implications for food composition information,

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4 North American Free Trade Agreement

5 South Asian Association for Regional Cooperation

6 Association of South East Asian Nations

identifying areas of disharmony and incompatibility, and assessing the impact of the disharmony if it remains unaddressed.

1.3.4 *Infrastructural* problems

Infrastructural issues were identified in the focus groups and during regional data centre meetings as the most significant problem in managing food composition programmes at the national level. This was perceived as causing some of the difficulties in harmonisation efforts, although the effects on harmonisation were indirect. INFOODS has addressed some of the national and regional infrastructural problems, on an *ad hoc* basis, by providing equipment, training and Internet access. Nevertheless, many problems related to infrastructure are still to be identified and remedied. The most serious of the problems were identified as:

- Commitment
- Training
- Resources
- Authority

Some of these—training and resources, for example—are obvious and universal management issues. Others, like commitment and authority, are subtler. Commitment involves individuals and organisations, and the priorities and priority afforded the work. Authority relates to the organisational mission or area of responsibility for management of food composition work. In some countries there is no authorised agency, creating one set of management difficulties. In other countries there are many agencies that have, or believe they have, the mandate for food composition work, creating a completely different set of management difficulties. However, the impact on harmonisation was lower for this category than for any of the four categories examined.

1.3.5 *Affiliation* problems

As with the challenges related to the involvement of many different sectors, the challenges of agency affiliations have not been effectively addressed. Some of the key agencies with involvement in various aspects of food composition work have been identified as:

- Food and Agriculture Organization (FAO), World Health Organization (WHO) and other United Nations agencies
- Codex Alimentarius Commission
- World Trade Organization (WTO)
- AOAC International[7]
- International Standards Organization (ISO)
- International Union of Physical and Applied Chemists/International Union of Nutritional Scientists (IUPAC/IUNS)
- Global Environmental Monitoring Systems (GEMS)
- Hazard Analysis of Critical Control Points (HACCP)

Each of the different sectors has a specific agency focus in many cases. The agriculture sector, for example, generally has a strong association with FAO and AOAC International. The health sector has strong ties with WHO, the trade sector has strong ties with the World Trade Organisation, and the environmental sector interacts with Global Environmental Monitoring Systems. Food control laboratories are working more frequently with HACCP (FAO, 1995). Many of these agencies work independently of one another, and inadvertently create disharmony in the management of food composition activities.

Affiliation problems were infrequently cited as having an impact on the management of food composition activities. With all the information resources used, affiliation only

[7] AOAC has evolved **in name** from the *Association of Official Agricultural Chemists*, to the *Association of Official Analytical Chemists*, and finally to *AOAC International* with no designations for the letters AOAC.

surfaced as relevant in the international conferences. Nevertheless, affiliation with these agencies and programmes is seen as highly important by the global INFOODS secretariat for the effective development of guidelines that will permit harmonisation (Burlingame & Scrimshaw, 1997).

Additionally, it is likely that one or more of these agencies/programmes will provide an appropriate management model for the food composition community.

1.4 CONCLUSIONS

Some of the reasons why food composition data are still generated, compiled and disseminated without the managers of those activities attempting standardisation or harmonisation have been demonstrated through this analysis. The results point to the problem areas that require attention at the national, regional and international levels. Sector issues have been shown to be the most significant of the national problems related to harmonisation, while technical issues were identified as the most important at the regional level. It has been established that food composition programmes have management problems relating to the far-reaching implications of, and applications for, the information.

At the national level in particular, the sector relationships, and the infrastructural problems need to be addressed. It is impractical to think that a national approach or even a regional approach to the affiliation issues would be reasonable, and therefore INFOODS should assume the primary role. Similarly the lead for addressing the technical issues needs to come from an international focal point such as INFOODS.

The remainder of this thesis will build upon the information basis established in this chapter. Several of the problems identified will be examined and evaluated in detail, the risks attendant to the lack of standardisation and harmonisation will be highlighted and quantified where possible, and pragmatic management solutions will be proposed.

As implied in this chapter, the potential risks associated with not recognising and/or not addressing the problems are manifold and could include economic impediments such as non-tariff trade barriers, misinterpretation of findings in health research, and poor policy decisions over public health, agricultural and environmental issues. With the major problems identified, the solutions will come from expressing the magnitude and significance of the risks in the language of the decision-makers, and implementing management strategies and tactics that take into consideration the complex, technical, multi-sectoral, multi-level framework of food composition activities.

2. MANAGING NEW ZEALAND'S FOOD COMPOSITION PROGRAMME

2.1 INTRODUCTION

A national food composition programme is usually the combination and coordination of activities, within some defined administrative framework, related to food composition data generation, compilation, dissemination, and use (Greenfield & Southgate, 1992). Data generation is the process whereby foods are sampled, prepared and analysed in the laboratory; data compilation is the process whereby the data from the laboratory are examined, manipulated, and incorporated into a food composition database; data dissemination is the preparation and publication of books and electronic data products which are made available to users in the various sectors described in Chapter 1 of this thesis; and data use is the application of these data to tasks, projects, and programmes, again as described in Chapter 1 of this thesis. Often a single organisation holds the overall responsibility for managing a national food composition programme. In New Zealand that organisation is the Crown Research Institute, the New Zealand Institute for Crop & Food Research (previously the Department of Scientific and Industrial Research (DSIR)).

In spite of the fact that a single organisation usually holds the overall responsibility for a national programme, it is rare that that organisation accomplishes all four activities itself. In most countries there are other agencies with activities that have direct or indirect relationships with food composition data, some of which operate in concert with the national program, and others of which operate independently or in competition with the national program.

In New Zealand, the national programme undertakes all the data compilation and dissemination, and approximately 70% of the data generation, but does not have direct involvement in most data use activities.

In addition to the desirablility of a coordinated approach nationally for accomplishing the

four essential activities, it is productive and important for a national food composition programme to operate in conjunction with its Regional Data Centre, and the international activities that are on-going. In this regard, New Zealand participates actively in OCEANIAFOODS, the INFOODS Regional Data Centre which also includes Australia, Fiji, Papua New Guinea, and 20 other island countries in the Pacific. New Zealand has also participated in some food composition expert committees, and has been among speediest of national programmes to trial and implement international recommendations.
The infrastructural, sectoral, affiliation and technical harmonisation issues that affect the management of New Zealand's national food composition programme will be analysed by:

- examining the organisational structure and financial obligations of Crop and Food Research, and the compatibility of operating a national food composition program within this framework;
- identifying other agencies in New Zealand involved in food composition activities and determining the inter-agency disharmony;
- determining regional harmony/disharmony with New Zealand's partners in OCEANIAFOODS;
- determining disharmony between New Zealand and other nations, and international regulatory and policy agencies; and
- proposing solutions and future directions for eliminating or alleviating the problems.

2.2 METHODS AND MATERIALS

The approach used in this chapter is mainly as a case study of Crop & Food Research's food composition programme over a ten year period. It includes the operation of the national food composition programme, with particular emphasis on data generation activities; and involvement in OCEANIAFOODS as an active member, including a two-year term as coordinator of the regional data centre.

The examination of the organisational structure and financial obligations of Crop and Food Research, to assess the compatibility of New Zealand's national food composition programme within this framework, required analysis of relevant Acts of Parliament (Public Finance Act 1902 and amendments, Income Tax Act 1976 and amendments, Companies Act 1955 and amendments, Crown Research Institutes Act 1992), and Crop & Food Research's Annual Reports and Statements of Corporate Intent.

The remainder of the material used in this chapter comes from collection and analysis of the eight different types of information resources including four types of facilitated discussions, focus group sessions, international conference programmes, minutes of food composition steering committee meetings, and a literature review. A summary of these information resources, the number of events per resource, the time period covered for each, was presented in Table 1.1.

2.3 RESULTS AND DISCUSSION

2.3.1 The Organisational Framework within which New Zealand's National Food Composition Programme Operates

The government science environment changed in a very fundamental way with the creation in 1991 of the Foundation for Research, Science and Technology (FRST). FRST administers the Public Good Science Fund (PGSF). The funding for all public good science became contestable, with the salaries of all staff, all overheads and all operating funds dependent on successfully competing for the limited and shrinking (in some areas) research dollar.

The establishment of Crown Research Institutes (CRIs) in July 1992 marked another significant change for science in New Zealand. Crop & Food Research, the CRI within which the national food composition programme operates, is one of nine Crown Research Institutes. Crop & Food Research's formation brought together expertise and heritage from more than 70 years of four organisations highly regarded for their scientific achievements. They were DSIR Biotechnology (previously called Applied Biochemistry), DSIR Crop

Research, MAF Technology[1] and DSIR Plant Protection. The national food composition programme was officially started in Biotechnology Division in 1986, although a national food composition steering committee had been operating under the auspices of Applied Biochemistry since 1980. The Biotechnology Division was disestablished in 1990. Two-thirds of the the nutrition group and the national food composition programme became part of DSIR Crop Research, the other one-third, which represented most of the data generation capacity at the time, was placed with DSIR Grasslands, which subsequently became part of the AgResearch CRI.

The organisations that came together to create Crop & Food Research each had different organisational structures, scales of operations, management objectives, culture and management styles, and relationships with third parties. The amalgamation of diverse organisations and the new requirements imposed upon the new organisation, necessitated completely different approaches and policies. Most significantly, science became a "business", no longer operating under the Public Finance Act (1902), but operating under the Crown Research Institute Act (1992) and incorporated under the Companies Act (1955). CRIs are for-profit, limited liability companies, conducting market-focussed research.

The Institute has a board of six directors, a chief executive officer, four divisional managers (three for science and one for corporate services) and two shareholding ministers.

Shareholding Ministers

The two shareholding Ministers are the Minister of Finance and the "Responsible" Minister. The Responsible Minister currently has the title of Minister of Research, Science and Technology. The role of shareholding Ministers is to be responsible to the House of Representatives for the exercise or performance of the powers, duties, and functions conferred or imposed on them in a manner consistent with the purpose of a CRI, as defined by the Act or the rules of the CRI.

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1 A division of the Ministry of Agriculture and Fisheries

The shareholding Ministers are the ones determining the amount of dividend payable by the CRI in any financial year. They may exercise all the rights and powers attaching to the shares. Through to the end of the 1996/97 financial year, the shareholding ministers have not required payment of a dividend from any CRI. The Ministers may, from time to time, on behalf of the Crown, subscribe for or otherwise acquire shares in the capital of a CRI, in addition to those already held. Any money required to be paid for these shares must first be appropriated by Parliament for that purpose.

The responsible Minister is responsible for laying relevant documents before the House of Representatives. These documents include the statement of corporate intent (SCI), the annual report, the audited financial statements for the preceding financial year and the auditor's report on the financial statement.

The Board of Directors

The board of directors is appointed by the shareholding Ministers. The role of the board of directors is to be accountable to the shareholding Ministers in the manner set out in the CRI Act (1992) and in the rules of the CRI. Just like the shareholding ministers, the directors shall exercise or perform the powers, duties and functions conferred or imposed on them in a manner that is consistent with the purpose of the CRI and the principles of the CRI Act.

One important responsibility of the board is to deliver to the shareholding Ministers a yearly statement of corporate intent, an annual report, audited financial statements, and a statement of dividends that could be paid to the Crown.

The statement of corporate intent must be submitted not later than one month before the commencement of each financial year. The document must include, among other things, information on the ratio of consolidated shareholders' funds to total assets, and definitions of those terms; the accounting policies of the next financial year; and the performance targets and other measures by which performance of the CRI may be judged. Each statement of corporate intent shall also include the board's estimate of the current commercial value of the Crown's investment and a statement of the manner in which that value was reassessed.

The annual report, containing information on the operations of the CRI, is prepared by the board and delivered to the shareholding Ministers within three months after the end of the financial year. The audited consolidated financial statements must also be delivered to the shareholding Ministers within three months after the end of each financial year. This report consist of statements of financial position, profit and loss, changes in financial position, and other financial results of the CRI's operation. And the final output prepared by the board for the shareholding Ministers is a dividend statement, defining the dividend, if any, that could be paid to the Crown by the CRI for the financial year just ending. Additionally, the board is obliged to supply to the shareholding Ministers any other information on request.

Science Division

Each science division manager coordinates 50-100 scientists and technicians working in a variety of locations. The divisions are Crop Production Systems, Plant Improvement, and Food Science and Technology. The national food composition programme and the associated nutrition research programme operate in the Food Science and Technology Division.

Marketing of products and services is undertaken within each science division. The aim is to ensure the efficient transfer of research initiatives from science to the marketplace. The marketing and business development manager in the food science and technology division provides support to scientists in the extension of research programmes into successful commercial applications. Initiatives include technology/information transfer and joint ventures with private companies in the food industries.

The strategies for commercial success are reflected in the six primary management objectives in Crop & Food Research's Mission Statement: (1) to provide competitive advantage to the crop, food and fish industries; (2) to lead with research, science and technology; (3) to transfer technology to enhance New Zealand's economic and social wellbeing; (4) to meet client needs for innovation in product development, production and processing; (5) to provide quality research services; and (6) to operate in an international market.

Crop & Food Research engages in research and generates products in the form of papers in the scientific literature, conference presentations, and other publications. It also provides analytical and research-type services to commercial clients.

The most fundamental change in the type of "goods" generated by the Institute since science has become a business is in the category of intellectual property (IP). Intellectual property is anything new that has been generated by efforts of the mind and is of commercial value. Although IP is intangible, it is treated as "goods" because it can be valued, owned, transferred, misappropriated or stolen. The forms of IP of interest to Crop & Food Research are patents, plant variety rights, revenue from licencing of information and technologies. Crop & Food Research claims IP ownership of food composition data in the form of a copyright declaration. Commercial revenue is collected on the sale of these data, and when the data are reproduced in other materials for sale.

The new structure has improved effectiveness and efficiency in several ways and these improvements can be measured. The key for Crop & Food Research, of course, is to isolate critical measures in government science and compare one's own practices with those of organisations that have established themselves as leaders or innovators in science. Success can be measured in terms of earnings, jobs and research, and these data are presented in the Crop & Food Research annual reports (Crop & Food Research, 1994, 1995, 1996, 1997) and Statements of Corporate Intent (Crop & Food Research, 1994, July; 1995, August; 1996, July; 1997, July). Earnings, however, remains the most compelling of the measures of success. Critical financial success factors relating to profitability, administrative cost, personnel costs, overheads, consumable costs, capital, product quality, debt policies, are easily monitored.

It was felt that the cost of doing science in a government bureaucracy was too high, and full costings for work were calculated and then imposed. The clear message from the first financial assessment of CRIs was that costs needed to be brought down, especially those relating to the overheads. When full-cost recovery was first imposed, Crop & Food Research's commercial charges were higher than those of competitors in the commercial sector, identified after a semi-informal benchmarking exercise. Indeed, the charge out rates for commercial analytical services were between 50 and 100% higher for Crop & Food Research's nutrient analytical services. This type of financial monitoring has succeeded in making routine science-service activities efficient and competitive.

Research

Presentations and publications of original research, scientific reviews and commentaries, methods' development, and technologies' development, via the scientific literature and conferences, have always been markers of success. In recent years, with the accountability measures and the contestability of funding, and the decreased expenditure due to high overheads, science output, measured against these criteria, has been reduced. The number of publications in the scholarly literature has been significantly reduced, while the number of publications in food industry trade journals has increased.

2.3.2 Financial Obligations

The nature of accounting in Crop & Food Research reflects the requirements of the Companies Act (1955), the Crown Research Institute Act (1992), and its own processes and procedures. Under the principles of operation, as defined in the CRI Act, each CRI shall, in fulfilling its purpose, operate in a financially responsible manner so that it maintains its financial viability. The Act goes on to say, "...a Crown Research Institute is financially viable if -- (a) regardless of whether or not it is required to pay dividends to the Crown, the activities of the CRI generate, on the basis of generally accepted accounting principles, an adequate rate of return on shareholders' funds; and (b) the CRI is operating as a successful going concern."

These statutory responsibilities also include the requirement to maximise the value of the Crown's investment in research, and that social and environmental responsibilities will also guide decision making (Crop & Food Research, Statements of Corporate Intent, 1994-

1997).

The annual report has a strong commercial and financial orientation which includes:

- stated performance against targets as presented in the Statement of Corporate Intent for the annual period, and comparative performance figures against respective SCI targets for the previous two years,
- a commentary on operations and overall performance for the period,
- a description of other highlights for the period,
- an audited financial performance statement, financial position statement, statement of cashflows and notes to accounts (including accounting policies,
- the auditor's report on those financial statements,
- a management statement to accompany the annual financial statements, and
- a certification by the Board that the Institute has operated in accordance with the Crown Research institutes Act 1992 and Companies Act 1993 during the period.

The organisational structure of Crop & Food Research, and its financial operating requirements as a for-profit business make it unique as an organisation operating a national food composition programme. Food composition data are generated, compiled and disseminated as commercial activities. All data generation and compilation captures full cost recovery for all labour, overheads and operating costs, plus a minimum of 10% profit under most circumstances. Pricing for data dissemination products attempts to capture all materials cost and a significant profit margin, making some of the data products beyond the reach of many potential users. Table 2.1 shows the price of the five most frequently purchased data products, in the far left column.

All data compilation is undertaken by Crop & Food Research. Similarly, all data dissemination is undertaken by Crop & Food, by publication of books and electronic products, licencing other authors and publishers to use the data, and through joint ventures with software developers. Table 2.1 lists the major data dissemination products made available by the national food composition programme, the price of each product[2], and the amount and type of information provided by each. Several complaints are received each year, sometimes via the Minister of Science, about the high price of the products. However, data users respond favourably to the yearly surveys on "customer" satisfaction that are carried out as part of Crop & Food Research's food composition contract with the Ministry of Health.

Output form & NZ$ price	Foods	Components	Basis	Numeric data	Source/quality codes
FOODfiles $383.50	All (~2000)	54 to 503, according to users' needs	Per 100g e.p.; amino acids in mg/gN, fatty acids in g/100gTFA	Mean, standard deviation, standard error, number of samples	Complete for each nutrient in each record
Diet1/NZ $990	All	Subset of 54	Per 100g or any serving size as user selection	Mean	Not provided
Tables, unabridged $600	All	All	Per 100g e.p.; amino acids in mg/gN, fatty acids in g/100gTFA	Mean, standard deviation, standard error, number of samples	Complete for each nutrient in each record
Tables, abridged $300	All	Subset of 54	Per 100g and one common serve	Mean	Complete for each nutrient in each record
Tables, concise $35	Subset of ~800	Subset of 28	Per 100g and up to two common serves	Mean	Single majority source listed in index

Table 2.1 Data dissemination in different output forms from the New Zealand Food Composition Data base.

2 The prices listed for electronic data products, FOODfiles and Diet1/NZ, are for single user licences. Multi-user licences, 5-pack licences, and site licences are more costly.

This is very different from the United States, for example, where the largest single body of food composition data in the world, the USDA food composition database, is freely available to all via the World Wide Web. Many New Zealanders, particularly consumers, are using these data instead of the costly NZ data.

In New Zealand, data are not always sold. Data interchange agreements are in operation with many countries, whereby New Zealand data are supplied freely to a national food composition programme, or INFOODS regional data centre, free of charge, in exchange for that country's data files. There are provisions in the interchange agreement to prevent the data from being on-sold.

The concept of "selling" and "owning" food composition data is in conflict with the position of UNU/INFOODS which promotes the concept of free interchange of food composition data for all users. However, New Zealand is not unique in protecting its ownership by copyright. Most tables of food composition data, and electronic data products, have copyright declarations, including all of New Zealand's products. And in many cases where data are "borrowed" from other food composition data sources, permission and payment are sought. In 1987 New Zealand made a one-off payment of £100 to HMSO in London in order to use selected information from their copyrighted datafiles (Paul & Southgate, 1978; Paul *et al.*, 1980); in 1989 New Zealand entered into an arrangement with the "owner" of many of the Australian values for use of these data in the New Zealand database. The owner is not the national programme, but rather a food technology professor at one of the universities that undertook much of the work. The payment in this case is provision of copies of all books and computer products on an on-going basis.

Nevertheless, the subject of ownership of food composition data is not straightforward and several false starts have been made internationally to address the issue, including a presentation at the 1st International Food Data Base Conference entitled "International and Australian copyright considerations in data and data compilations" (Ricketson, 1995), and an attempt by FAO and UNU to write and issue a position statement on the topic which was never completed. Ricketson focussed on copyright legislation in effect at both the national (Australian) and international levels and categorised food composition databases as having copyright protection in both cases, but he never addressed the ownership of the data *per se.*

Notwithstanding the ownership issue, the INFOODS interchange system is a model of not just how data can be transported between regional data centres, but also a data interchange format definition derived from principles of "generic markup" (Klensin, 1992). The standard for generic markup (SGML) is compatible with hypertext markup language (HTML) used for "publishing" documents on the World Wide Web (ISO, 1988), the ultimate data dissemination medium. Although the New Zealand food composition data could be placed on the World Wide Web in exactly the way USDA data are, Crop & Food Research's marketing division has suggested that procedures for charging using this platform need to be explored carefully first in order to ensure a continuing revenue stream.

In examining the information resources described in Chapter 1, it is apparent that no other national food composition programme operates under the auspices of a for-profit organisation. The profit-making requirement has made it awkward to seek funding from charitable organisations (e.g. Heart Foundation and Cancer Society both supported some of the food composition database work in the mid 1980's); it makes it difficult to compete with organisations which seek grant support for operating funds and extra technical assistance (e.g. universities); it makes CRIs ineligible for some sources of funding that do not support overheads and salaries, much less the profit component (Meat Research and Development Council); and it often means turning down requests from other organisations and agencies to serve as members of expert committees or taskforces where their expertise would be for "public good" but a consultancy fee would not be paid to Crop & Food Research.

Nevertheless, the national programme continues to generate good quality food composition data on an on-going basis, and to effectively compile the data and consistently disseminate useful data products to users in New Zealand. There is no other organisation in the world for New Zealand to benchmark in relation to the financial requirements of the CRI structure and the effectiveness of operating a national food composition programme, but it will be appropriate for other countries -- developed countries in particular -- to undertake some benchmarking using New Zealand as an innovative model for a national food composition programme. Many of the participants in focus groups (outlined in Chapter 1), particularly those from developing countries without active national programmes, expressed an interest in this approach. It seems unlikely, however, that potential data users in these countries could afford the cost of products that were priced for cost recovery for a national programme.

Social Responsibility Accounting

Social Responsibility Accounting (SRA) has been defined as "a systematic assessment of and reporting on those parts of a company's activities that have a social impact" (Anderson, 1992). Anderson explains that there is a serious lack of attention to this area by stating, "Unfortunately, the current accounting system does not motivate managers to accept social or environmental responsibility as part of their normal work." All CRIs are obligated to consider SRA. The first Business Plan, issued in August 1992 as a confidential report, addresses SRA within the category of performance indicators and targets.

Societal issues can be markers of success. For Crop & Food Research these can include "green" issues, the Treaty of Waitangi, the healthy workplace, and good employer standing. Although harder to measure, these societal issues are not omitted from a discussion on improvements in the organisation.

Requirements for reporting on obligations under the Treaty of Waitangi and provisions for a healthy work environment (e.g. smoke-free workplace) are already part of some commercial contracts undertaken by Crop & Food Research, most notably, those of the Ministry of Health which funds about 75% of the food composition work as a commercial contract to Crop & Food Research.

Taxation Legislation

Crown Research Institutes operate in compliance with the Income Tax Act, 1976 and amendments, just like all businesses. There are some special exceptions, however.

Several amendments relate specifically to CRIs. They involve the definition of the assessable income, the exclusion from certain income tax exemptions, prohibition from maintaining imputation credit accounts and ensuring that CRIs can utilise the loss carry forward and grouping provisions.

Crop & Food Research, along with the other eight CRIs, has been included in the Income Tax Act's "special corporate entity" definition. This allows CRIs to be treated in the same way as State-Owned Enterprises and statutory producer boards. The special corporate entity status is designed to cater for companies with no ultimate natural person shareholders. The inclusion of CRIs in this category is beneficial, because it enables Crop & Food Research to utilise the loss carry forward and grouping provisions in the Income Tax Act. It will also prevent Crop & Food Research, or any other CRI, from grouping its losses with other CRIs or any other Crown-owned entities. This allows fiscally-responsible CRIs to benefit, unlike in the past where the fiscally-irresponsible divisions of DSIR were, in effect, rewarded for overspending. Crop & Food Research will only be able to group for loss purposes with its own subsidiaries.

CRIs will not be permitted to maintain imputation credit accounts. This is justified on tax policy grounds, as the Crown is the sole shareholder in CRIs and it cannot utilise any imputation credits arising from the payment of income tax by CRIs.

CRIs are expressly excluded from the income tax exemptions applying to public authorities and scientific/industrial research promoters. All payments that Crop & Food Research receives for producing public good science outputs are deemed to be assessable income. The public good science outputs fund, administered by the Foundation for Research, Science and Technology, represents the most substantial part of Crop & Food Research's income, although if only represents about 25% of the revenue from the food composition programme. Some controversy existed in the absence of an express legislative directive related to non-specific output funding. This is a category of funds untagged so that CRIs have complete discretion as to their use; unlike output funds which are specific to a defined piece of research work. It was argued that non-specific output funding could be described as having a capital rather than revenue character. However, the decision was taken that ALL public good science funds received by a CRI -- both output and non-specific -- were deemed to be assessable income.

All other taxation legislation is applicable to Crop & Food Research, just as it is to any other company.

2.3.3 New Zealand Agencies Involved in Food Composition Activities

As described earlier, the New Zealand Institute for Crop & Food Research is the agency that manages the national food composition programme. However, this management role is not an official mandate, as it is in many other countries; it is a de facto situation that could be challenged at any time. Even when the food composition programme was managed under the auspices of a true government department (DSIR), the project was never part of an official legislative mandate. Nevertheless, Crop & Food Research's national food composition programme management authority has never been tested or challenged.

Data use projects, in particular the large-scale nation-wide nutrition surveys, are conducted by other research groups, usually those firmly in health research, but the studies are always conducted using Crop & Food Research's food composition data products (usually FOODfiles). For example, the current (1997) National Nutrition Survey is underway. The provider is the Life in New Zealand Survey group (LINZ) at the University of Otago, the purchaser is the Ministry of Health, the project coordinator is a Crop & Food Research nutritionist on secondment to the Ministry, and Crop & Food Research is working as a subcontractor to LINZ for preparation of the survey nutrient database. This type of coordinated approach is proving to be very effective. The previous LINZ survey (1991) was undertaken with far less involvement from the national food composition programme.

Data generation is undertaken by a variety organisations, often in competition with Crop & Food Research for the same projects. These organisations include private laboratories, other Crown Research Institutes, government departments, State-Owned Enterprises, and universities. Data generation is where the most hard fought competition takes place.

Aside from Crop & Food Research, the most significant of the other data generators is

ESR[3]. This Crown Research Institute, formerly DSIR Chemistry Division, has a long history of and dedicated funding for data generation involving government research projects and analysis related to regulatory issues for the Ministry of Health and food companies; whereas DSIR Biotechnology Division (formerly DSIR Applied Biochemistry and subsequently DSIR Crop Research) has a long history of and dedicated funding for data generation for animal feed and human food nutrient analysis. With the restructuring of government science, the disestablishment of DSIR, and the creation of Crown Research Institutes in 1992, ESR and Crop & Food are now competing for the same limited pool of funds from both the government and the private sector.

Another organisation with involvement in food composition activities is the Ministry of Agriculture and Fisheries (MAF). This is the government department that has the responsibility as the national Codex Alimentarius Commission's contact point, and has the official involvement in all the Food and Agriculture Organization's work, described in greater detail in Chapter 5, *Harmonisation for Food Legislation and Food Trade Regulations.* MAF and the Minister of Agriculture led New Zealand's delegation to the 1996 World Food Summit, and MAF assigns representatives to special FAO and Codex committees and expert consultations. A modestly privatised division of MAF, MAF Qual, operates an extensive network of laboratories around New Zealand where nutrient analyses, as well as analyses for food control are undertaken. Crop & Food subcontracts much of its analytical work to MAF Qual. This work involves analysis of several vitamins (e.g. thiamin, riboflavin, niacin, vitamin B6, pantothenic acid, vitamin C and vitamin D). As an informed contractor for these analytical services, Crop and Food Research dictates the methods to be used, the reporting format, and the supporting documentation. But problems of compatibility and harmonisation still arise. Examples include expectations of receiving all raw data, including replicate determinations on the same sample, and all vitamers characterised and quantified in the analytical methodology, rather than aggregated figures. Or discovering that a particular matrix-specific modification had not been applied to the relevant sample. Or receiving nutrient data on a freeze-dried sample, without receiving the fresh weight or freeze-dried moisture values.

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3 Institute of Environmental Science & Research

Statistics New Zealand is another privatised former government agency with some peripheral involvement in food composition work. This agency has historically prepared the nation's Food Balance Sheets (FBS).

From FAO's World Wide Web site (1997), food balance sheets are described as follows:

> A food balance sheet presents a comprehensive picture of the pattern of a country's food supply during a specified reference period. The food balance sheet shows for each food item i.e. each primary commodity and a number of processed commodities potentially available for human consumption the sources of supply and its utilization. . . . The per caput supply of each such food item available for human consumption is then obtained . . . Data on per caput food supplies are expressed in terms of quantity and by applying appropriate food composition factors for all primary and processed products also in terms of caloric value and protein and fat content.

INFOODS goals are in perfect alignment with the goals and purpose of the food balance sheets, that is to "...reveal the extent to which the food supply of the country, as a whole, is adequate in relation to nutritional requirements." The technical issues acknowledged in the food balance sheet area are also comparable to INFOODS technical issues. These include component identification, sampling, and methods of analysis issues related to, "Data on per caput food supplies...expressed in terms of . . . applying appropriate food composition factors for all primary and processed products also in terms of caloric value and protein and fat content." From the food balance sheets, the "average" consumption of energy, protein, fat and carbohydrate are derived. These calculations have a wide use both nationally and internationally, and for all the sectors described in Chapter 1 of this thesis.

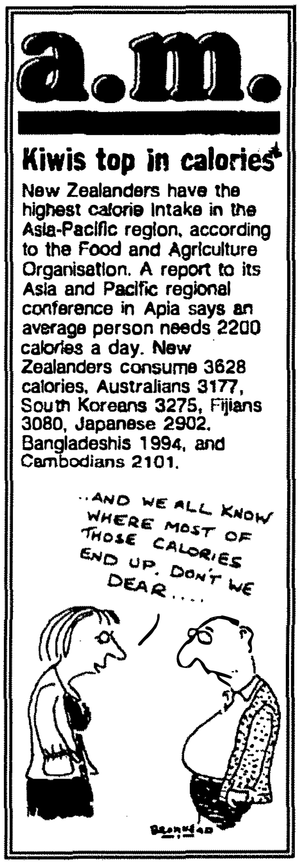
The FBS background information acknowledges some 'accuracy' problems: "The accuracy of food balance sheets, which are in essence derived statistics, is of course dependent on the reliability of the underlying basic statistics of...foods and of their nutritive value. These vary a great deal between countries, both in terms of coverage as well as in accuracy." The documentation goes on to say that "even more important are external consistency checks based on related supplementary information, such as the results of surveys conducted in various parts of the world as well as relevant technical, nutritional . . . expertise . . . while often being far from satisfactory in the proper statistical sense, provide an approximate picture of the overall food situation in the countries which may be used for . . . nutritional studies, the preparation of development plans and the formulation of related projects, as in fact is being done in the FAO."

These are some of the same issues that INFOODS is working to remedy, but so far, no coordination of these activities has taken place.

There are food identification issues with food balance sheets, and these are being dealt with independently of food composition programmes, and even independently of food identification issues in other divisions of FAO. For example, the classifications in food balance sheets states "...processed products do not always appear in the same food group...butter is under Animal fats and not under Milk." The Codex Alimentarius Commission, described in detail in Chapter 5, *Harmonisation for Food Legislation and Food Trade Regulations*, is also operated from FAO, and yet in their food classification system, butter is categorised with milk as a dairy product, not under Fats and Oils.

In New Zealand, a so-called New Zealand Harmonised Systems Classifications was introduced in 1996 by Statistics New Zealand for use with FBS. It was based on the World Customs Organisation's (WCO) system of classification for declaration of goods (not exclusively foods) traded between countries. The system involves "standalone" descriptions at all levels and eliminates the previous hierarchical eight-digit customs tariff coding system. The new system relies on coded and descriptive classifications and vocabulary, e.g. dried pineapple is classified and described as Dried fruit pineapple (Fruit317-C2J), with a harmonised system code 0804.30.0009 (Statistics New Zealand, 1996). This system was not developed in conjunction or in consultation with food composition researchers, nor is it compatible with any of the food identification/classification systems used in food composition activities and described in detail in Chapter 3, *Harmonisation Issues in Identification of Foods.*

Food balance sheets and food composition programmes have been successfully combined projects in at least one country, Lebanon (Dagher, 1997). This combination is appropriate and effective because among the important data from food balance sheets are per caput food supplies expressed in terms of energy, protein and fat content. In countries like New Zealand it could include a much more comprehensive nutrient set if the linkage between the national programme and food balance sheet preparation was established. Statistics New Zealand and the previous government Department of Statistics never was able to adequately integrate the food composition aspect into their work. This led to the nationally embarrassing incident in 1996 of FAO declaring that New Zealanders had the highest per caput energy intake of all countries in the Asia-Pacific region (The Dominion, 1996, May 15) (Figure2.1).


a.m.

Kiwis top in calories

New Zealanders have the highest calorie intake in the Asia-Pacific region, according to the Food and Agriculture Organisation. A report to its Asia and Pacific regional conference in Apia says an average person needs 2200 calories a day. New Zealanders consume 3628 calories, Australians 3177, South Koreans 3275, Fijians 3080, Japanese 2902, Bangladeshis 1994, and Cambodians 2101.

Figure 2.1 Newspaper clipping from Wellington's daily morning newspaper listing the results of the food balance sheet calculations for the countries in Asia and the Western Pacific which were reported at FAO's Asia Pacific Regional meeting in Western Samoa in May 1996 .

The report stated that New Zealanders consumed 3628 kilocalories per day compared with South Koreans at 3275, Australians at 3177, Fijians at 3080, Japanese at 2902, and Bangladeshis at 1994. When New Zealand disputed this assertion, the food balance sheet compilers, together with FAO's project manager for the Asia Pacific region, re-evaluated the data and attempted to apply more standardised factors to the data set. A corrected, lower value was later presented. Again, this illustrates the "accuracy" issue, already identified by FAO in the balance sheet area.

When relatively autonomous government departments undertake work they are less compelled to adopt standards promoted by others. However, managing a national food composition programme outside of a government department, and with forced competition with other providers, makes harmonisation a less difficult prospect when standards are specified by purchasers. For several years Crop & Food Research proposed harmonisation and adherence to minimum standards, including INFOODS recommendations, for all Ministry of Health contracts with a food composition component, regardless of who the provider was. MoH was in agreement with this in principle, but felt the providers should make the effort independently. This was not successful. In 1995 the issue was forced by specifying in service level agreements with ESR that the data be compatible with the New Zealand Food Composition Database. Even this specification was not entirely successful, because no resources were provided in the contract. In 1996/97 MoH forced a collaboration between Crop & Food Research and ESR on a project which was tendered for vigorously by both organisations: The Total Diet Survey. Each organisation wanted control of the project and all the associated revenue.

Prior to 1996, however, tendering by the MoH was not undertaken, and food composition work (and the funds) were given directly to Crop & Food Research; and other analytical projects (and the funds), including the Total Diet Survey, were given directly to ESR. The food composition work has not yet been tendered, because Crop & Food is considered by the MoH as the only qualified organisation to manage this work. For many years this was true, because the public good science funding provided the appropriate research backdrop and infrastructure enabling the health funding to be applied effectively to food composition projects of most use to the health sector (e.g. nutrient composition of snack foods and baby foods), work that would not be funded by the science sector. The combination of rigorous food composition scientific research and very applied food composition health sector "service work" was synergistic. But with the decline in public good science funding for the food composition research activities, it could be argued that the food composition database would be better maintained directly by the MoH or another government department such as the Ministry of Agriculture and Fisheries because core-funding required for activities and projects of national importance would then (potentially) be available. PGSF does not provide funds for the necessary, non-research maintenance and attention that the food composition database requires. Another funding avenue pursued by the nutrition programme was to submit this database as a “PGSF database of national significance” so that funding for general maintenance and updating could be provided. This avenue was rejected by Crop & Food Research’s top-level management on the basis that it would restrict the Institute’s ability to charge commercial rates for data products and could affect the ability to treat the data products, and the data, as Institute-owned intellectual property.

2.3.4 New Zealand's Nutrition Labelling and Methods of Analysis

Up until July 1, 1996 in New Zealand, the Ministry of Health was responsible for operating the Food Standards Committee which drafted and gazetted food legislation. Crop & Food Research was, and continues to be, responsible for developing and maintaining the country's food composition data base and coordinating the nutrient analysis programme. Harmonising nutrition labelling with nutrient analyses nationally had not been difficult. New Zealand's nutrition labelling legislation, contained in the *Food Regulations 1984 and Amendments* (Department of Health, 1992), is reasonably flexible. With the exception of "special purpose" foods, and foods for which a claim is made, nutrition labelling is voluntary. There is only one prescriptive analytical methodology, AOAC Prosky dietary fibre (Official Methods of Analysis, 1990). The far right column of Table 2.2 shows that this is one of the components for which there is incompatibility between food composition data base and food labelling. In New Zealand, the routine fibre method used for the Food Composition Database is Englyst soluble and insoluble non-starch polysaccharides (Englyst and Hudson, 1987). The only other prescribed methodology is for carbohydrate, but this is ambiguous and internally inconsistent:

> (a) Means any carbohydrate substance that is capable of being metabolised, and includes glycerol and any other sugar alcohol; and
> (b) May be calculated by subtracting the percentages of water, protein, fat, and ash from 100:

In other words, carbohydrate can be analysed “available carbohydrate” (with the implied

INFOODS tagname <CHOAVL>)[4] or it can be "total carbohydrate by difference" (with the implied INFOODS tagname <CHOCDF>). The values for the different expressions of carbohydrate for the same food would be different, and by a significant margin for foods high in fibre.

No other methods of analysis are specified in New Zealand's food regulations. This presents another harmonisation issue – non-prescription of methods can be even more problematic because a range of "correct" results is possible for the same nutrient in the same food. It is conceivable, and legal, for a manufacturer to pick methods of analysis that will give the most nutritionally-flattering profile to the food in question even if the results are internally inconsistent (e.g. n-3 fatty acids content higher than total fat content). Additionally, the information is usually supplied without the understanding or documentation of method. The potential for ambiguity has been avoided in the Food Composition Database by the use of INFOODS tagnames to identify the food components; many tagnames are method-specific (Klensin *et al.*,1989). Chapter 4 of this thesis, describes food components in greater detail as a technical management issue.

2.3.5 International Nutrition Labelling and Methods of Analysis

Incompatibilities within and between organisations, countries and regions

By way of comparison, it is not uncommon for one organisation in a country to have the responsibility for determining nutrition labelling requirements, and another to have the responsibility for that country's food composition programme, as shown in Table 2.2.

One familiar example is the United States, with the US Department of Agriculture (USDA) having food composition data responsibilities and the US Food and Drug Administration (FDA) having most of the nutrition labelling responsibilities (Food and Drug

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4 INFOODS tagnames, contained in the angled brackets < > and their significance in managing food composition harmonisation issues, are described in detail in Chapter 4, Harmonisation Issues in Identification of Components.

Administration, 1993). The far right column of Table 2.2 shows that the incompatibilities between these two agencies includes the food component "fat". The USDA determines fat by a solvent extraction and gravimetry procedure, while the FDA's Nutrition Labelling and Education Act (NLEA) (Food and Drug Administration, 1993) requires fat to be expressed as the sum of the analysed individual fatty acids, calculated as triglyceride equivalents. The energy content of foods is another area of methodological disharmony. The FDA requires the so-called "4-9-4" rule for energy factors, that is grams of protein, fat and carbohydrate should be multiplied by 4, 9 and 4 respectively. The USDA uses a range of factors for each energy-yielding component, and these are detailed later in this chapter.

COUNTRY	**ORGANISATION RESPONSIBLE FOR FOOD LABELLING**	**ORGANISATION RESPONSIBLE FOR FOOD COMP DBASE**	**NUTRIENT INCOMPATIBILITY**
USA	FDA	USDA	Fat, Energy
UK	MAFF	Royal Society	Carbohydrate, Protein, Energy, Vit A
NZ	Ministry of Health	NZ Institute for Crop & Food Research	Fibre, Carbohydrate
Australia	National Food Authority	National Food Authority	Fibre, Carbohydrate

Table 2.2 Organisations with major roles in food labelling and food composition databases, and their nutrient incompatibilities.

Australia is unusual among the countries listed, in that the same agency, the National Food Authority (NFA)[5], is responsible for both activities. NFA was created in 1991 for the purpose of consolidating these various food-related activities. Even so, there are still some areas of incompatibility between methods used in the food composition work and methods prescribed for nutritional labelling, specifically carbohydrate and fibre as shown in the far right column. For instance, crude fibre <FIBC> is a labelling requirement for breads, and

5 On 1 July 1996, the agency became known as The Australia New Zealand Food Authority.

Prosky AOAC fibre <FIBTG> is presented in the food tables/data files. The carbohydrate values in the food tables are "available" carbohydrate obtained by summation of sugars, starch, glycogen and other related compounds <CHOAVL>[6] (NFA, 1992) and on food labels it is total carbohydrate obtained by difference (i.e., 100g minus the grams of water, protein, fat and ash) <CHOCDF>.

Another example of a country where food labelling and food composition data base development reside with different agencies is Canada; Agriculture and Agri-Food Canada has the responsibility for food labelling, and Health Canada has the responsibility for the national food composition database.

Regional and international organisations further compound the issue by their involvement in food composition-related regulatory and policy development activities. For example, in Europe there are the EC Directives, individual countries' legislations, and the Codex Alimentarius Commission, all with their own compositional standards, labelling regulations, and nutrition guidelines. There is not a coherent coordinated approach. This topic is discussed in greater detail in Chapter 5 of this thesis, *Harmonisation for Food Legislation and Food Trade Regulations.*

With the exception of New Zealand, all the countries and organisations listed in Table 2.2 have official, government-endorsed responsibility for their food composition-related activities.

2.3.6 Effects of international disharmony of New Zealand's food composition data generators and the national programme

There is a multiplicity of methods of nutrient analysis and food composition information disclosure for food labels for export markets around the world. This problem is compelling

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6 The term used in the Australian food composition tables is "Carbohydrate, total," although the definition used is "carbohydrate obtained by summation of sugars, starch, glycogen and other related compounds," i.e., excluding dietary fibre.

for food exporting countries like New Zealand when each food must comply with the labelling legislation in each of its export markets. It is also compelling for food composition data generators and the agency compiling the national food composition database. New Zealand's food manufacturers, producer boards, and food exporting authorities require high quality food composition data to use for compliance with the regulations in their export markets. For this they rely on the published data in the national food composition database, and they are also reliant on data generators throughout the country. When data generation is part of the national programme's activities, a significant contribution to the programme's revenue can be earned by offering commercial analytical services. New Zealand's national programme is so placed, and thus provides nutrient analysis services to industry. Because the national programme is only one of many commercial laboratories in New Zealand, many other laboratories provide commercial nutrient analysis services and data to New Zealand companies. Many of the data generators do not provide analytical data which will meet the quality criteria demanded for inclusion in the national food composition database, or which complies with the regulatory demands or methods in the export markets. Crop & Food Research is made aware of the methodological disharmony when companies offer their data for inclusion in the national database, and when products are rejected by the overseas market because of improper or incorrect label information. This has been a common occurrence for the national programme since 1993 (Burlingame, 1996) with the enactment of the Nutrition Labelling and Education Act (NLEA) (Food and Drug Administration, 1993). Nutrition labelling of most food products had been almost universally voluntary until that point. Because foods needed a Nutrition Facts label for the very important US market, food exporters wanted to make the most of their investment in analysis and provide data on all their product labels. Most companies were very unpleasantly surprised to find out that food label nutrition information was not standardised.

Some of the problems encountered relate to the other data generators, and Crop & Food Research has documented the following:

- Ignorance of, or unfamiliarity with, market requirements. This has been illustrated on many occasions when food companies have requested "nutrition analysis," and have been provided with an incomplete or incorrect profile of nutrients; or profiles excessive to their needs. For example, the provision of a sodium value without provision of a potassium values (if one of these is on the label, the other must be also, according to the New Zealand regulations). Or provision of total carbohydrate by difference when a complete analytical carbohydrate profile was required (or less frequently, a complete and costly analytical carbohydrate profile, when total carbohydrate by difference was all that was required).

- Incomplete or missing documentation of methods of analysis and laboratory quality control and assurance procedures. Many methods are rational, meaning the analyte in questions is what is measured, and the result is mostly independent of the method. There are, however, significant numbers of methods that are empirical, meaning that the result obtained is reflective of the method used as much as the analyte measured (Codex Alimentarius Commission, 1997). For these components, the methods must be documented before the data can be used in the national database. Documentation is not required for a food label, except when that label is subjected to compliance testing.

- Unfamiliarity with, or ignorance of, the food matrix. For example, one New Zealand finfish exporter provided nutrition information with his smoked fish fillet exported to the Canadian market, that stated a total carbohydrate content of 20%. This shipment was rejected from the Canadian market because inspectors knew that either it could not be labelled as smoked fish if it had a carbohydrate content that high, or that the nutrition information was grossly incorrect. The reanalysis was conducted by Crop & Food Research, at which time the analyst contacted the first laboratory to see what their difficulty had been. The laboratory manager said that they were not familiar with the food matrix, delivered a value of total carbohydrate by difference. The manager did state that had he known it was just fish fillets, he would have insisted that all the proximate analyses be redone. Other examples include lipid extraction procedure validated for meats but used for cereals; and a vitamin B12 analysis validated for serum and used for mushrooms.

- Provision of only processed or aggregated data. Without baseline data, other required expressions of nutrient content cannot be calculated. For example, a protein value alone is often provided, without any indication of the total nitrogen (N) or the nitrogen conversion factor. This will prevent the manufacturer from knowing how to comply with the different export markets, some of which demand N multiplied by 6.25 for all foods, and others of which demand N multiplied by a range of factors depending on the food. With the protein value plus either the N or N conversion factor, the alternative expression of protein can be calculated.

- Incorrect or incomplete provision of the data in valid units. The most trivial differences relate to different units of presentation, requiring the simplest of calculations for conversion. For example, sodium is expressed in milligrams in New Zealand and the United States, and in grams as part of the EC Directive (The Royal Society of Chemistry and Ministry of Agriculture, Fisheries and Food, 1992); conversion back and forth simply requires multiplying or dividing by 1000. Sometimes the requirements involve slightly more elaborate calculations such as vitamin A in micrograms of retinol equivalents as required in Canada (Food Division, 1993, 1994) and New Zealand, versus international units as required in the USA pre-NLEA, and as a percentage of a daily reference value (DV) since NLEA. The requirements can involve different factors in the simple calculations; for example energy in kilojoules in most countries, sometimes with kilocalories as an optional addition, versus kilocalories exclusively; and protein calculated with the standard 6.25 as prescribed by the EC Directive, versus a calculation with a different reference nitrogen conversion factor as prescribed by Codex Alimentarius (Codex, 1995).

For some of these incompatibilities between different markets, a typical food technologist or nutritionist could easily take basic laboratory data and satisfy all these different market requirements, but they must receive the baseline data and all the associated and relevant documentation.

Some differences are more significant and problematic, requiring different methods of analysis for reporting basically the same nutrient entity.

Fat

One of the most problematic of the nutrients is fat, as defined by the NLEA as triglyceride equivalents of fatty acids. This method requires analysis of the individual fatty acids, and then the application of an algorithm to calculate the fatty acids as if they were all part of a triglyceride molecule. Most fat analyses involve extraction and gravimetry. The method to determine the quantity of fat by extraction in a food is significant because different methods and modifications to methods result in different extractions of fat from the same food. It is inappropriate to prescribe one method of analysis because no single method is "correct" for all food matrices (AOAC, 1990). In addition to methods, correction factors are sometimes used to account for behaviour of some lipid fractions under physiological conditions, e.g. subtraction of the wax ester component from the total lipid in certain marine species. This can have a dramatic effect on the reported fat value. In New Zealand, seafood companies have gone to the expense of having the non-metabolisable fat component of their product analysed when they were told it would allow them to report a lower fat content in some markets.

Protein

Protein is rarely analysed directly. The most common method for expressing protein is by direct analysis of nitrogen, and multiplication of this value with a selected nitrogen conversion factor. This is not straightforward. The nitrogen values used can be total nitrogen <NT>, amino nitrogen <NAM>, and protein nitrogen <NPRO>. The nitrogen conversion factor can be the standard conversion factor 6.25, or specific factors as used and/or recommended by FAO (1970), Jones (1941), and USDA (1975-94). These specific factors can range from a low of 4.17 for mushrooms to a high of 6.38 for milk.

Protein calculated as nitrogen times the standard 6.25 is dictated by the EC Directive, whereas Codex Alimentarius prescribes calculation with at least one different reference nitrogen conversion factor, i.e., 5.7 for durum wheat semolina and durum wheat flour.

Most food composition tables use the full range of specific factors, but most do not document this fact by including the analysed N value or the factor.

Carbohydrate

The two major distinguishing features between different expressions of carbohydrate are (i) "available" versus "total" (i.e., available + unavailable) and (ii) monosaccharide equivalents vs the weight of the carbohydrate. The New Zealand food regulations are ambiguous, as described earlier, and can be interpreted as permitting use of either available or total carbohydrate. Nowhere in the NZ regulations, or the Australian regulations, is mention made of expressing carbohydrate in monosaccharide equivalents or by weight of the carbohydrate. The inference is that either would be acceptable. Carbohydrate is used as the primary example of the food component identification as a technical harmonisation issue in Chapter 4 of this thesis. Data are provided in this chapter which illustrate the magnitude of the differences in numeric values with the different expressions of carbohydrate.

Fibre

As mentioned earlier in this chapter, fibre is the only component with an explicitly prescribed method of analysis in New Zealand's food regulations. Nevertheless, fibre from crude fibre determinations, total dietary fibre determinations, and non-starch polysaccharide determinations are all found on food labels. It seems that food companies make no distinction between the methods, even though the nutrient entities, *per se*, are different (Monro & Burlingame, 1996). Being in breach of this regulation for a food label is inconsequential in most markets because surveillance and compliance testing are rare. Fibre, along with carbohydrate, is used as an important illustration of the food component identification as a technical harmonisation issue in Chapter 4 of this thesis. The implications are detailed both qualitatively and quantitatively.

Energy

The requirements for energy determination can involve different factors in the simple calculations; for example energy in kilojoules in most countries, sometimes with kilocalories as an optional addition, versus kilocalories exclusively. Many conventions are in use, most commonly by calculation using factors with energy-yielding components. Some conventions specify the same factor for each component, e.g., 4 X g total protein for energy in kilocalories from protein; while others use a range of different factors for each component.

Factors to calculate energy contributed by protein can range from a low of 1.82 for bran, to a standard value of 4 for all foods, to a high of 4.36 for eggs.

Factors to calculate energy contributed by fat can range from a low of 8.37 for most grains, to a standard value of 9 for all foods, to a high of 9.02 for eggs.

Factors to calculate energy contributed by carbohydrates can range from a low of 1.33 for chocolate, to a standard value of 3.75 for available carbohydrate in monosaccharide equivalents <CHOAVLM> and 4 for total carbohydrate <CHOCDF> for all foods, to a high of 4.12 for distilled spirits.

Other components provide energy, and factors have been recommended for individual organic acids (Livesey, 1989), polyols (Livesey, 1992; FASEB, 1994), and fractions of dietary fibre that yield energy from short-chain fatty acid production and absorption after colonic fermentation (Livesey, 1990). The New Zealand and Australian Food Composition Databases provide energy data including the contribution from individual organic acid data, when these data are available. The food regulations for Australia, but not New Zealand, specify factors for individual organic acids for food label energy. The cost of analyses for these other components is comparatively high. For example, the cost of analyses for gravimetric fat, Kjeldahl N (protein), moisture and ash are from NZ$16 - NZ$ 60 each. The cost for analysis of individual organic acids is approximately $200. Most data generators would not be set up to perform analysis for polyols or fractions of dietary fibre. Crop &

Food Research has only occasionally received requests for analyses for organic acids and fibre fractions, but never has the national programme received a request for polyol analyses from commercial clients.

In addition to selecting the components to use in an energy calculation, and selecting the factors to apply to the energy-yielding components, the method or convention for expressing the components (as described above for fat, protein, carbohydrate and fibre) will affect the calculated energy value.

Nutrition labelling is accepted by most food producers around the world and even embraced by many (Burlingame & Brennan, 1991). However, regulations and requirements such as the NLEA are often described as on-tariff trade barriers, particularly when exporters calculate the cost of the nutrient complying (Burlingame, 1996a). In most commercial laboratories, the cost of a gravimetric fat analysis is about 25% of the cost of a comprehensive fatty acid analysis, which is needed for determining fat as the triglyceride equivalent of fatty acids. This cost, together with those for total nitrogen, individual mono- and disaccharides, starch, fibre, sodium, calcium, iron, vitamins A and C, and cholesterol, for the "short" form of the NLEA label, represents a substantial cost for each food analysed. It should be noted that NLEA does not prescribe methods of analysis *per se* for food labels, but rather it specifies the methods of analysis that will be used for “compliance testing” (Code of the Federal Regulation, 1997).

Efforts could be undertaken by the national programme to make the other data generators aware of the nutrition information requirements in markets around the world, but this would compromise one of Crop and Food Research’s competitive advantages as a data generator. Efforts could also be undertaken for running food composition workshops specifically related to export markets, and directed at the food industry. Some analogous seminars have been run by TradeNZ and Food & Beverage Export Council, but these focussed, largely, on the regulatory environment created by the establishment of ANZFA, with general information transfer regarding all aspects of New Zealand and Australia’s closer economic relations.

The topic of nutrition labelling compliance is also addressed in Chapter 5, *Harmonisation for Food Legislation and Food Trade Regulations.*

2.4 CONCLUSIONS AND RECOMMENDATIONS

New Zealand is unique among the countries evaluated in that it operates its national food composition programme as a commercial activity. The future impacts of anticipated changes with respect to financial accountability of the Institute, and the ability to compete for commercial revenue, may continue to be problematic for operating a national food composition programme in a commercial environment. Many of the requirements of the PGSF are incompatible with the operational needs of a national food composition programme. Submitting the food composition database as a PGSF database of national significance, and receiving funding for its routine maintenance and development, would solve some of the immediate and long term problems. It would also enhance the national programme's opportunities for attracting funding for PGSF research in food composition data generation such as new methods development, nutrient variations related to climate change, and composition of novel foods and genetically-modified crops. Alternatively, finding a new "home" for the national food composition programme within a government department, and obtaining an official mandate for its necessary maintenance and development, would also provide a solution.

Although the current operation appears more difficult than when it was undertaken within the structure of a government department with "core" funding, it is difficult to judge the impact of commercialisation on all of its activities. Other countries investigating privatisation of government activities will be able to look to New Zealand's national programme's operation and assess the feasibility of commercialising. In some countries where the activity is currently not funded at all, commercialisation, or some cost recovery in full or in part, may prove beneficial.

Still to be resolved with an international-level position statement is the issue of 'ownership' of food composition data. It would be naive to believe that this will be a straightforward issue, taking into consideration the costliness of national programmes' operations and the investments of governments.

Recent development in New Zealand that have brought about greater inter-agency harmonisation in food composition activities include the following:

- the Ministry of Health's contract for the Total Diet Survey has specified a collaboration between Crop & Food Research and ESR,
- a subcontract with LINZ on the National Nutrition Survey for the preparation of the nutrient database which will be used to analyse the results of the survey,
- the requirement in other MoH contracts with ESR and others to provide data that are compatible with the NZ Food Composition Database (eg nutrition supplements project), and
- the dialogue established with Statistics New Zealand for the food composition-related features of the Annual Agricultural Survey and Food Balance Sheets.

The year 1997 was the culmination of all these events, after at least four years of proposals and advocacy from Crop & Food Research for standards' development and/or harmonisation. In most cases, it was the purchaser (MoH) dictating by contract to the providers that this harmonisation was necessary that brought about the desired result. It was not the good intentions of the providers that ultimately facilitated the harmonisation efforts.

The year 1997 was also that year that Statistics New Zealand advised the country that it would no longer prepare the Food Balance Sheets. This becomes another opportunity for the national programme to step in with some harmonisation initiatives to combine the food balance sheet project with the NZ food composition data projects. This will help make the data useful to not just the agriculture sector, but also the health and educations sectors. Furthermore, by combining these projects, finer detail may be elucidated that would contribute to more specific health and agriculture policy-making. Potentially problematic would be the allocation of funds that would be insufficient to cover labour, overheads, operating costs, and the minimum 10% profit required by the Institute.

The problem that is most significant to the greatest number of New Zealanders is dealing with a multiplicity of overseas labelling requirements for export products. This is a difficult problem for a country so reliant of food exporting industries, when each food must comply with the labelling legislation in each of its export markets. Undertaking nutrient analysis and label preparation to comply with labelling requirements for all exported products in all markets, is achievable analytically and administratively, but it is burdensome and expensive. Many data generators have difficulties related to keeping up with the variety of nutrient analysis requirements and data presentation requirements in the different markets around the world. Not all food companies are convinced, however, that this is one of the unavoidable costs of doing business, and many companies prepare a food label for one market and use it in others. This is certainly the case for the very prescriptive NLEA label that can be found on many foods on the supermarket shelves in New Zealand, in spite of the fact that it is in violation of New Zealand's food regulations.

The near future will likely not see international harmonisation for food composition databases or labelling requirements, and the difficulties will continue. The greatest hope, at least for nutrition labelling, is the universal adoption of the principle of mutual recognition. These trade and regulation issues are discussed in greater detail in Chapter 5 of this thesis, while the technical issues of identification of food and food components will be discussed in Chapters 3 and 4.

3. HARMONISATION ISSUES IN IDENTIFICATION OF FOODS

3.1 INTRODUCTION

As established in the first chapter of this thesis, food composition activities are being undertaken by a variety of agencies, programmes/projects and people, for an ever-increasing number of reasons, without a cohesive framework or proper management guidelines. The result is that these data are not nearly as useful or effective as they should be for their many important purposes. This is a management problem with implications that are national, regional and international. Among the requirements for solving the problems is the need to establish, quantify and resolve the key technical issues. Principal among the technical issues is food identification.

With food identification, the technical harmonisation issues have proved difficult. Disharmony in the area of identification of foods, as in other areas of food composition project management, takes many forms. The problems can manifest as poor, incomplete or ambiguous names or descriptions of foods listed in data bases, improperly named foods available for sale in the domestic market, or food names that do not comply with food standards when traded internationally. Not only does this limit the usefulness of the information (Burlingame, 1991) for all the sectors and purposes described in Chapter 1 of this thesis, but improper identification of foods can also result in legal action, loss of markets or market share, and other tangible and quantifiable problems (The Press On-Line, 1997).

A few solutions have been recommended over the years to deal with the technical issue of food identification. These include systems developed in the 1970's and 1980's including modifications to the International Feed Information Center system (Harris *et al.*, 1980), Eurocode 2 (Arab *et al.*, 1987), the Factored Food Vocabulary system (McCann *et al.*, 1988), and the CoData system for nutritional epidemiology (Butrum, 1985). All these proposed solutions relied on words, alphanumeric codes, position-specific facets, etc., and they did offer an approach to standardising the way foods are identified.

Up to the present time, only two potentially useful food identification systems presented to the international food composition community have shown some endurance: Langual (Pennington & Butrum, 1991) and the INFOODS Nomenclature and Terminology System (INT) (Truswell *et al.*, 1991).

Langual's original development was undertaken for the purpose of creating a system that could meet the regulatory responsibilities of the US Food and Drug Administration (Pennington & Hendricks, 1992). It is a rigid hierarchical food description language, relying on alphanumeric codes, not text, within the facets, and thesauri to provide the translations (Hendricks, 1992). It was these principles and philosophies that appealed to the EUROFOODS regional group. In their attempt to deal with the multiplicity of languages on the European continent, a European Langual Working Group was established in the early 1990's, to be the focal point for Langual use in Europe and to communicate needs to the US Langual Committee where all the computer programs were housed. It is currently the system of choice for EUROFOODS, and has been incorporated into the country databases in France, Denmark, Sweden, and Slovakia. To date, it has never been used in the US for regulatory purposes (Chatfield, 1995). In fact, the USA handed over all responsibility for management, updating, and maintenance to the European Langual Committee in early 1997 (Schlotke, 1997). Although widely used in Europe by the food composition professional community, Langual has no regulatory role in the European Union.

INT is text based and relies on a multifaceted descriptor approach. It is open-ended without standardised terms, allowing data generators to describe foods in their own words. The system distinguishes between single and mixed (multiple ingredient) foods with different facets. The INT, or modestly customised forms of it, is used in New Zealand, the Pacific Islands, seven ASEAN countries, at least two African countries and ten Latin American countries. It is also being incorporated into the working systems in Middle Asia (China, Korea, etc.) and South Asia (Pakistan, India, Sri Lanka, etc.) (Burlingame, 1993b, 1993c, 1994b,1994c, 1995b, 1995c, 1996b, 1996f).

In this chapter the following will be presented:

- An overview of the current systems and how they are managed and used;
- an analysis of the major advantages and disadvantages of those systems, including the impact of language, culture, food standards and international interchange;
- a complementary solution—images—for alleviating some of the inadequacies of the two systems;
- examples of the benefits to different sectors arising from harmonisation in food identification;
- a set of recommendations for managers of food composition programmes; and
- future directions for achieving harmonisation in the identification of foods.

3.2 MATERIALS AND METHODS

Three separate approaches have been taken to address the issue of harmonisation in the identification of foods: a critical analysis of Langual and INT, a survey of regional data centre coordinators, and the development and trialing of a graphics system. Each is described below.

3.2.1 Critical Analysis of Langual and INT

New Zealand's Food Composition Data System, managed in Advanced Revelation® relational database management systems software (ARev®), on a Pentium® file server with multi-user access, was adapted to allow incorporation of Langual and INT systems.

Langual was studied by obtaining coding for the entire finfish section of the New Zealand Food Composition Database. The data file was submitted by electronic mail to the United States Food & Drug Administration (FDA). Langual coding was undertaken by Elizabeth Smith, Technical Information Specialist of the FDA's Center for Food Safety and Applied Nutrition. The coding was prepared, printed and mailed back to New Zealand. A field was created in ARev® to allow entry of this information. Langual coding manuals were also used within the food composition programme to assist with the understanding of the codes and vocabulary.

The INT system was applied to the entire food composition database by modifying the multifaceted naming system that had been in use since 1988.

The criteria for evaluation of the two food identification systems were constructed from informal and formal discussions and focus group sessions at regional and international meetings (as reported in Chapter 1 of this thesis), and subsequently confirmed and modestly expanded during meetings of the New Zealand Food Composition Programme team.

The criteria used to evaluate the two systems included the technical usage of the systems by New Zealand's database systems' analysts and data compilers, the use by local professionals within New Zealand, and international data interchange of the information. These two systems were also examined to determine their suitability for use with food composition data files from seven other countries involved in data interchange with New Zealand (Australia, Pacific Islands, Chile, the United States, Guatemala, Philippines and Thailand). Assessment of the systems with several different national databases, as well as the OCEANIAFOODS regional database, provided the opportunity for differentiation of both the national and regional applicability of the two systems.

3.2.2 Survey of Regional Data Centre Coordinators

Based on these experiences, a questionnaire (see Appendix 3) was constructed that would either confirm that the criteria, and therefore the results, elucidated in New Zealand were generally applicable, or would determine if there was a broader set of criteria important for others involved in similar work. Regional data centre coordinators worldwide were selected as the most appropriate group of people to respond to the questionnaire because of their experiences managing food composition programmes at both the national and regional levels.

For ranking ***national*** importance, regional data centre coordinators were asked to base their responses on their experience managing their countries' food composition programmes, including their knowledge of the personnel involved in compiling data, and their understanding of the needs of their national data users. For ranking ***regional*** importance, they were asked to base their responses on either their actual experience of managing the compilation of a regional database, or the future likelihood that they would receive data files from countries in their region for the purpose of compiling a regional database. For those who had not actually been involved in the preparation of a regional database, they were reminded that this would entail, among other things, the assessment of which foods/processes were the same and which were different, and categorisation of many nations' foods into the correct groups.

Two sets of rankings, "regional" and "national", for relative importance of food database criteria as perceived by the regional data centre coordinators were analysed using two nonparametric statistical methods: the Kruskal-Wallis One Way Analysis of Variance of Ranks (Kruskal & Wallis, 1952) and the Friedman Two Way Analysis of Variance of Ranks (Friedman, 1937). Minitab® statistical analysis program was used for both the K-W analysis and the Friedman analysis. The K-W analysis was repeated in Genstat® statistical analysis program. Friedman analysis uses regions as seven blocks, and looks at the effect of criteria to answer the question: "Do the criteria differ in importance?" K-W analysis does this without removing block effects first. It analyses the Criteria first to answer the question "Do the criteria differ in importance?" with somewhat less precision than the Friedman analysis, and then treats Regions as a fixed effect in a fresh analysis to answer the question: "Do some authorities tend to make everything more important than others?". These three analyses are performed for both the regional and national data sets.

The questionnaire is shown in Appendix 3.

3.2.3 Images

The final method used to study harmonisation issues for food identification was imaging. This process of food identification was initiated in 1992. Food samples were collected and then prepared in the laboratory. Samples were photographed intact, raw, and after consumer-type preparation (e.g. processed by cooking). Each sample was photographed with a scale definition (metric ruler), and one of two different colour indices (Pantone sheets and Kodak colour panels) (see Figures 3.1 and 3.2). Food packaging and labels were also photographed so that all packaging details, including ingredients and bar codes, were readable. This procedure was always used as a complement to conventional documentation of word descriptors and detailed text containing the standard details (e.g. maturity of sample, date of sampling, geographic region, common and scientific name, physical state, processing, packaging, etc.).

The photos were then digitised using an optical scanner at 400 dpi resolution and converted into PCX, and/or GIF and JPEG formats. The images were stored on a 1 GB hard disk and on CD-ROMs, and were viewed on Super VGA monitors using 1 MB video cards capable of displaying 32,000 colours from a palette of more than 16 million colours.

The image files were then made accessible for internal use by the scientists and technicians in the food composition programme, and for external use by food industry and health researchers around New Zealand. Results of the use of images were documented over a three-year period.

3.3 RESULTS AND DISCUSSION

3.3.1 Critical Analysis of Langual and INT

Implementation of INT was a simple, straightforward exercise that caused little disruption to the system in place or the people involved in food composition work in New Zealand. Switching to INT required less than one hour of programming time to incorporate a few new facets into the naming system that had been in existence since 1988. Use of the system required no re-training of staff because the earlier system resembled INT and because staff viewed INT as a pragmatic and intuitive approach for identifying foods. Some of the reasons for the ease of conversion related to the original philosophy of INFOODS; that is that a food identification system should consider the great cultural and commercial complexity of human foods and allow these foods to be described at the level of analysis in sufficient detail so that subsequent users of the analytical data, including users in other

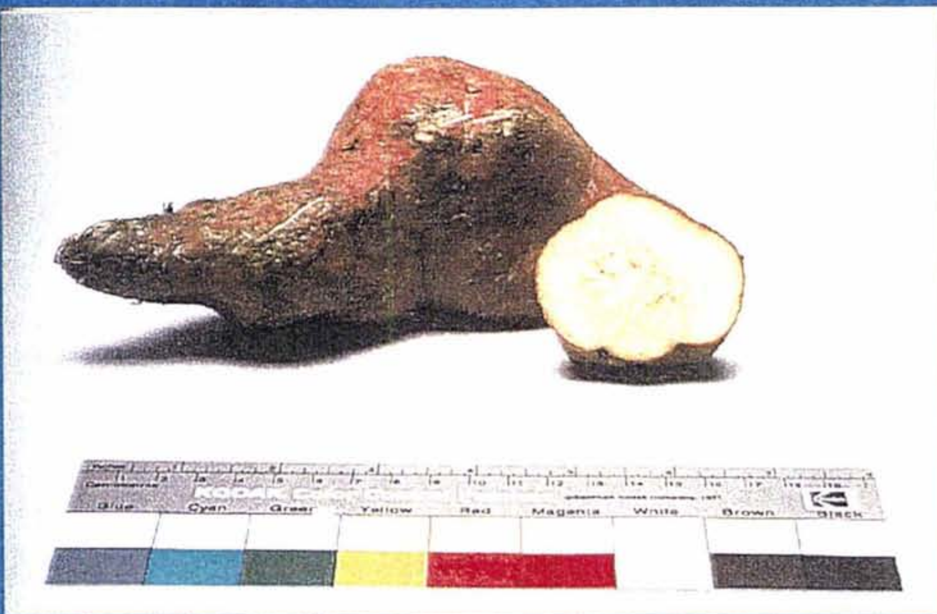

Figure 3.1 Sample documentation of a NZ kumara using an image with a metric scale ruler and colour standard sheet (Kodak Color Control Patches).

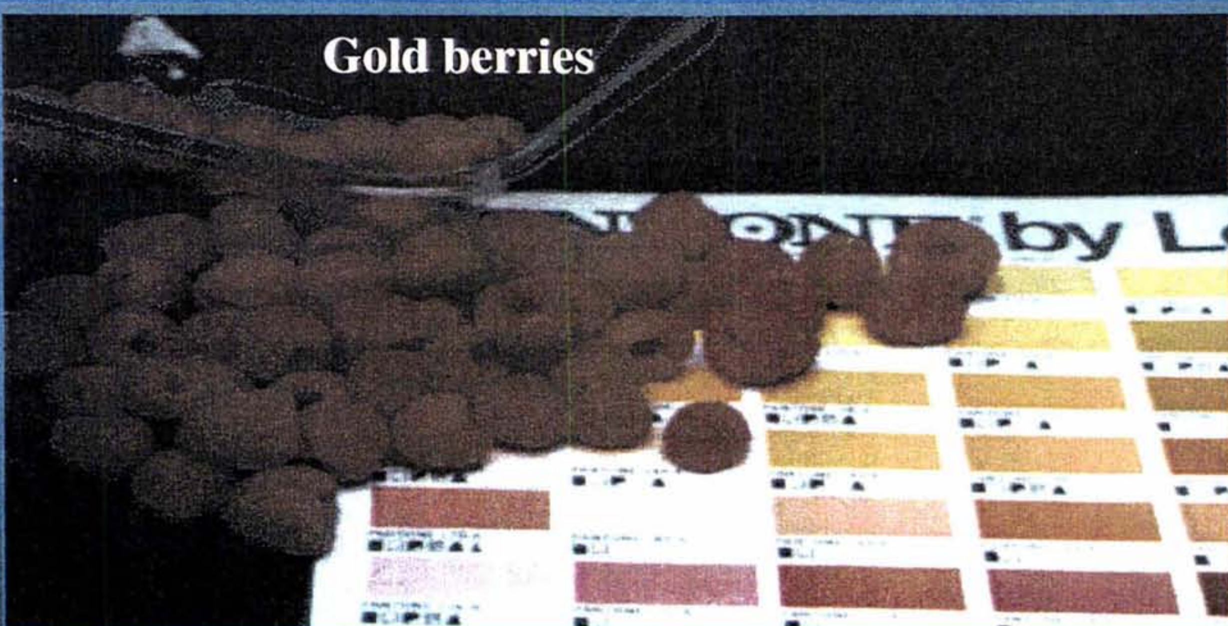

Figure 3.2 Sample documentation using a Pantone sheet as the colour standard.

countries, could clearly recognise a food and distinguish it from other foods (Truswell *et al.*, 1991).

Langual involved a more difficult implementation process, and, in fact, has never been successfully integrated into the New Zealand system. At the time of the study, all Langual coding was undertaken at FDA headquarters in Washington, DC, where the Langual database was attached to a Vax hardware system in a hierarchical database management software system (as opposed to relational database management software). The necessary thesauri were not available for outside use, making the coding received from FDA untranslatable locally.

In the assessment of the suitability of the systems for endorsement as the international standard, the systems were ranked against a set of parameters believed to be important for identifying foods. All of the parameters were based on personal experience in managing the New Zealand programme and creating the OCEANIAFOODS database, and as a result of national, regional and international discussions, focus groups and other interactions described in Chapter 1 of this thesis.

Eight criteria emerged as relevant to the issue of identifying foods; these are shown in Table 3.1. They cover language and cultural independence (items 1 and 2), the labour and skill required for learning and maintaining the system (items 3 and 4), usefulness for local users of food composition tables and databases (items 5 and 6), adequacy for visual documentation, such as colours (item 7), and their benefits and/or requirements for international trade of foods (item 8). Three of these criteria are strictly local (3-6) in their applicability, while the others have both local and international relevance.

Table 3.1 shows that Langual and INT scored differently when viewed on the basis of local development and use, and on the basis of international interchange of food composition data. Langual scored better in relation to addressing issues of barriers of language and culture. INT scored better in relation to "friendliness" to data compilers and local usefulness. However, some fundamental limitations are common to both systems. Both systems of food identification failed to adequately address certain requirements for international applicability, such as adequately identifying colours of foods and cultivars of the same species. Colour is an important parameter in the identification of foods because one of the world's most prevalent nutritional deficiency disorders relates to the micronutrient vitamin A. Carotenoids, the yellow/orange pigment in many fruits and vegetables, have significant vitamin A activity, directly proportional to the intensity of the colour (Eder, 1996). Cultivars are often distinctive in their nutrient attributes, and often these cannot be adequately differentiated with codes or text descriptors.

Criteria	Langual	INT
1. Language independence	good	poor
2. Culture independence	good	poor
3. Compiler-friendly	very poor	very good
4. Ease of maintenance	very poor	very good
5. Local usefulness in food composition tables	very poor	very good
6. Usefulness in computer dietary assessment software packages	very poor	very good
7. Ability to visually document foods (e.g. the colour of foods, packaging, bar codes, etc.)	poor	poor
8. Usefulness in international food trade	potentially good	poor

Table 3.1 Ratings of two international food identification systems, based on assessment in Crop & Food Research with local data and overseas databases.

Language Independence

In the actual use of data files with Langual codes, Langual showed a high level of language independence when assessed with data sets in English, Spanish, and Thai. That is, for common foods, there are Langual codes that can be computer-read and converted using a faceted thesaurus (part of the 1997 Langual package), allowing the "foreign" national language to be ignored. One of the reasons European countries have adopted Langual for regional interchange is because it serves that region's most critical criterion of language independence (Schlotke, 1996).

However, in assigning Langual codes to data files, it became apparent that the system was indirectly highly language-dependent. The first difficulties became evident when coding was undertaken for foods where descriptors had not been assigned Langual codes, and where there seemed to be subtle differences between Langual facets. Raw, for example, was not among the facets that could be chosen, and many difficulties arose when trying to differentiate between "product type" and "food source", 'extent of heat treatment' and 'preservation method'.

A second, and potentially more serious problem became evident, namely, the human element of using the local knowledge and language, and coding with Langual. The ambiguities inherent with the English language manifested immediately with several mistakes relating to inconsistencies in terminology applied to foods. A Langual coder must understand a certain form of American English in order to properly assign codes. Table 3.2 illustrates some equivalent food terms from the New Zealand Food Composition Database and the United States (USDA) food composition database. In all of these examples, the equivalent foods have different names. Adding to the confusion, there are cases where the same name is used for different foods (e.g. biscuit, tomato sauce). In all cases, the incorrect Langual code was applied to at least one facet by the New Zealand coder[1].

This should not be surprising. Studies have shown that even within the same country and same city, there are many ambiguities in the identification of foods. In the same city in the United States, trained interviewers who independently collected 24-h dietary recalls from the same children disagreed on 24% of the food names (Frank *et al.*, 1984).

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[1] Beyond the coding manual use and the examination of datafiles with Langual codes, Langual was further explored during 1996 and 1997 by using the partially-completed International Interface Standard, commissioned by FDA and prepared by TAS; and the first electronically available Langual version 0.0, with Thesaurus Manager®, which is also only partially-completed.

European countries have adopted Langual because it serves the fundamental function of language independence, notwithstanding the other difficulties it presents. The lack of rigidity with INT has been viewed as a liability of the system, rather than an asset, by most in Europe (Schlotke, 1996).

New Zealand term	**US term**
Biscuit	Cookie
Scone	Biscuit
Jelly	Gelatin/Jello
Potato crisps	Potato chips
Chips	French fries
Beetroot[2]	Beet
Lollies	Candies
Tomato sauce	Ketchup
Tomato puree	Tomato sauce
Golden syrup	Corn syrup
Gherkins	Pickles
Corn flour, wheaten[3]	Corn flour
Mince	Ground beef
Muesli	Granola
Custard	Pudding
Pudding	Dessert

Table 3.2: Language dependency; equivalent food terms in New Zealand and the United States

INT was viewed as highly language-dependent in the files examined. The Thai descriptor files had both English language and the Thai language character set, the Chilean descriptor files had only Spanish language, and New Zealand had English with some Maori food

2 Beet is ambiguous to New Zealanders, requiring differentiation between root and edible leaf. In US, the word beet is understood to be the root, but the leaf is qualified as "beet greens".

3 Corn flour in the US is always made from corn/maize and has no further qualifier. In NZ cornflour can be made from wheat or corn.

descriptors as alternative names. In all cases, translations and interpretations were required in order to match equivalent foods and processes. The matching required people familiar with the data sets and food supply for each country to explain the foods, the processing and preparation, describe the edible portion, and then determine if there were equivalent foods. This is roughly the same process that must be undertaken for Langual coding.

An interesting dilemma emerged in this evaluation of language independence: the rating of "poor" at the national level is actually a desirable attribute. For example, New Zealand is (mostly) a monolingual country, and therefore a system that is independent of language, as the Langual system is, is not especially useful for local data users. English is spoken by all, so a system relying on alphanumeric codes that require translation, is less appropriate than a system that is text-based, like INT, relying on well-understood English language descriptors. Nevertheless, when interchange takes place with other countries, China for example, the English language descriptors are not useful and alphanumeric codes have more value.

Cultural Independence

All the food composition data systems evaluated to date rely on grouping, or classification of food. Foods are generally grouped by food source or type (e.g. fruits, vegetables, meat). Most food composition databases have between ten and 25 food groups. Even though the concept of food grouping seems to be internationally agreed upon, the actual classification has been shown to be highly culturally-dependent. Langual requires standardisation on food groupings as the first facet, 'product type', while INT does not. Hence, the defined Langual groupings effectively dismiss many food-culture relationships in the attempt to tightly manage food identification.

This study has shown that food culture can be illustrated by major food groupings, and most national databases have unique examples. The Pacific Islands food composition tables (Dignan *et al*., 1994) have coconut products as a group, because of the economic and cultural importance of this food and the many products made from it. Other countries divide coconut products into several different food categories such as Fats & Oils for coconut oil; Nuts & Seeds for coconut flesh; Beverages for coconut water. Also unique to the Pacific Island tables is the category of Wild Animal Foods. The Central America and Panama (INCAP) database has three groups that are unique: Bananas, Maize, and Cornbreads. The Thai food composition database has Edible Insects as a group.

Cultural differences show up too in the placement of foods within groups. Table 3.3 shows some examples of the difference in the classification of foods in different food composition databases. Even countries with many cultural, historic and economic similarities have different cultural approaches to the categorisation of some foods. Butter, for example, is Dairy in New Zealand, but Fats & Oils in Australia.

FOOD	NEW ZEALAND CLASSIFICATION	OTHER CLASSIFICATION (COUNTRY)
Butter	Dairy Products	Fats & Oils (Australia)
Coconut flesh	Nuts & Seeds	Vegetables (Philippines), Coconut Products (Pacific Islands)
Coconut oil	Fats & Oils	Coconut Products (Pacific Islands)
Hamburger	Fast Foods	Cereals & Cereal Products (Australia)
Taro	Vegetables	Starchy Staples (Pacific Islands), Starchy Roots and Tubers (Malaysia)
Olive	Fruit	Other Vegetables (Pacific Islands)
Avocado	Fruit	Vegetables (Australia)
Jam	Sugars and Confectionery	Fruit (Philippines)

Table 3.3: Culture dependency in food composition classification of foods.

In New Zealand, Pacific Islands and ASEAN, the reasons and rules for classifying foods were developed before the classification process began. Groups were selected based on local food customs, importance of a food in the food supply (economic and health), and patterns of consumption. Some commonly used rules include usage over taxonomy (or vice versa) (e.g. tomatoes are taxonomically fruits but are used as vegetables); major ingredient by weight in mixed dishes (e.g. rice in a rice + vegetable casserole); and proportion of a significant food component in the food (e.g. starch content in foods grouped as Starchy

Staples, fat content in foods grouped as Fats & Oils). In Australia, the philosophy of food grouping for mixed food dishes has been to assign a food to a category from which the major component is derived. A typical Australian hamburger bun weighs more than the meat portion of the food, and hence hamburgers are categorised as Cereals in the Australia food tables (English *et al.*, 1990). Langual requires this procedure too, with the main ingredient by weight representing both the 'product type' and 'food source'.

In the first round of a study by Deary (1993), 18 participants from 13 different European countries coded the same 20 foods in Langual in an experiment to determine if this system of food identification would be useful for Europe. All 18 participants were nutrition or food technology professionals working on food composition database projects. With the 'product type' facet, equivalent to food group, only 60% of the selected codes were correct (60% hit rate) by the assessment of the Langual experts.

Even when food groups and food names are standardised, ambiguity can still arise in other facets. Another cultural issue relates to the edible portion facet of foods. For example, during a EUROFOODS meeting, an argument occurred between France and Germany over the nutrient composition of Brie cheese, identified by its own Langual code. It was finally realised that in one country, the cheese's rind was part of the food (i.e. included in the edible portion), while in the other country, the rind was considered to be the inedible portion (Klensin, 1993). The provision for this essential piece of information was not included in the Langual system for Brie cheese, nor is it a mandatory facet in the INT system.

Compiler-friendly and Ease of Maintenance

The criteria of 'compiler-friendly' and 'ease of maintenance' relate to the labour and skill involved in learning and maintaining the system. This is of great concern to managers of food composition programmes where staff expertise and turnover rate can compromise the functioning of the programme when the computer systems are difficult to learn and operate.

Between 1988 and 1996, the food composition data compilation activities in New Zealand were conducted by a group of two programmers/systems analysts, one nutritionist, one dietitian, and the programme leader (this researcher). All participated in the assessment related to compiling the data and maintaining the system.

Langual was rated as compiler-unfriendly. The compiling difficulties experienced included long lead time in developing familiarity with the coding system and codes, delays in coding when local terms were not identical to Langual terms, and the inability to code when descriptors had not been assigned Langual codes. Further difficulties related to the base language of Langual being American English.

Langual requires information that has no relationship to nutrition *per se*. This information includes several facets for packaging (packaging material, contact surface). None of the data sets examined included this information, and yet the fields required an entry (in this case, it was a code meaning 'not specified').

The INT system was considered highly compiler-friendly. The INT system allows food descriptors to be used with the nomenclature and terminology of the compiler; it is only the faceted arrangement of the descriptors that imposes a structure for the terms. Because New Zealand's original system was a multifaceted, field specific structure, the integration of INT was a simple exercise. It became immediately clear that the INT system offered some advantages that New Zealand's system was lacking, so even before the evaluation was completed, the system was modified and the data compilers began to use the additional descriptor facets. The INT system was applied to the entire food composition database and continues to be used.

Maintenance of Langual codes in a database is time consuming. Often, assigning codes requires the opinion of more than one person from the small group of experienced people participating in the International Langual Steering Committee. In assessing the systems with the data files from other countries involved with New Zealand in interchange, there were many foods and several processes that could not be matched with Langual codes. One example is mumu'd from Papua New Guinea, a process involving cooking with heated stones in a pit. There were many examples found in the data files from New Zealand and seven other countries where the Langual codes had not been created for the particular food or process. The procedure for creating new codes for these foods, processes, or other descriptors involves proposing the terms to an international committee. They are then discussed, agreed to, registered, and then added to the Langual index.

In the first round of the Deary study (1993), the worst hit rate for all foods and all candidates was less than 40% for facet H, 'treatment applied' and the best was just over 80% for facet Z 'adjunct characteristics'. Deary reported improvement with learning, i.e. the second round, but still the hit rate for facet H was under 50%. Several recommendations from the candidates were reported: the need for further clarification of some facets; the need to improve completeness with regard to ability to further describe, or discriminate between food characteristics of interest; the need for the system to evolve through a central committee to manage the model; the need to review the entire vocabulary and eliminate ambiguity. Deary posed the question, "Can different Langual coders be expected to code the identical food identically?" Based on the experimental results, his answer was no. However, he goes on to conclude the following:

> "...it is evident that most candidates, especially in round 2, did achieve a high degree of conformance with the experts' views for most of the foods. We cannot, therefore dismiss Langual out of hand as an unsuitable model for describing foods. On the contrary, despite the negative statistical results, the degree of conformance with the set of ideal codes was impressive. It is important therefore, to understand the reasons why candidates differed and to assess whether the reasons are a cause for concern and whether they could be expected to be corrected with appropriate advice and guidance."

Local usefulness in food composition tables and dietary assessment software packages

Langual was assessed as having no usefulness in food composition tables and dietary assessment software products that were prepared for users in New Zealand. INT was assessed as being useful and appropriate, as is, in food tables and software packages.

Nevertheless, a significant omission was identified in both systems: a facet that incorporated the most significant information for identifying a food with a fixed character length, so that this could be used in printed tables and computer products where long text fields would be unsuitable. The "shortname" facet was created with a 32 character limit. It is the single most useful facet in the New Zealand system, as it is the facet used in the body of the Concise New Zealand Food Composition Tables (Burlingame *et al*., 1997), the only facet used in Diet1/NZ (Xyris Software), and the most commonly used facet by users of FOODfiles (Hapanyengwi & Burlingame, 1995). When a shortname facet is not created in a database system, dietary assessment software packages often truncate the name (Xyris, 1990-1997), and extensive manual typesetting is required for printed food composition tables (as opposed to preparing a camera-ready report straight from the databases) (Burlingame, 1996g).

In 1993 when Deary conducted his study, the Langual coding procedure was "paper-based". All candidates reported that this made Langual unacceptable, and that "computer aided tools need to be developed to support Langual coders." Some of those tools have recently been developed (Schlotke, 1996), and these could improve the local usefulness of Langual.

Usefulness in food trade and food legislation

The name of a food carries significant information related to national, regional and international regulations. Often, what a food is and therefore what it can be named, is specified in food standards of individual countries, and regions with trading bloc agreements. When, where, and how much can be traded is often dependent on what the food is.

Recent examples in butter trade have helped to illustrate the importance of harmonising food identification. In New Zealand, semi-soft or cold-spreadable butter, is traded as butter. The New Zealand Food Regulations specify the following (Ministry of Health, 1995):

> Butter shall be a product in the form of a plastic emulsion, this is of the type

water-in-oil, prepared from any one or more of the following:

(a) Pasteurised cream:

(b) Pasteurised milk:

(c) Butter oil, anhydrous butter oil, anhydrous milk fat:

(d) Whey.

Because semi-soft butter is made from anhydrous milk fat using a fractionation process (Kaylegian & Lindsay, 1992), it qualifies to be called butter in New Zealand. This is not the case in the United Kingdom and Europe where food standards require that butter must be made directly from only pasteurised cream or milk (EC Directive, 1994).

This is a particularly interesting example of the importance of harmonising food nomenclature and terminology in the area of food trade and food standards, because New Zealand and Europe were harmonised with the standard for butter until New Zealand changed, presumably to keep up with modern processing technologies. The Food Regulations through to October 1994 specified clearly in Regulation 111, clause 1, that "Butter shall be the clean, non-rancid, solid product obtained by the churning of milk or cream, with or without the addition of salt and lactic acid cultures." There are four more clauses in this regulation, but none contradicts or exempts any part of clause 1, and this was in harmony with the European standards. In October 1994 Amendment No. 9 was issued, allowing butter to be made from anhydrous milk fat and the standards were not longer in harmony.

Semi-soft butter is a record in the New Zealand food composition database, in the dairy group. Its first facet is BUTTER. It is further described as "semi-soft". This butter record is not treated differently from unsalted butter, or salted butter. By the EC Directive, however, it should **not** be treated as butter, but as a butter-type product. Neither INT nor Langual makes specific provision for a food regulation/food standard type of description or identification. Both, however, have the potential to do this, with Langual as a code-based system having perhaps more potential than INT.

Another recent legal case, this time heard in New Zealand's court system, related to ham. The Commerce Commission contracted Crop & Food Research to conduct analyses on several brands of ham and prepare a report interpreting the data against the nutrition claims made on the packaging (Burlingame & Milligan, 1995). Upon receipt of the report, the Commerce Commission filed charges against Plumrose ham for misleading adverting. The specific composition and nutrient claims made by the company, and printed on the can, were as follows:

> Lite Deli Ham 90% fat free;
>
> Enjoy healthier eating with Plumrose Deli Ham. This quality ham is 90% fat free yet still delivers full Deli Ham flavour (author's note: 90% fat free equals 10% fat).

The descriptors 'Lite', '90% fat-free', were examined. The Food Standards (Ministry of Health, 1995) state that a food must contain at least one-third less fat when compared with its normal counterpart, in order to make the claim stated above. This meant that the normal counterpart would have to have just over 15% fat to make this a fair and true claim, in compliance with the food regulation.

The key to resolving this case was in the determination of the normal counterpart. This is entirely a food nomenclature and terminology issue. In order to determine the 'normal counterpart', the words 'deli' and 'ham' were examined. There are no regulatory definitions for the words deli or ham, nor is there any prescription for fat or energy content (although there is for protein). Therefore, opinions had to be used. The company understood this and began arguing on the basis of food nomenclature and terminology.

The contention from the company was that even though their product was called ham, it should be compared to pork-based luncheon meats that are much higher in fat, averaging about 30% (USDA, 1993), and not to other hams. In the opinion of the report authors, the normal counterpart, decided on the basis of similarly named foods, was <u>ham</u>, and was judged to have an average fat content of 11.3 % fat. This meant that ham would have to contain 7.5% fat or less to make a claim suggestive of a lower fat content. The judge did not accept the company's assertion, and the nutrition claim was judged as misleading (Abbott, 1997). The company has dropped the nutrition claim from its packaging, continues to call the product ham, and has paid the legal fees for the Commerce Commission as their penalty.

The topic of food composition harmonisation for trade will be dealt with in greater detail in Chapter 5, *Harmonisation for food legislation and food trade regulations.*

Adequate for Visual Documentation

Neither INT nor Langual was adequate for colour identification, cultivar differentiation when the cultivar was not named, or several other criteria requiring visual documentation because they are difficult to explain with precise words. Dissatisfaction among data users and data base compilers in this area led to experimentation with images, discussed in section 3.3.3.

3.3.2 Survey of Regional Data Centre Coordinators

Regional data centre coordinators from ten countries were surveyed to determine what criteria are most important in designing or selecting a system for identifying foods in food composition data programmes. The expectation was that the results would either confirm that the criteria and the results obtained in the critical analysis of food nomenclature and terminology systems in New Zealand were generally applicable, or would identify a broader set of criteria important for others involved in similar work. Of the twelve regional data centre coordinators contacted, seven responded to the questionnaire. Replies were received from the following REGIONS/Countries: AFROFOODS/Zimbabwe, ASEANFOODS/Thailand, CEECFOODS/Slovakia, LATINFOODS/Chile, NORAMFOODS/United States, SAARCFOODS/Pakistan, and OCEANIAFOODS/Fiji.

National Context

Overall, the most important criterion for national food composition programmes was usefulness in international food trade (19/21) with six of the seven respondents ranking this criterion as absolutely essential, while one ranked it as only moderately important. The latter represented a small country not reliant on food export industries. Compiler-friendliness and ease of maintenance both scored 18/21, and usefulness in food composition tables and databases and usefulness in dietary assessment packages both scored 17/21. Least important was language independence (8/21). The range of scores was wide for the criteria for national — from 8 to 19. The results for management of national food composition programmes are shown in Table 3.4. When compared to the assessment criteria in Table 3.1, they demonstrate that INT satisfies the national requirements better than Langual.

The Friedman two way analysis of variance of ranks (Friedman, 1937), with the Regions as the seven blocks, looked at the effect of Criteria to answer the question: "Do the criteria differ in importance?" The results of the Friedman Test for National Rankings, by Criteria blocked by Region gave a "Friedman Statistic" (S) of 10.49, degrees of freedom (DF) equal to 7, and probability (P) of 0.019 (adjusted for ties). $P < 0.05$ indicates that the difference observed from the general assessment of the rankings are statistically significant (see Appendix 4 for the statistical tables).

The Kruskal-Wallis One Way Analysis of Variance of Ranks (Kruskal & Wallis, 1952) addressed the same question in the national context, with less precision than the Friedman analysis because there is no correction for regions. This analysis showed P equal to 0.136, and therefore not significant. The K-W was used again, with regions treated as a fixed effect in a fresh analysis to answer the question: "Do some authorities tend to make everything more important than others?" The results of this analysis gave P equal to 0.006 (adjusted for ties), showing that the Regional Data Centre coordinators differ in their ranking of overall importance for the national context (see Appendix 4 for the statistical tables).

* The rankings represent the total number of points assigned by all the respondents against the total number of points possible for each response. The total number of points is the maximum score of three, times the number of respondents which was seven. For example, 19/21 represents a score of 19 out of a possible 21.

Regional Context

The most important criteria for regional purposes were compiler-friendliness and ease of maintenance (19/21 for both). Three criteria tied for last place, scoring 17/21: language independence, culture independence and visual information. The range of scores — from 17 to 19 — was tighter for regional than national. The results for management of regional food composition programmes are shown in Table 3.5, and they do not demonstrate clearly that either Langual or INT would be the preferred system.

Neither the Friedman (P = 0.996, and P = 0.977 adjusted for ties) nor the K-W (Chi-square P = 0.97) analyses showed any statistical significance in the differences between the rankings in the regional context, indicating that for regional data base development, all the listed food identification criteria are of similar importance. The K-W when used again with regions treated as a fixed effect to answer the question: "Do some authorities tend to make everything more important than others?" gave P equal to 0.009 (adjusted for ties), showing that the Regional Data Centre coordinators differ in their ranking of overall importance for the regional context (see Appendix 4 for the statistical tables).

Several additional comments were received for the listed criteria, but only one suggested any additional criteria: creation within each region of a resource person with key responsibility for food nomenclature and terminology.

The overall result of this survey supports the findings from the critical assessment of the systems in New Zealand in identifying the criteria of importance related to identification of foods.

Criterion	NORAM	ASEAN	AFRO	CEEC	LATIN	SAARC	OCEANIA	TOTALS
A. Language independence	0	0	3	2	0	3	0	8
B. Culture independence	3	1	3	2	1	1	1	12
C. Compiler-friendliness	3	3	3	2	2	3	2	18
D. Ease of database maintenance	2	3	3	3	2	3	2	18
E. Ability to visually document the foods (e.g. colour, packaging)	1	3	3	2	1	3	•	13
F. Usefulness in tables/databases	3	3	3	2	1	3	2	17
G. Usefulness in computer dietary assessment packages	3	3	1	2	3	3	2	17
H. Usefulness in international food trade	3	3	3	3	3	3	1	19
I. Other:	nil	nil	nil	nil	nil	nil	nil	

Table 3.4: Ranking of food identification criteria for national importance (0=not important, 3=essential)

Criterion	NORAM	ASEAN	AFRO	CEEC	LATIN	SAARC	OCEANIA	TOTALS
A. Language independence	3	1	3	3	2	3	2	17
B. Culture independence	3	2	3	3	2	2	2	17
C. Compiler-friendliness	3	3	3	2	2	3	3	19
D. Ease of database maintenance	2	3	3	3	2	3	3	19
E. Ability to visually document the foods (e.g. colour, packaging)	2	2	3	3	3	3	1	17
F. Usefulness in tables/databases	3	2	3	3	2	3	2	18
G. Usefulness in computer dietary assessment packages	3	1	2	3	3	3	3	18
H. Usefulness in international food trade	3	2	3	3	3	3	1	18
I. Other:	nil	nil	nil	nil	nil	YES	nil	

Table 3.5: Ranking of food identification criteria for regional importance (0=not important, 3=essential)

3.3.3 Images As A Complementary System

There are several inadequacies in food nomenclature and terminology systems that are not easily remedied with either INT or Langual. For example, the leanness of meat cannot be codified to convey any more information than words can; the depth and intensity of the colour of an apricot cannot be conveyed more easily by codes than words; and the identity of a muttonbird is no less a mystery to people outside of this region when it has an international code representing it.

Another food identification method, or an adjunct to an existing one, was clearly required in the management of food data systems. The least disruptive to food programmes already in operation was an adjunct system that would have local as well as international benefits and applicability. Furthermore, the system needed to address the weaknesses of the two systems in common usage.

In 1993, food identification by **image** was examined as that adjunct to the system in place in the New Zealand Food Composition Database. Technologies at the time made it feasible to include images in a food composition database, along with descriptive and numeric data (Burlingame & Cook, 1994; Burlingame *et al.*, 1995b).

Hardware and Software Limitations

At the start of this study in 1993, several hardware and software limitations and problems with using images in food composition data bases were identified. These included restrictions related to storage, compression, decompression, image resolution and faithfulness to the original object. Presently, there are more than 300 images in the NZ Food Composition Database, occupying about 100 MB of disk space. The size of the individual files ranges from 25 KB to 2 MB each. Compression significantly reduced the amount of disk space required.

Lossy compression is the type used with many formats trialed. It is so named because redundant or otherwise unnecessary data are deleted in the compression process. Two compression types that can be used for lossy compression are accepted as current standards for still images: JPEG (Joint Photographic Experts Group) and fractal compression. JPEG was designed as a digital image compression standard for continuous-tone, greyscale and colour still images (Wallace, 1991). It is based on a generic mathematical function known as forward DCT (Discrete Cosine Transform), which transforms the image to take up less space. Its compression is very fast, but the JPEG-compacted image files are larger for the same quality than files compressed by other methods. Fractal compression (Barnsley, 1993) uses a mathematical transformation called an affine map that identifies all patterns that can be matched even if it means rotating, stretching or squashing the pattern. It is resolution-independent. Lossy compression used by both these compression types involves a trade off between information and compressed size. Both methods intentionally discard parts of the data (Carlson, 1991; Simon, 1993a; Simon, 1993b).

Disk space requirements vary depending on size of the image, number of colours, and the image resolution. Various manipulations can be applied to achieve efficient storage. One NZ beverage record represents a composite of three different brands of powdered drink mix. The packaging scanned in 16 million colours (PCX colour) occupies nearly 2 MB; the same file compressed with PKZIP occupies 1.2 MB; and as a GIF file, only 317 KB. The same information contained on the packaging, when entered into the database as text, occupies a mere 946 bytes. Figure 3.3 shows disk space required for different file formats for the composite of three powdered drink mixes on the far right, along with the disk space requirements for two other image files in the different formats, including plain text.

Using a number of different software packages and shareware, images stored in PCX format can be transferred to media as other less byte-consuming formats such as GIF. This is important because users will have different hardware and software products available to them. GIF and TIFF have become industry standards, and JPEG with the ISO (International Standards Organization) and CCITT (Consultative Committee on International Telegraph & Telephone) backing (Wallace, 1991) is popular for compressing still images for storage. Exchanging images will be facilitated by having image format flexibility.

Over the course of the four years since image documentation began, the internal limitation of size of files has become far less significant, with the advancement of hardware and software technologies. More and more software products are allowing the inclusion of digitised images. Advanced Revelation® 3.0, the development environment used for the New Zealand Food Composition Database, does not incorporate graphics procedures. Presently, however, scanned images of food are associated with the data files using other software. ARev® had been programmed to call DOS-based programs, ColorView®, which could display digitised images stored under various formats. Currently, with Windows-based applications, several different programs, including graphics' programmes, are used simultaneously with the ARev® screens.

Information Capture

Images cannot be searched in the same way as text files. For example, a bread wrapper image identifies ingredients, one of which is potassium bromate; and a beverage package, artificial sweetener added. However, the image file cannot be searched for potassium bromate or artificial sweetener the way a descriptor text file or an alphanumeric code file can, and therefore will not substitute for documentation by words or codes. An area that requires greater exploration related to data capture is barcodes. Image files can contain the actual barcodes, which are capable of storing large amounts of data, and a barcode scanner, theoretically, is able to read the barcode from an image on a computer screen, or a printout of that image file. Figure 3.4 shows the image of a packaged food product, including the barcode, along with food identification using a multifaceted naming system and an alphanumeric coding system.

Uses and benefits

Agriculture Sector: Sample verification and data validation

Verification and validation of information has been determined to be the most valuable use to date from the effort to document by images. Often, managers of food composition programmes have reason to question the identity of a food or their

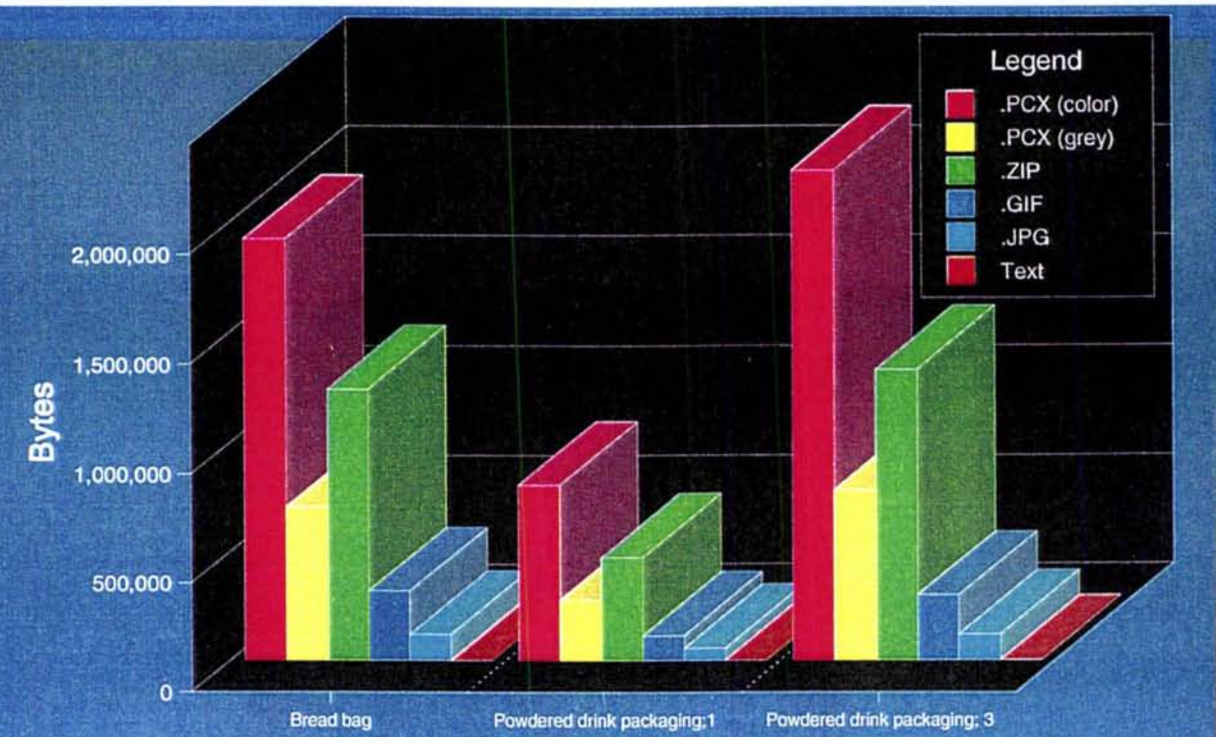


Figure 3.3 Disk space requirements for five different graphics' formats and plain text for an image of a bread bag, an image of a powdered drink package, and an image of a composite of three powdered drink packages.

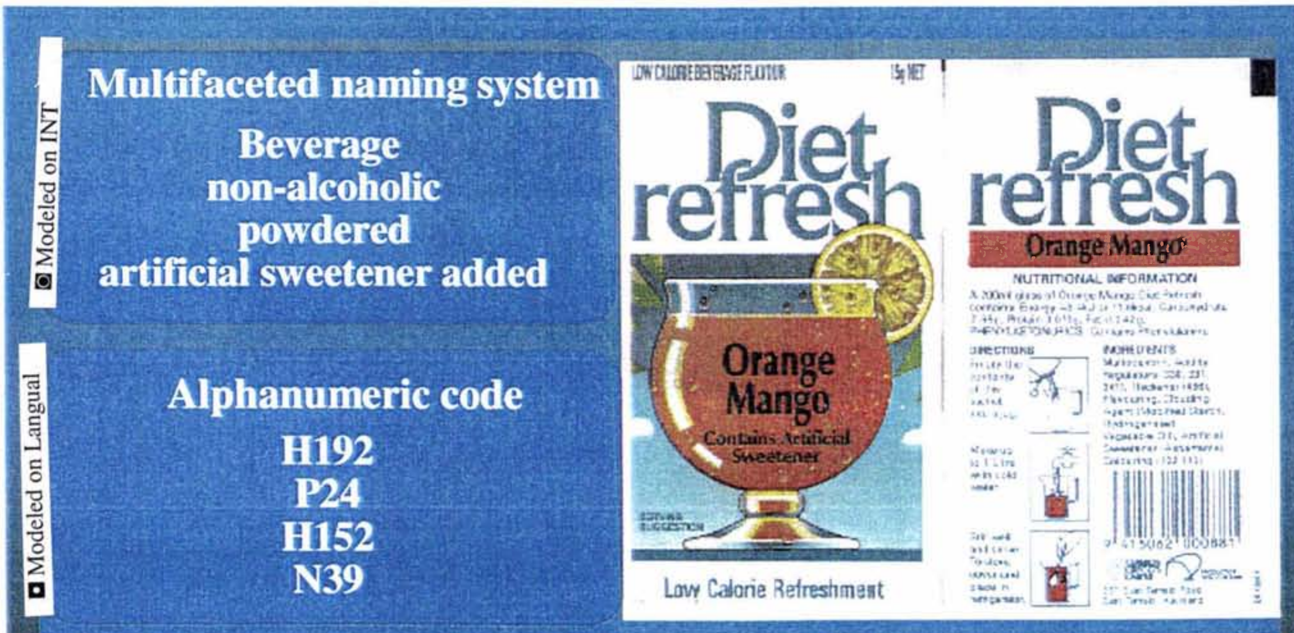


Figure 3.4 Image of food package from which bar code, ingredients, nutrition information, manufacturers details, and directions for preparation can be read. The image file does not permit, with most software systems, searching for information such as "contains artificial sweetener". This information is better found using descriptor files or alphanumeric codes.

analytical data. In New Zealand, images have, on many occasions, allowed decisions to be made about accepting or rejecting the results of nutrient analyses. For example, some very high values for beta-carotene in tamarillos were obtained in 1989. In some later work, values that were significantly lower were found. Details of methods, comparisons of sampling and sample preparation protocols, and other factors were investigate to explain the discrepancies. The problem was ultimately resolved by comparing images (earlier photographs) of the actual samples used. The images showed that the earlier samples had a much deeper, darker, orange colour than the more recent samples. Figure 3.5 shows the images of the two New Zealand tamarillo cultivars, along with the numeric data for beta-carotene.

Another example of data verification involves the New Zealand muttonbird. Its iron content is higher than that expected for a bird, and resembles the iron content of beef and lamb. The image shows the flesh of this bird is a deep red colour, suggesting that the high level of iron is not unreasonable (see Figure 3.6).

Frequently, analyses are undertaken on new cultivars of fruits and vegetables, before these cultivars have been named. Images have been the most dependable way of assuring that the analytical information is associated with the correct cultivar (see Figure 3.7).

Health Sector: Food Intake Surveys

Communication barriers exist within countries and between countries. Language, culture, age, are just a few of the factors responsible for communication barriers encountered by researchers undertaking food intake surveys. In New Zealand there are several Polynesian languages in use, as well as Maori and English, and children are often subjects in nutrient intake surveys. Images of foods used under these conditions have proved valuable in New Zealand and elsewhere (Kohlmeier *et al.*, 1995).

Even when communication barriers do not exist, *per se*, food intake survey work presents problems related to food identification.

β-Carotene 600 µg /100g | **β-Carotene 763 µg/100g**

Figure 3.5 Data validation is facilitated when images can be compared. The tamarillo cultivar on the right has a higher β-carotene content than the cultivar on the left; it also has a deeper orange colour.

Components	Mean
Water (g)	50
Energy (kcal)	370
Energy (kJ)	1550
Protein (g)	16
Fat (g)	34
Ash (g)	0.9
Iron (mg)	5.3

▪ Data are per 100 g edible portion

Figure 3.6 Muttonbird data show an unexpectedly high iron content for a bird. This value is not in question when the deep red colour of the flesh is observed.

For example, the NZ Food Composition Database has over 100 beef records. For many of these records, the word descriptors are identical up to the facet containing the ratios of separable lean and separable fat (e.g. there are five records for beef, rump steak, grilled, having different ratios of separable lean and fat: 85:15, 90:10, 95:5, separable lean only and separable fat only). Once the database is searched for the words grilled rump steak, and five records are presented, a judgment is required which many people cannot make without the benefit of visual examples. It is far easier for most people, nutrition professionals and lay people alike, to select a picture of meat that looks like what they would consume, rather than to say with confidence that their grilled rump steak was 95 percent separable lean and 5 percent separable fat. Figure 3.8 shows the images in the New Zealand data base for two cuts of beef, with two and five percent separable fat. Nutritionally, the proper selection is significant. For individuals and populations, one selection versus another can sometimes make the difference between whether nutrition goals and guidelines are being met or not.

Environment Sector: Wildlife Feeding Programs

The unavailability of images proved extremely disadvantageous for a project to provide nutrient data to an aquarium in New Zealand. The aquarium was bringing in penguins for exhibition that had been successfully bred and reared for many generations on fish from the Northern seas. The New Zealand food composition programme team was assisting them in determining what locally available fish could substitute for their Northern Hemisphere diet. The task of matching the nutrient composition of Antarctic finfish with Arctic finfish would have been easier if the nutrient data, a plethora of which is available in the USDA Standard Reference 10 (1993), were accompanied by images. This would be particularly useful where the sample numbers are only one or a few, where the data presented do not specify different stages of maturity, different seasons of the year and different catch areas for the samples. Image comparisons between the two databases would have helped in the assessment of the physical similarities of the different species, for example, as size of the finfish would be relevant to the penguins' diet. The fact that the entire finfish section of the New Zealand data base had been coded in Langual did not offer any advantage in this project. Figure 3.9

Figure 3.7 Sample documentation by image shows two new cultivars of apricot, visually distinctive, but yet to be identified by varietal name.

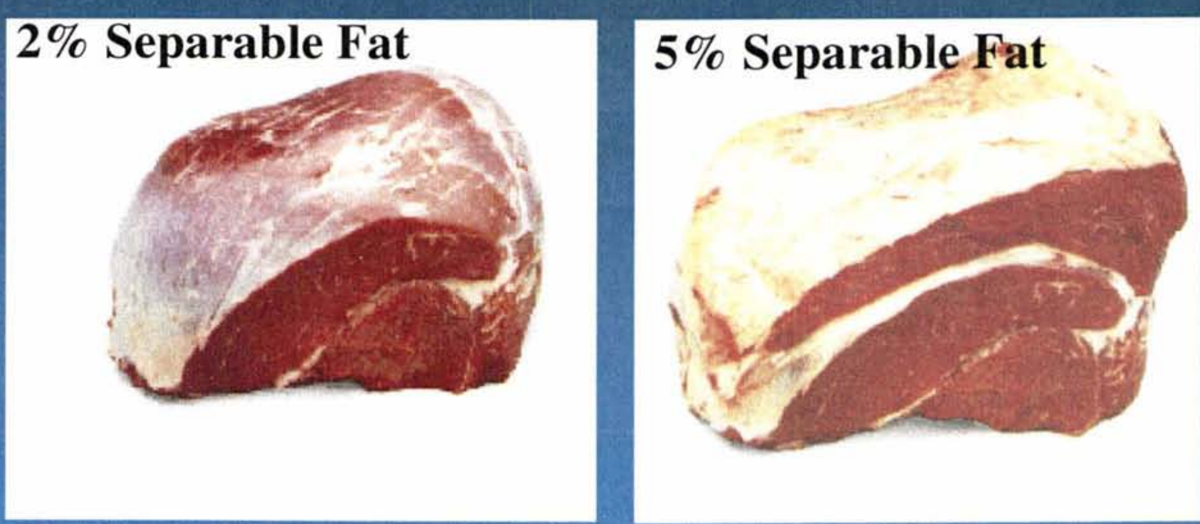


Figure 3.8 Ratio of separable lean to separable fat in beef cuts is difficult to determine without visual assistance in food intake surveys.

illustrates the physical differences between a juvenile and mature snapper. Analyses show that there are substantial chemical compositional differences in fish related to maturity (Vlieg, 1984; Gong & Farrell, 1990).

In the same area of wildlife nutrition, nutrient data, coupled with images, have assisted others attempting to reproduce the dietary aspect of native habitats. The right nutrients in the right sorts of foods will improve the wellbeing of the wildlife, including enhancing the potential for reproduction (James *et al.*, 1991). In New Zealand, some endangered bird species have been relocated from their native habitats in the South Island, to small offshore island sanctuaries. Their traditional foods are not all available, so the nutrient content, as well as physical similarities of the native food, must be considered when designing the supplementary feeding programme.

Trade Sector: International Interchange

INT deals with language differences that present a challenge by including an "alternative names" facet in each food descriptor file. Langual ignores language. Still, with international interchange and international trade in agricultural products, some descriptors, however comprehensive and however many language translations are provided, and codes that specify minute details about a food, will never be enough. For example, the New Zealand kumara, with the alternative name sweet potato, is quite unlike the North American sweet potato; the New Zealand pumpkin is unlike the typical North American pumpkin. The differences seen in the nutrient composition are not so surprising when the physical differences are shown with a picture of the food (see Figure 3.10).

What is a feijoa? What is a pukeko? What is a karaka berry? Again, with the exception of New Zealanders, most people in the world would not know what these foods are. Even the alternative names would be meaningless, as these are (almost) uniquely New Zealand foods (see Figure 3.11). Yet with international interchange of food composition data, many people in many parts of the world have these food records.

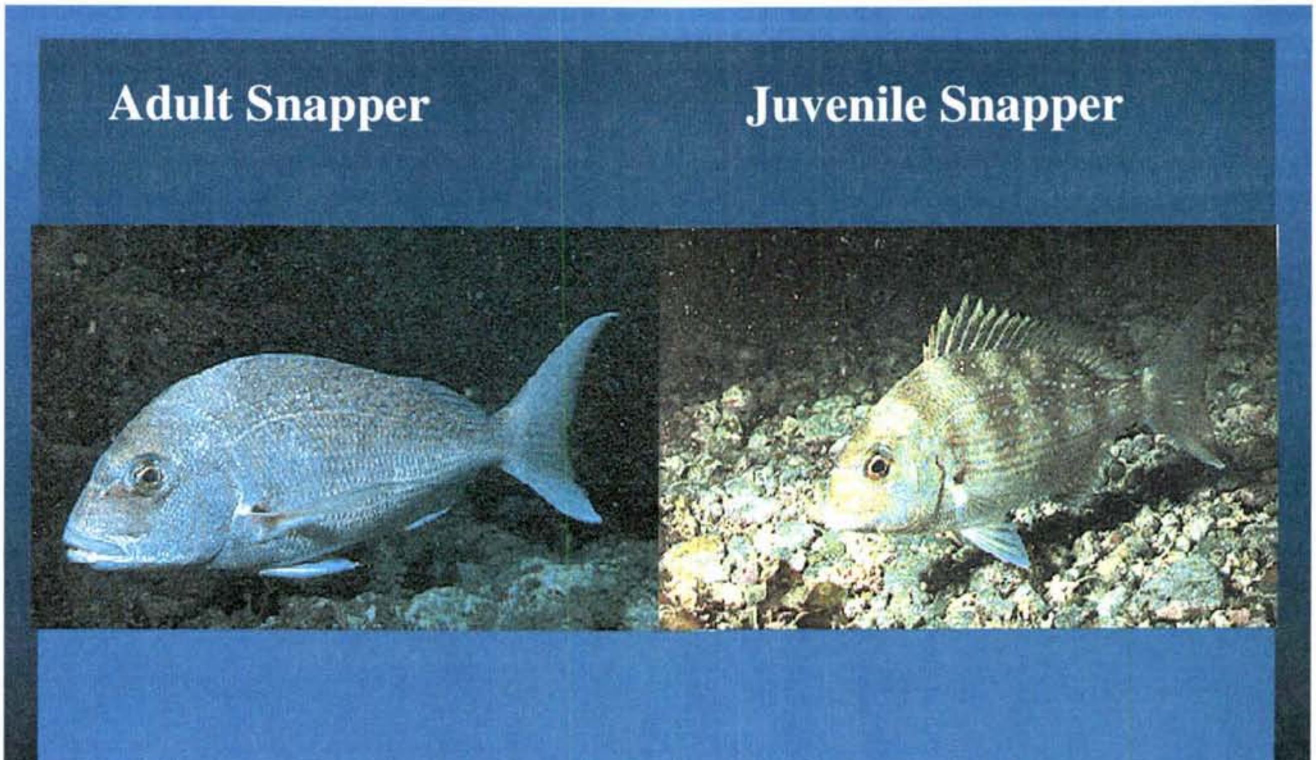


Figure 3.9 Juvenile and mature snappers differ markedly in their physical characteristics and nutrient composition.

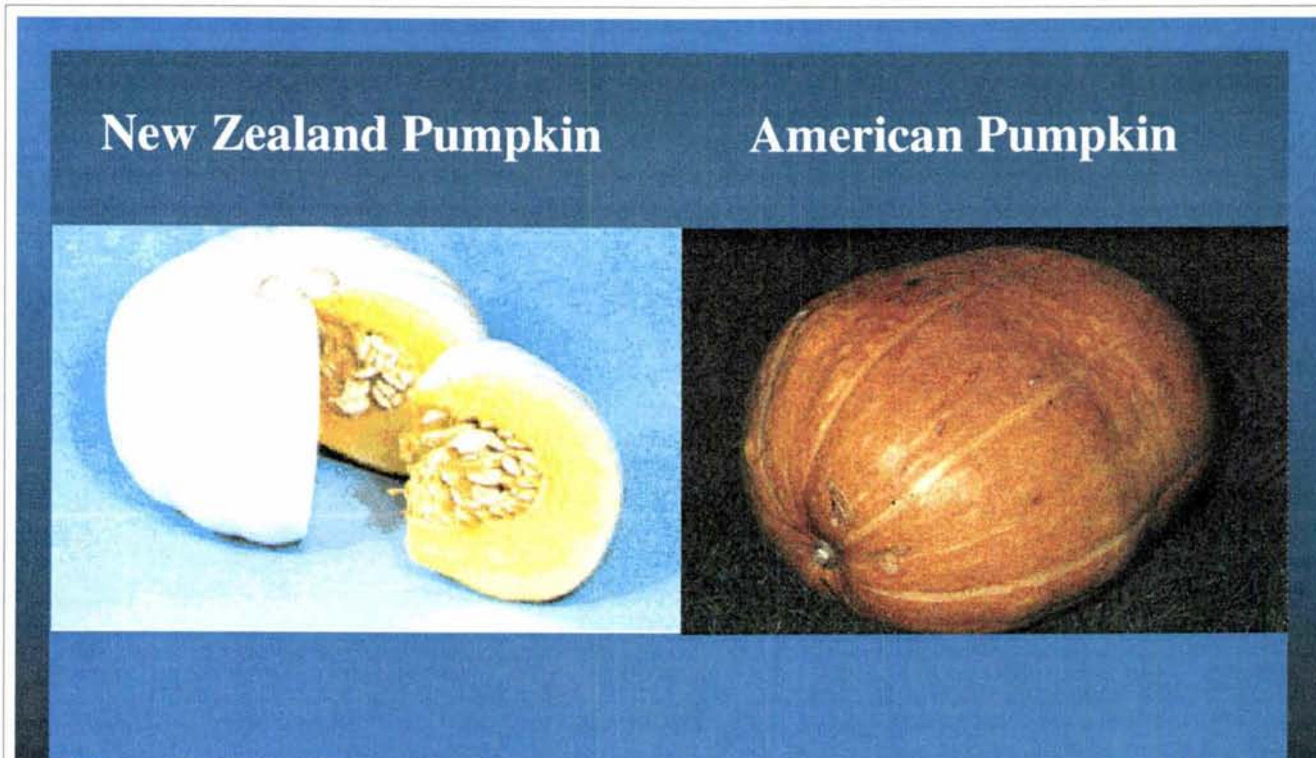


Figure 3.10 New Zealand pumpkin and American pumpkin; in shape, size, colour and nutrient content, the two similarly-named foods are very different.

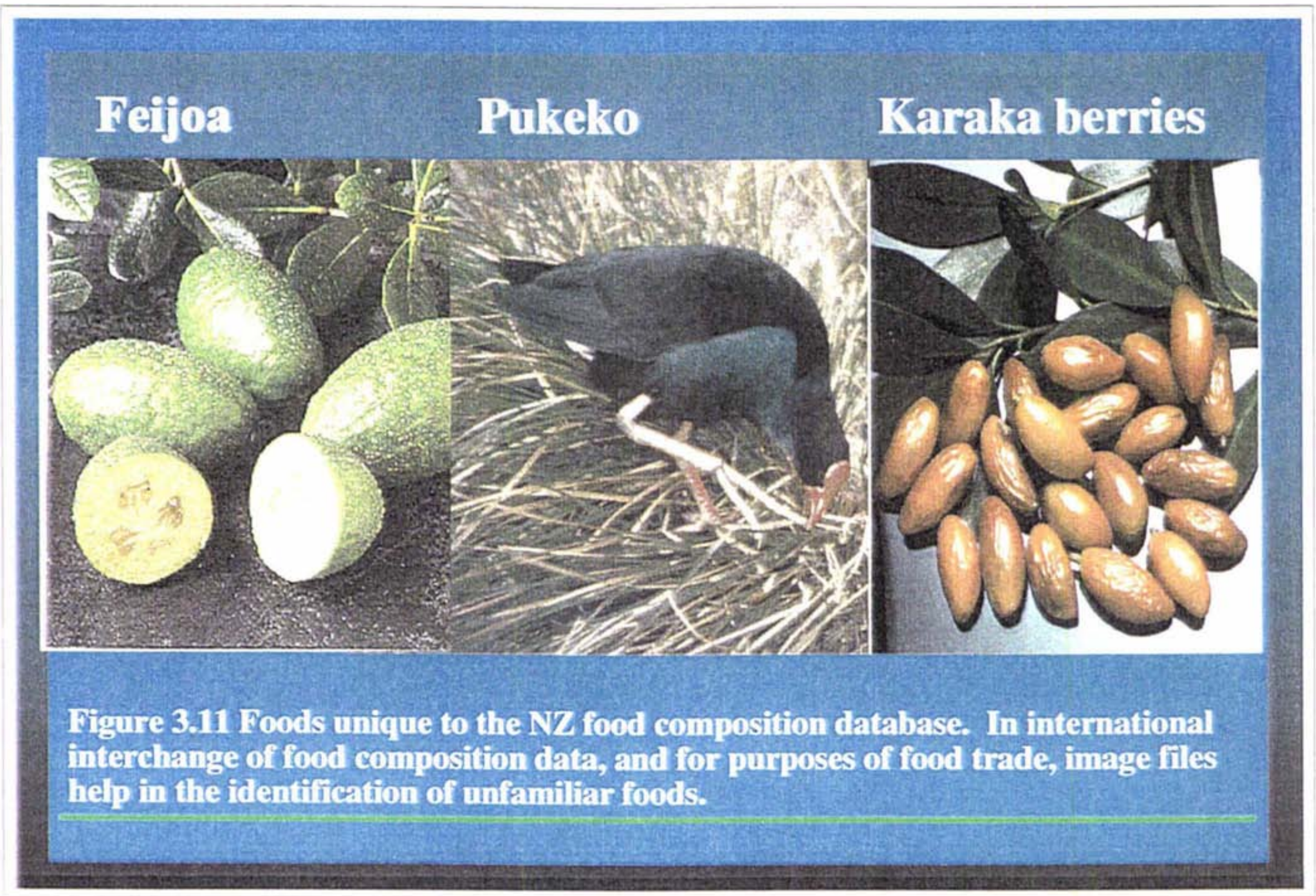


Figure 3.11 Foods unique to the NZ food composition database. In international interchange of food composition data, and for purposes of food trade, image files help in the identification of unfamiliar foods.

INFOODS considered the issue of images in food composition databases long before anyone started using them (Klensin, 1991), and an image element is included in the interchange model (Klensin, 1992)*. The proposal was entirely theoretical, and it was the single structural element in the interchange model that did NOT exist in any national database.

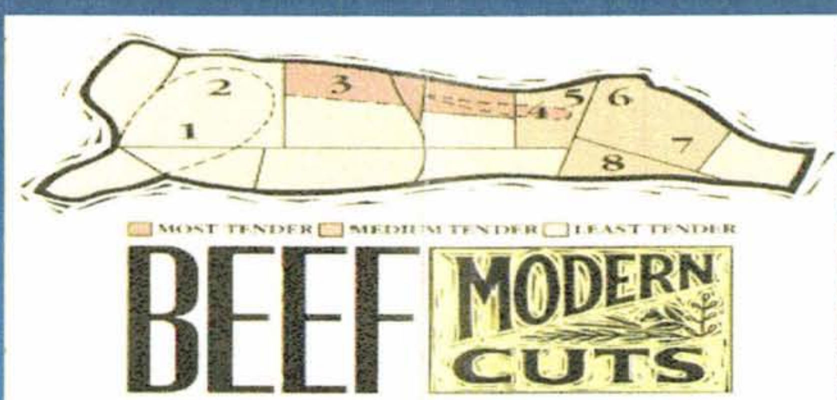
The structure for interchange using the INFOODS' model requires elements that indicate the picture encoding type as well as providing the actual image. A comment element may also be used. The images are subsidiary to the **classification** element, which is the first immediate subsidiary of the **food** element (see Figure 3.12). Images associated with a cut of meat record might include a carcass diagram showing the position of the cut and a photograph of the cut itself (see Figure 3.13).

* The interchange model defines the organising principles, format, structure and rules for moving data files between countries and regional organisations in a way that preserves all the information available.

<image><pcx/> *the first image itself in PCX format* </pcx/><cmt/>beef carcass diagram with cut sites identified</cmt/></image>

<image><gif/> *the second image itself in GIF format* </gif/><cmt/>image of cut</cmt/></image>

Figure 3.12 INFOODS interchange format, showing tags to use when images are included in interchange files.



Source: NZ Beef & Lamb Marketing Bureau

Figure 3.13 The image file associated with a cut of meat; a carcass diagram showing the position of the cuts.

With food composition data interchange, data comparisons are often made using data sets from different countries. Figure 3.14 shows vastly different values for carotenoid data (expressed as β-carotene equivalents), from 208 micrograms for Australian apricots, to nearly 7000 micrograms for a particular apricot cultivar from New Zealand. It is known that colour in apricots can vary from a pale yellow to a flaming orange, and this would be reflective of the expected carotenoid content. Without visual representation it is difficult to make judgments about data quality or to make comparisons of nutrient content for the "same" foods.

Data

Database	µg β-carotene equiv.
USDA (09021)	1566
British (860 5th ed.)	405
Australian (06C1-002)	208
New Zealand (L19)	6940
German (Pg 746-749)	1790

Image

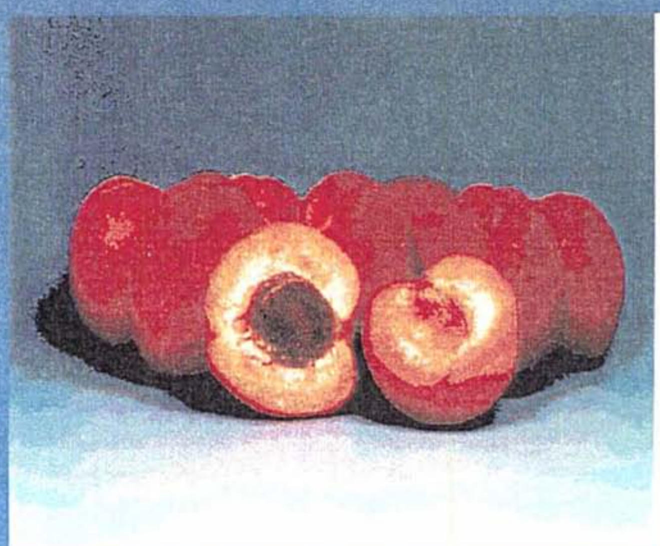


Figure 3.14 Apricot data from other countries differ dramatically from the New Zealand data for cultivar shown. The intensity of the colour is predictive of the high carotenoid content.

3.4 Conclusions and Future Directions

For the all the difficulties associated with the technical issue of identification of foods, programme managers in all sectors described in Chapter 1 of this thesis should think not just of the qualitative words to describe the problems, like poor quality data, incomplete information, ambiguous identification, but also some of the more potent and quantifiable words like illegal labelling information and fraud in international food trade.

In spite of the recognised need for food identification harmonisation, and the years of effort from many people, neither Langual nor INT is an adequate system for adoption/endorsement as the international standard in their present forms. Neither can images be used independently of other descriptor or coding systems. There is no convincing evidence that it is possible to create an acceptable, international system that solves all the current problems that exist in food identification. Nevertheless, there is no inherent incompatibility between the systems and all three can be used in the same database. The most reasonable approach for most managers of food composition programs is to adopt INT to eliminate ambiguity and facilitate the ease of local usage, and include food images along with descriptive text.

Indeed, since 1996, the New Zealand Food Composition programme team has been issuing food composition information as a set of relational files that include the standard numeric and text files, and now include relational image files that are being used in dietary assessments in the nutrition department of a major New Zealand hospital. In spite of the uses and advantages for images to identify foods, there will always be a need to use words, and some requirement in some places for codification, and thus an internationally endorsed system may be developed and adopted.

The principles and philosophy behind Langual seemed sound but its actual implementation and use was difficult. Although developed for regulatory use by the United States Food and Drug Administration, to date, it has never been used in the US for regulatory purposes. As of early 1997, the USA has declined to participate further in its management, updating, and maintenance, leaving that job entirely to the European Langual Committee. And in spite of being widely used in Europe by the food composition professional community, Langual has no regulatory role in the European Union. If there was a call for a system to use for regulatory purposes in some economically strategic regions (like Europe and the USA) this would probably make the strongest case for adoption of Langual as the key system for harmonisation.

To progress in this area, another expert committee meeting on food nomenclature, terminology and descriptors, should be convened, with invitations extended to active food composition program managers. The tasks for this committee should be the following:

- determine if it is possible for a single food description language or a set of minimum criteria to be adopted among various countries;

- assume responsibility for the compilation of an electronic international food description dictionary/thesaurus/concordance, possibly including food images;

- prepare an update, as a continuation of the development of the INFOODS system, previously published in the Journal of Food Composition and Analysis (Truswell *et al*, 1991).

- link the system(s) to food standards, now that the World Trade Organisation has given power to Codex Alimentarius (this topic is discussed in depth in Chapter 5 of this thesis).

For the future, barcodes, or Universal Product Codes (UPCs) have the potential to revolutionise food composition programmes and could possibly force harmonisation and/or standardisation of many different aspects of food identification. Certainly trade will be the most immediate use, but the possibility of barcodes to identify key aspects of foods beyond name and manufacturer offers some exciting research opportunities.

4. HARMONISATION ISSUES IN IDENTIFICATION OF COMPONENTS

4.1 INTRODUCTION

As established in the first chapter of this thesis, food composition activities are being undertaken by a variety of agencies, programmes/projects and people, for an ever-increasing number of reasons, without a cohesive framework or proper management guidelines. Some harmonisation is needed. Among the requirements before harmonisation can be achieved is the need to establish, quantify and resolve the key technical issues. Second only to food identification, presented in Chapter 3 of this thesis, is the key technical issue of food component identification.

The term ***components*** refers mainly to nutrients in foods, but also encompasses non-nutrient food components and anti-nutrients. Anything in a food that can be analysed, or calculated from analytical information, is a food component. Virtually all measurement information and numeric data in food composition data bases are associated with food components.

Food component identification is, therefore, an important issue for laboratory managers, managers of national food composition programmes and regional data centre managers. It is also an important issue for the health, agriculture, environment and trade sectors where food composition data play a part (e.g. research, policy, food labelling).

The main reasons for disharmony in the area of component identification include disregard for, or ignorance of, systems that have been developed with wide consultation; and creation and implementation of new, competing "international" systems and guidelines. With food component identification, the technical harmonisation issues are much more straightforward than with food identification, and an international system of food component identification with some endorsement and acceptance does exist —INFOODS tagnames (Klensin *et al.*, 1989). A second system — Component Aspect Identifiers— has been proposed (Unwin & Becker, 1996) and is being developed under the EUROFOODS/COST '99 programme. And a third system-of-sorts also exists in the form of the Codex Committee on Methods of Analysis and Sampling.

In this chapter on food component identification, the following will be presented:

- An evaluation of the current situation;
- an assessment and comparison of INFOODS tagname system and CAId system for component identification;
- an assessment of the actual and potential relationship of the Codex Subcommittee on Methods of Analysis and Sampling to food composition work;
- an analysis of the nature and magnitude of the harmonisation problems, using specific nutrient examples;
- examples of the importance of unambiguous identification of food components for different sectors;
- a set of recommendations for managers of food composition programmes; and
- future directions for achieving harmonisation in the identification of food components.

Carbohydrate and fibre will dominate this chapter as the most striking examples of the requirements for harmonisation. The other components commonly analysed and presented on food labels and in food composition tables — nitrogen and protein, fat, and energy — will also be examined to further illustrate the situation. For convenience and simplicity, food components will be identified in this chapter by INFOODS tagnames, contained in angled brackets as they appear in SGML-type datafiles, except when they occur in headings of sections or in tables that describe them in detail. This is meant too, to help differentiate tagnames from other acronyms and abbreviations.

4.2 Background: An Evaluation of the Current Situation

Disharmony is far less obvious, yet far more consequential, for food component identification than for food identification. Food component analysis, determined in the data generation phase of a food composition programme, is an area of research subjected to the inflexibilities and limitations of chemistry and the contingencies of biology. In an attempt to satisfy both, a large number of methods for food component analysis and expression have been proposed, adopted and used (Southgate, 1995). They can represent rigorous chemical measurements, without consideration of nutritional significance, e.g. <FATCE[1]>; chemical measurements with conversion factors to account for a biological, physiological or nutritional context, e.g. <PROCNT[2]>; physiological methods using animal models, e.g. <PER[3]>; and calculations based on very crude approximations, e.g. <CHOCDF[4]>. For some components, the different methods or expressions represent different fractions or aggregations of the component, while the same simple term may describe them all. For example, there are five commonly used methods for measuring and/or expressing carbohydrate, each of which would represent a different mixture of constituents and be represented by a different "correct" value for the same food (Monro & Burlingame, 1996). Each would be associated with the common term ***carbohydrate*** in the food composition data set. To scientific users of these data, the information associated with the terms is

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1 <FATCE> Fat, total, by analyses using continuous extraction. This method measures all compounds — not just dietary fat — which are soluble in the highly non-polar solvent used.

2 <PROCNT> Protein, total, calculated from total nitrogen using a factor that is reflective of the amino acid profile of the proteins in a particular food or food type.

3 <PER> Protein efficiency ratio; a measurement that involves feeding the test protein to rats, measuring their growth, and comparing that growth to the growth achieved in rats fed a reference protein.

4 <CHOCDF> Carbohydrate, total; calculated as the difference between 100 grams and the sum of the other proximate components, water, protein, fat and ash, in units of grams per 100 grams.

ambiguous, and further details would be sought. For the 'trusting' users, the ambiguity would not necessarily be recognised, and could lead to serious misinterpretation of information, potentially affecting policy development, results from dietary intake studies, clinical decisions, and all the areas identified by sectors in Chapter 1 of this thesis.

In a single country, disharmony and incompatibility in measuring and/or expressing a food component can exist in the following situations:

- between analysts within a laboratory;
- between different laboratories undertaking nutrient analyses for the same purpose; and
- between agencies where one is responsible for setting nutrition labelling requirements and another is responsible for developing and maintaining the national food composition data base.

Disharmony also exists between countries/regions, where different methods of analysis and presentation formats are ***prescribed*** in food legislation for nutrition labelling. In most cases, however, the problems result from ***non-prescription*** of methods for any or all purposes, in both the national and international context. There is only one prescriptive analytical methodology in the New Zealand Food Regulations, and that is for a particular fibre method (Department of Health, 1992). Different methods have protagonists and antagonists in laboratories and in regulatory agencies around the world. Often, laboratory managers or even individual analysts feel entitled to use their preferred methods when methods *per se* are not specified by law or convention. It is not surprising, therefore, that disharmony and incompatibility exist.

In the United States, with the enactment of the Food & Drug Administration's (FDA) Nutrition Labeling and Education Act (Federal Register, 1992, 1993), regulatory methodologies have become very prescriptive (DeVries, 1995). Some of the prescriptions in this legislation are new, unique and in conflict with the food composition data generated, compiled and disseminated by the United States Department of Agriculture's Nutrient Data Laboratory. Not only do the food component specifications differ from those used by convention by the USDA, but they also differ for America's close trading partners. Canada, for example, specifies many different nutrient methods and expressions for its food legislation (Agriculture and Agri-Foods Canada, 1993; Consumer and Corporate Affairs Canada, 1994).

From the mid-1970s through the mid-1980s, several sets of guidelines for how some food components should be identified and reported were created. These included Generic Descriptors and Trivial Names for Vitamins and Related Compounds (IUNS[5], 1976), Nomenclature and Symbolism of Amino Acids and Peptides (IUPAC[6], 1983), other reports from IUPAC's Commission on Biochemical Nomenclature (1973, 1978, 1987), reports from IUNS's Committee on Nomenclature, and reports from the Commission on Nomenclature of the American Institute of Nutrition. Other notable contributions included specifications from AOAC International[7], the International Standards Organisation, (ISO, 1992) and Codex Alimentarius (discussed below). INFOODS tagname system and the CAId system both represented new approaches that integrate computerisation and data interchange into their systems.

4.3 Materials and Methods

Three separate approaches have been taken to address the issue of harmonisation in the identification of food components: a critical analysis of INFOODS tagnames and

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[5] International Union of Nutritional Sciences

[6] International Union of Pure and Applied Chemistry

[7] Formerly known as the Association of Official Analytic Chemists

EuroNIMS[8] CAIds, an investigation of the food component-related activities of the Codex Committee on Methods of Analysis and Sampling (CCMAS), and an examination of actual food composition data files and tables from several different countries and regions, showing how components are identified and the resulting ambiguity.

4.3.1 An analysis of tagnames and CAIds

A critical analysis of INFOODS tagnames and EuroNIMS CAIds was undertaken. New Zealand's Food Composition Data System, managed in Advanced Revelation® relational database management systems software (ARev), and currently on a Pentium® file server with multi-user access, was adapted to allow incorporation of INFOODS tagnames in 1992. Tagname mapping was undertaken for the 265 components that were represented in the New Zealand Food Composition Database at the time. The criteria used to evaluate the two systems included the technical usage of the systems by New Zealand's database systems' analysts and data compilers, the use by local professionals within New Zealand, and international data interchange of the information. CAIds were studied in 1995/96 by designing methods' documentation screens that would permit entry of information for each of the CAId fields of information.

These two systems were also examined to determine their suitability for use with food composition data files from seven other countries involved in data interchange with New Zealand (Australia, Pacific Islands, Chile, the United States, Guatemala, Philippines and Thailand). Assessment of the systems with several different national databases, as well as the OCEANIAFOODS regional database, provided the opportunity for differentiation of both the national applicability and the international interchange capabilities of the two systems.

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8 EuroNIMS food management system was a multinational collaboration among European countries to develop a software product to facilitate the recording, documentation and evaluation of food composition data. A full version has never been completed.

4.3.2 Codex Committee on Methods of Analysis and Sampling

Food component identification, as addressed by the Codex Committee on Methods of Analysis and Sampling (CCMAS), was investigated in 1997. This was undertaken by examination of reports, agenda items and draft guidelines, published between January and June 1997, and comparing their decisions with those already implemented by INFOODS and EuroNIMS.

4.3.3 Assessment and Interchange of Data Files and Tables

Food composition data files and tables from several different countries and regions were examined, along with nutrition labeling requirements from those same countries. The differences within countries were examined, along with the differences between countries in the same region and internationally. Actual and potential differences in values for energy, protein, carbohydrate, fat and fibre were calculated for selected foods. INFOODS tagnames were assigned to each component and compared with the common terminology. Explanations for the possible numeric differences have been described as they relate to each component.

4.4 RESULTS AND DISCUSSION

4.4.1 Assessment and comparison of INFOODS tagnames and EuroNIMS CAIds

To date there have only been two comprehensive systems proposed for standardising and harmonising food component nomenclature: INFOODS tagnames, which were presented to the international community in 1989 (Klensin *et al.*, 1989), and EuroNIMS Component Aspect Identifiers (CAId), which were first presented to the international community in August 1995 (Unwin & Becker, 1996).

An INFOODS expert committee was convened for the purpose of creating a system of international food component identifiers, for the proper and effective management of food composition programs, to facilitate international interchange of food composition data, and to reduce the possibilities for ambiguity and misinterpretation of nutritional information. This committee developed and published international food component identifiers, also known as tagnames, in 1989. Tagnames incorporate the food component entity, the method of analysis (or method of calculation) when different methods are known to produce different values, and the units of expression. Each tagname reflects a unique representation of a food component. Tagnames, however, are not prescriptions for what nutrients, forms of nutrients, or methods of analyses should be used. The dominant principle for the creation of tagnames was to impose differentiation between numeric compositional values that COULD be compared, and those that COULD NOT be compared. Where INFOODS tagnames overlap with other component nomenclature recommendations (e.g. those from IUNS and IUPAC), they are often very similar (Klensin *et al.*, 1989).

The CAId concept was developed to define what the EuroNIMS group considered to be key information relating to components, and to provide a convenient mechanism for handling this information. The CAId contained information beyond that contained in a tagname, including origin of the value, source of the value, source reference and quality of the value. The CAId is displayed as a string with the eight parts separated by delimiting punctuation characters. Those fields are shown below in Table 4.1, with starch as the example.

Component Identifier	Mode of expression	Origin Flag	Origin Method Indicator	Origin Method Identifier	Source Flag	Source Identifier	Quality Index
COMP	*MODE*	*OTF*	*MethInd*	*MethID*	*STF*	*RefID*	*QInd*
	Mono-saccharide equivalents						
STARCH	M	a	Polarimetry	J0002	f	B0007	--

Table 4.1: CAId fields of information, with a component example, starch (Unwin & Becker, 1996).

For most CAIds, the first two fields are equivalent to tagnames. However, some tagnames are truncated because some of the information contained in a tagname is included in field number four of the CAId. Because the CAId string is delimited, there is some interchangeability with systems using tagnames.

The CAId holds more information than tagnames. In spite of the "complete" appearance of a CAId, significant difficulties with the system were identified in this study that would impact on those working on food composition programmes and engaging in food composition data interchange. Some information necessary to prevent ambiguity is missing, and other information is redundant and/or burdensome in its requirement for inclusion. The first field of the CAId, identifies the component independently of value-related aspects such as mode of expression (field two) and analytical method (field four). This first field is the specifier for the food component. Field 1 is explained on the basis that its purpose is to be able to "collect together all information relating to the same component, and to distinguish between values measuring different components." In the example shown in Table 4.1, values for starch expressed in monosaccharide equivalents would be associated with for values for starch expressed as the weight of the polysaccharide. Tagnames, on the other hand, require the association of monosaccharide equivalents with the starch as the identifying tagname <STARCHM[9]>. Values for <STARCHM> and <STARCH[10]> would be treated not as the same component, but different components, with the expectation of different correct values when measured and presented for the same foods. The fundamental purpose of tagnames was to eliminate the possibility of calling starch in monosaccharide equivalents and starch as the weight of the polysaccharide "the same component", whereas the effect of CAIds is to allow this association to continue.

The mode of expression, the second field of a CAId, is a mixture of incompatible entities. In the example, monosaccharide equivalents is listed as a mode of expression, whereas the description of this field is the "unit weight of component per unit weight of food" and "alternatives which may also be used to express the amount of a component." The example illustrates another flaw in the CAId, and that is that the weight aspect—usually grams per 100 grams edible portion for starch—is omitted with the inclusion of monosaccharide equivalents in this field, further confounding interpretation of the information. The INFOODS tagname for this components includes the **units** of grams per 100 grams edible portion (g/100g ep) as a feature of the tagname for this component.

Incorporation of INFOODS tagnames was undertaken with the New Zealand Food Composition Database in 1992. Of the 265 components in the database at the time of conversion, each represented by a code invented by the New Zealand Food Composition Database team, approximately 239 were exactly matched to tagnames. A further 25, mostly fatty acid isomers, required creation of new tagnames, and the INFOODS secretariat accommodated this request. And only one New Zealand code required segmentation to match three different tagnames. The procedure did not require any New Zealand components to be collapsed. Tagnames proved to be very useful, so in 1994, the New Zealand Food Composition Database discontinued the use of their own codes mapped to tagnames, and now uses tagnames exclusively. Even though the general context for

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[9]<STARCHM> Starch, total, expressed in monosaccharide equivalents.

[10]<STARCH> Starch, total, expressed as the weight of the starch.

INFOODS tagnames was an "interchange scheme", their usefulness has been demonstrated in national food composition database structure and usage (Burlingame, 1996g).

Incorporation of CAIds into the New Zealand Food Composition Database was also attempted. Analytical methods data entry screens were redesigned in 1995/96 to accommodate information in the format of a CAId. Because there were no standardised codes or vocabulary that could be used with the CAIds, like the database that existed for INFOODS tagnames, standardisation was not possible. A limited vocabulary was invented for some of the fields, but the experiment was discontinued because the conversion was labourious and was judged to serve little purpose either nationally for database personnel or users, or internationally for data interchange.

These two systems were also examined to determine their suitability for use with food composition data files from seven other countries involved in data interchange with New Zealand. The first data sets incorporated into the ARev System in 1992 were those from Australia and the United States. Each data set represented component with different codes. These components were all represented on the tagname list, so each country's data set had a tagname conversion applied. This required an expansion in the ARev System because many of the components used routinely in these data sets, particularly in that of the USA, were not the same as the ones in the NZ data set. Nevertheless, there was no conflict in managing the data sets with multiple modes of expression for ostensibly the same component (for example, after these data sets were incorporated, there were seven different expressions for fibre and four for "carbohydrate" (a detailed discussion follows in section 4.5). The Pacific Islands Food Composition Database was unique among these data sets in that the data system was developed using tagnames from the start, in 1993.

From 1993 through 1996, another four data sets were incorporated: Chile, Guatemala, Philippines and Thailand. These data files resembled the US and Australia, in that they required assignment of tagnames, and then incorporation into ARev. In all cases the conversion was straightforward and uneventful. Where knowledge of the method of analysis was required (e.g. carbohydrate, fibre), these necessary details for assigning tagnames were found in written documentation that accompanied the data sets or through follow-up communications with the database's contact person. Subsequently, interchange was facilitated when other countries imbedded tagname files in their systems so that tagname assignment in New Zealand was not required.

The seven data sets were examined to see if it would be possible to attach CAIds. None of the data files contained any information that could be matched with details related to origin flag, origin method indicator, origin method identifier, source flag, source identifier, or quality index.

The cumbersome nature of the CAIds have prohibited their use in countries where food composition data systems are already in place and conversions must be applied. Most of these systems had codes to represent the nutrients and their units, and the INFOODS tagnames were readily substituted for these codes. As well as being available in book form (Klensin *et al.*, 1989), a regularly updated database of tagnames has been available for browsing or downloading from the INFOODS World Wide Web server (INFOODS, 1997) since 1995.

Notwithstanding the difficulties related to identifying food components *per se* with CAIds, the principles of the CAIds reflect sensible and appropriate documentation procedures that should be recommended to all national data base developers. Many of the "aspects" relate to other recommendations within the INFOODS interchange scheme (e.g. data source, data quality), and represent documentation procedures already implemented by some countries (including New Zealand). However, a standardised vocabulary and associated database, desirably linked at least with AOAC methods, must be available first.

4.4.2 Codex Committee on Methods of Analysis and Sampling

Codex Alimentarius representing food standards (FAO/WHO, 1993), and INFOODS representing the food composition, have never been effectively aligned. In the 1980's INFOODS acknowledged the role of Codex, but felt it was confined to the area of food control rather than food composition, and the overlap was insignificant (Rand & Young, 1984). In recent years, however, there has been a blurring of the lines of demarcation between Codex and INFOODS.

Codex has developed recommendations and standards that INFOODS needs to ratify, and adopt and expand for food composition purposes. INFOODS has developed recommendations and standards that Codex should adopt and refine for its purposes. And both are independently dealing with the same issues. For example, Codex is effectively aligned with IUPAC, ISO, and AOAC for the purpose of harmonising protocols for proficiency testing, and laboratory guidelines for quality control in analytical chemistry laboratories (FAO, 1995; ISO, 1993), activities that are very relevant to INFOODS, and could be adopted and modestly extended.

The Codex Committee on Methods of Analysis and Sampling (CCMAS) is debating and proposing standards that INFOODS has already dealt with and defined, in the area of food component identification. At the CCMAS 21st Session, 10-14 March 1997 in Budapest, the committee debated the merits of a system of method/value identification/categorisation that is analogous to and compatible with the INFOODS tagname system. The first category is for **empirical** methods, where the results are specific to the method of analysis. This is equivalent to the INFOODS tagname principle of identifying the component with its method (or ***by*** its method) when different methods are known to produce different **correct** results. The second category is for **rational** methods, where the results are not specific to the method of analysis, and therefore the method need not be associated with the results for proper, unambiguous comparisons. Again, this is the INFOODS tagname principle, and not the CAId principle.

The meeting's agenda also included an item on "Criteria for evaluating acceptable methods of analysis for Codex purposes: Methods of analysis or method criteria" (Codex, 1997). This session included debate on prescriptive analytical methodology and method types. This is a current INFOODS issue, and the two groups would benefit from engaging in dialogue and uniting the expert committees.

The remainder of this chapter will address the issue of tagname usage as an important system for managing food composition data in all its forms and for all its uses. INFOODS tagnames will be contained in angled brackets except when they appear as headings for sections or in certain tables. Their expanded meanings are not listed in footnotes, but rather will be found in the sections and/or tables that follow.

4.4.3 Carbohydrate(s) and fibre(s)

Qualifying the problem

Making sense of food components that can be classified as carbohydrates, dietary fibre or constituents of these, can be difficult. The large number of methods for expressing and/or analysing carbohydrates and dietary fibre (Southgate, 1991; Monro, 1996), and the continuing debate about the meanings of these terms create problems for those who manage food composition programmes and use food composition data. In analysis and/or expression of the nutrient entity called carbohydrate, the aggregation can include or exclude a number of components.

Table 4.2 shows tagnames for five commonly used, and very different, methods of expressing the proximate compositional entity, often simply referred to as carbohydrate.

Tagname	Meanings
<CHOAVL>	Carbohydrate, available (by summation of analytical values). Includes free sugars plus dextrins, starch and glycogen.
<CHOAVLDF>	Carbohydrate, available (by difference). Calculated as: 100g minus the sum of grams of water, protein, fat, fibre and ash.
<CHOAVLM>	Carbohydrate, available (by summation of analytical values), expressed as the monosaccharide equivalent. Includes free sugars plus dextrins, starch and glycogen.
<CHOCDF>	Carbohydrate, total (by difference). Calculated as: 100g minus the sum of grams of water, protein, fat and ash
<CHO->	Carbohydrate, method unknown

Table 4.2: Aggregations of constituents commonly referred to as the proximate entity **Carbohydrate**; their tagnames and meanings. (Monro & Burlingame, 1996).

The three most important distinctions made by these proximate representations of carbohydrates, in terms of proper interpretation of values, are:

➢ *By difference* values vs analytical values; the DF in a carbohydrate tagname denotes a value calculated by difference.

➢ Available vs total (total being available + unavailable); referring to availability to human digestive enzymes; the AVL in a tagname denotes available.

➢ Weight of the carbohydrate vs monosaccharide equivalent weight; the terminal M in a carbohydrate or fibre tagname represents expression of this component as its monosaccharide equivalent.

<CHOAVL> and <CHOAVLM> are aggregations of analytical values (i.e., the sum of individual mono-, di- and oligosaccharides + starch), while <CHOCDF> and <CHOAVLDF> are calculated by difference (i.e., 100 grams minus the sum of the gram

amounts of the other proximate entities). <CHO->, representing carbohydrate with an unknown method of determination, is a useful tagname when retrospectively evaluating food composition data that have insufficient documentation to determine the expression used. The expression of carbohydrate as the weight of the carbohydrate constituents or as its monosaccharide equivalent (ME) can be interconvertible if the individual entities are known. Conversion of disaccharides, trisaccharides, tetrasaccharides, pentasaccharides and starch to ME requires multiplying by 1.05, 1.07, 1.08, 1.09 and 1.1 respectively (Southgate, 1991).

It should be clear from the above discussion that the different representations of "carbohydrate" would necessitate differences in the correct numeric values for this proximate entity. Since virtually all food composition tables in the world present carbohydrate values (INFOODS, 1995), this component is particularly useful in demonstrating the importance of tagnames as they relate to eliminating ambiguity and misinterpretation of the numeric data.

Terms representing the proximate carbohydrate entity from food composition tables from several different countries were examined, compared and categorised (ASEAN Food Habits Project, 1988; Burlingame *et al.*, 1994b; USDA, 1993; English *et al.*, 1990; Holland *et al.*, 1991; USHEW & FAO, 1972). The theoretically-true compositions of two foods — standardised wheat bran and maize flour — were determined and calculated on a dry matter basis. A "correct" value for each term was then calculated to illustrate the magnitude of numeric differences possible with the different expressions of the proximate entity carbohydrate. Other reasons for variability were not addressed or considered. These food examples were chosen to represent the most extreme situation, and the differences in carbohydrate values for most foods will not be as great.

Country	**Term used**	**Expanded description**	**Tagname**	**Standardised value for wheat bran (dry matter basis)**	**Standardised value for maize flour (dry matter basis)**
USA (USDA, 1993)	Carbohydrate, Total	Total carbohydrate by difference	<CHOCDF>	75 g/100 g	85 g/100 g
UK (Holland *et al.*, 1991)	Carbohydrate	Available carbohydrate (summation) in monosaccharide equivalents	<CHOAVLM>	42 g/100 g	93 g/100 g
East Asia (US Dept HEW/FAO, 1972)	Carbohydrate	Total carbohydrate by difference	<CHOCDF>	75 g/100 g	85 g/100 g
Australia (English *et al.*, 1990)	Carbohydrate, Total	Available carbohydrate (summation) (not in monosacch. equivalents)	<CHOAVL>	40 g/100 g	85 g/100 g
New Zealand (Burlingame *et al.*, 1994b)	Available carbohydrate	Available carbohydrate (summation) in monosaccharide equivalents	<CHOAVLM>	42 g/100 g	93 g/100 g
Malaysia (ASEAN, 1988)	Carbohydrate	Available carbohydrate by difference	<CHOAVLDF>	40 g/100 g	85 g/100 g

Table 4.3 Terms, meanings and tagnames associated with carbohydrate values[11] in food composition tables (Monro & Burlingame, 1996).

Columns one and two of Table 4.3 show examples of the simple, common terms used for carbohydrate as a proximate constituent in food composition tables from seven different

11 The values presented are the standardised, theoretically correct values. Other sources of discrepancies or error are not considered.

countries/regions. An expanded description of what the terms mean follows in the third column. Typically, the expanded description, related to the method of determination and/or the fractions included within the entity carbohydrate, is found somewhere in the introductory pages of tables of food composition or in a READ.ME file that might come with electronic data.

As can be seen in the second column, the same term is often used to describe different mixtures and expressions of carbohydrate. For example, both the USA and Australia use the term "Total carbohydrate". The expanded description shows that two very different aggregations are represented, with the major difference being that the USDA's includes fibre and Australia's excludes fibre. Therefore, the true and correct carbohydrate values for high fibre foods will be expected to be very different in these two countries. Wheat bran is such a food. The column headed "Standardised value for wheat bran" shows carbohydrate values of 75 vs 40 g/100 g dry matter for the USDA and Australia respectively.

Another reason for differences in values in some tables is the expression of "available carbohydrates" in monosaccharide equivalents. For foods high in starch, oligosaccharides, and disaccharides, the differences are marked. Tables in the United Kingdom and New Zealand express available carbohydrate as the monosaccharide equivalent, while the others listed do not. The difference is usually calculated as 10% for starch and 5% for disaccharides. The last column in Table 4.3 shows carbohydrate values of 85 vs 93 g/100 g dry matter in maize flour, a high starch food, with the sole difference being the expression of the carbohydrate as the monosaccharide equivalent for the higher value (again these values have been standardised to eliminate other potential differences such as different extraction rates for flours in different countries, and normal biological variability).

Their are some legitimate management reasons for selecting one method of carbohydrate expression over another. These can include skills of the analyst, access to analytical instrumentation, and the simple cost of the method. <CHOCDF>, for example, is ‘free’, because it is a simple arithmetic procedure based on values for other components. Its drawbacks are many, including the fact that it disguises errors in the other measurements by giving a proximate profile of 100 grams of proximates per 100 grams of food. For many years it has been acknowledged that this expression— the most commonly used in the food composition world— should be replaced by an actual analytical method (Greenfield & Southgate, 1992, Stewart, 1996). A recent expert consultation on carbohydrates (FAO/WHO, 1997), has also recommended that measures and expressions for carbohydrate obtained by difference be discontinued. Nevertheless, the single largest food composition organisation and body of food composition data, the USDA, continues in the use of total carbohydrate by difference.

Comparing tagnames for the term carbohydrate in Table 4.3 makes clear an important reason for the significant differences in values for the same food in different tables. The simple term used in the tables or data files does not suffice.

Fibre

The nature of the dietary fibre entity is determined by the method used for fibre analysis. This, in turn, is dictated by fibre definition (Trowell *et al.*, 1976). For instance, defining fibre as non-starch polysaccharide (NSP) requires that steps be taken to remove all indigestible starch, and to measure NSP by methods that measure polysaccharide specifically. Thus, differential extraction and recovery selects components that may be measured as dietary fibre, and which of these components is selectively measured determines the apparent composition of the "dietary fibre" preparation finally obtained.

In Table 4.4, the relationship between food polymer fractions that typically comprise dietary fibre, commonly used terms for dietary fibre, and tagnames of fibre preparations is shown, as well as the approximate contribution of various food constituents to the fibre preparations. One can see that although plant cell walls are central to the concept of dietary fibre in human nutrition, cell wall polymers are not fully recovered in some fibre preparations. On the other hand, non-cell-wall materials including polysaccharides, amylase-resistant starch, and any other materials that resist digestion by enzymes of the human digestive tract may be contained in the preparation, depending on method and definition.

Dietary fibre solubility and, therefore, the distribution of NSP between insoluble and soluble fractions is very method-dependent, but even so, conditions for extracting starch/soluble fibre have not been standardised. Methods differ in both pH and buffer species, either of which can have a powerful effect on solubility of pectic substances that are a major component of soluble fibre (Monro, 1991), so "soluble fibre" food components may not be equivalent for a given sample.

Most methods for soluble fibre analysis are simply modifications of total-fibre methodology, with a step inserted after starch digestion to separate soluble fibre from insoluble material by filtering or centrifuging the digestate. The soluble fibre is then recovered from the liquid phase, most often by precipitating with ethanol.

As a result of interest in the role of soluble non-starch polysaccharides in health, it has now become standard practice to measure soluble and insoluble dietary fibre in a sample, and figures for the two fractions are permissible on food labels in the United States (Ellefson, 1993). The usual approximate distribution of other food components classified as dietary fibre between soluble and insoluble fibre fractions is summarised in Table 4.5. The distribution is represented by pluses (+) and minuses (-). The "+" represents complete partitioning of a food polysaccharide components in one fraction; a "-" represents a near absence of that component in one fraction; and a "±" represents appreciable distribution of that component between both fractions.

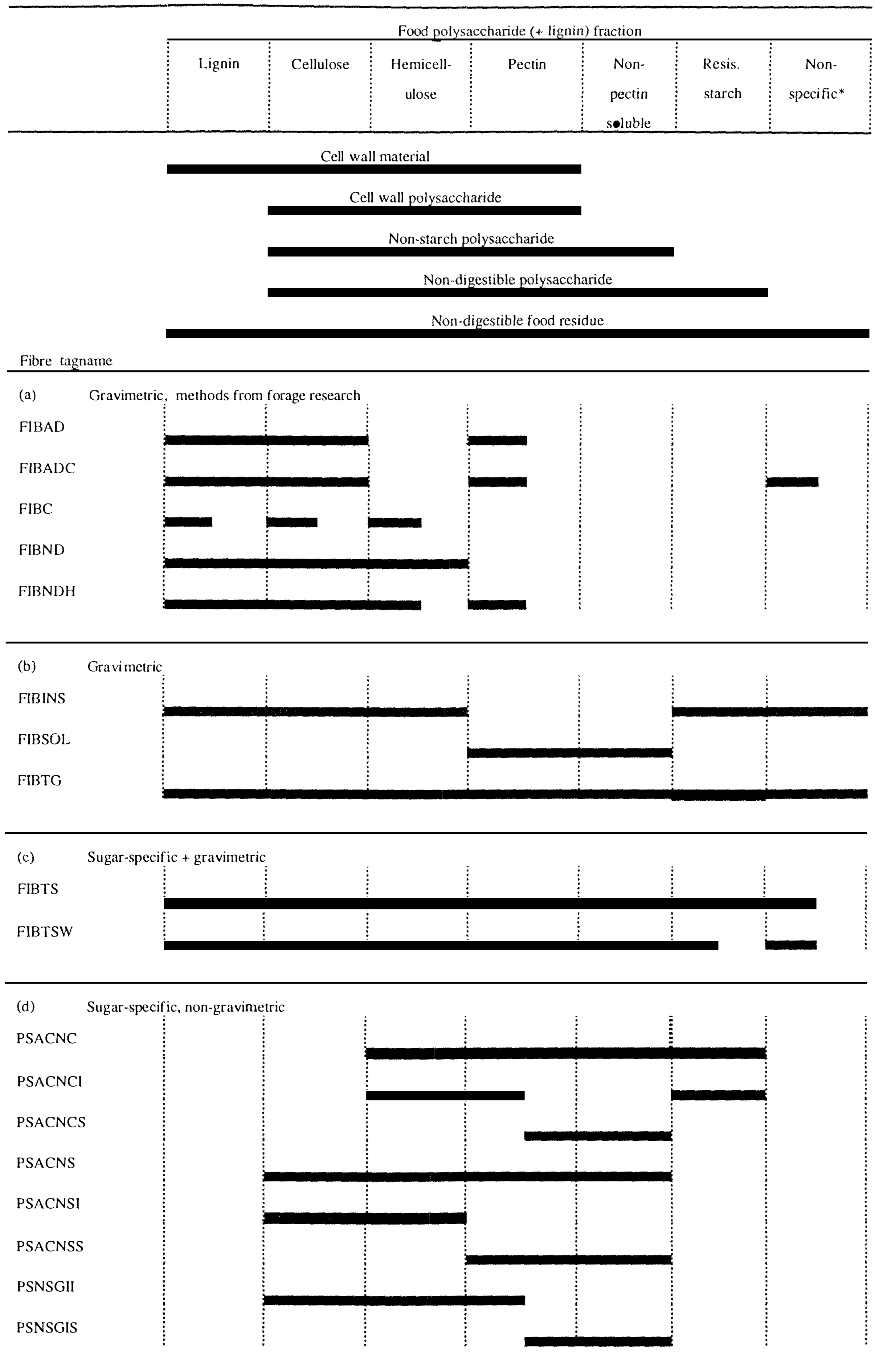

Table 4.4 Tagnames, definitions of dietary fibre, polysaccharide fractions, methods for fibre analysis: approximate relationships (Monro & Burlingame, 1996) .

Food Polysaccharides		Insoluble	Soluble
		FIBINS	FIBSOL
Tagname	Component	PSACNSI	PSACNSS
		PSNSGII	PSNSGIS
PECT	Pectin	±	+
HEMCEL	Hemicellulose	+	–
CELLU	Cellulose	+	–
LIGN	Lignin	+	–
PENSN	Pentosan	±	±
HEXSN	Hexosan	±	±
PURAC	Polyuronic acid	–	+
ARAN	Arabinan	–	+
GALTN	Galactan	–	+
GLUCNB	Betaglucan	–	+
XYLN	Xylan	+	–
MANN	Mannan	+	–
STARES	Starch, resistant	+	–
AGAR	Agar	–	+
ALGNT	Alginate	–	+
CARGN	Carrageenan	–	+
GUMS	Gums	–	+
MUCIL	Mucilages	–	+
PSACALG	Polysaccharides, algal	–	+

Table 4.5: Distribution of food polysaccharide components between soluble and insoluble fibre fractions (Monro & Burlingame, 1996).

FIBAD

Acid detergent (van Soest, 1963) leaves a low-nitrogen residue of mainly lignin plus cellulose, used for predicting forage digestibility. It is used as a pretreatment before lignin (ADF lignin; AOAC method 973.18D) and cellulose analysis, although there is some loss of lignin, and extraction of hemicellulose and pectin may be incomplete. Because it is hydrolytic and measures only the filtered residue, there is usually considerable loss of dietary fibre.

FIBC

The crude fibre method (Henneberg and Stohmann, 1859) (AOAC method 962.09, AACC method 32-10) is empirical and technically difficult. Most pectin and hemicellulose, and some cellulose and lignin are destroyed. The fibre residue may be high in nitrogen.

In short, the method is unsuitable for food analysis. It was developed to predict forage digestibility (with only partial success), but is not suitable for human foods, in which the typically non-fibrous "dietary-fibre" is extensively destroyed, to the extent that FIBC is not consistently related to the amount of NSP in a food. Table 4.4 illustrates the incomplete recovery of the lignin, cellulose and hemicellulose in the crude fibre method.

<FIBC> is one of the few tagnames that comes with the disclaimer, "Obsolete method with no nutritional relevance" (Klensin *et al.*, 1989, p 32). Nevertheless, this method still has the most widespread use of any fibre method in the food composition literature and it is still prescribed in food standards and food regulations in many countries (ANZFA, 1997).

FIBND, FIBNDH

The neutral detergent method (Robertson & van Soest, 1981) gives low-nitrogen residue. It was designed to measure "cell walls" in forages, but is less suitable for foods, as most soluble fibre (e.g. pectin) is extracted by the heat plus EDTA[13] present in the detergent. <FIBND> minus <FIBAD> has been used to measure hemicellulose.

Starch may contaminate the fibre residue in starchy samples, slowing filtration and inflating fibre values. Several modifications (Schaller, 1977; Robertson & van Soest, 1977; Mongeau & Brassard, 1986) incorporate an amylase treatment to overcome the problem (AACC insoluble dietary fibre method 32-200, AOAC method 992.6, AACC method 32-06 respectively).

FIBINS, FIBSOL, FIBTG

<FIBINS>, <FIBSOL> and <FIBTG> are measured by the AOAC gravimetric method (Prosky *et al.*, 1988). The aim of measuring soluble, insoluble and total dietary fibre rapidly by such a method, with full recovery of dietary fibre, has been pursued for a number of years, resulting in a string of methods (Monro, 1996) representing progressive modifications, each with an associated set of results. The gravimetric methods involve correction (with associated error) for ash and protein in the residue. They tend to give higher total fibre values than the sugar-specific methods that measure fibre as polysaccharide, because a range of resistant components are present in the residue.

FIBTG is determined by AOAC method 985.29, or as FIBINS plus FIBSOL measured by AOAC method 991.42. Most recent modifications (AOAC method 991.43, AACC method 32-07) for <FIBTG>, <FIBINS> and <FIBSOL> involve changing the buffer from phosphate to MES/TRIS, to eliminate a pH adjustment, reducing the number of steps, averting phosphate precipitation (which had given inflated fibre values), and improving precision (Lee *et al.*, 1993).

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[13]Ethylenediaminetetraacetate

FIBTS, FIBTSW

These are determined by summation of cell wall polysaccharide fractions (water-soluble NSP, hemicellulose, cellulose) measured specifically in a sample after starch digestion, plus lignin. The Southgate procedure (Southgate, 1969) involves measuring hexoses, pentoses and uronic acids colorimetrically in the fractions. More recent methods involve measuring soluble and insoluble non-digestible polysaccharides as the sum of monosaccharides by more reliable means such as GLC and HPLC. "Lignin" is determined gravimetrically. <FIBTS> and <FIBTSW> contain resistant starch, but <FIBTSW> contains less than <FIBTS> by the Southgate method because a more effective starch digestion was used (Wenlock *et al.*, 1985).

Results are similar to but often lower than with the (AOAC) gravimetric methods for total dietary fibre.

PSACNC, PSACNCI, PSACNCS

These polysaccharide fractions are isolated as in the Southgate procedure above, and then measured specifically. <PSACNCI> corresponds to conventional hemicellulose <HEMCEL> plus some pectin <PECT>, because acetate buffer is used to extract soluble polysaccharides rather than the conventional pectin extractants such as EDTA or ammonium oxalate. Englyst's modification (Englyst *et al.*, 1982) of Southgate's method uses GLC, and colorimetry only for uronic acids. It does not exclude resistant starch. The fractionation is complex for routine analysis but provides detailed information. It has been modified to the more rapid Englyst procedure for NSPs.

PSACNS, PSACNSI, PSACNSS

These are the NSP fractions produced by methods such as Englyst's. Usually total NSP <PSACNS> and insoluble NSP <PSACNSI> are measured, either chromatographically

(Englyst *et al.*, 1992) or colorimetrically (Englyst & Hudson, 1987), with soluble NSP <PSACNSS> obtained by difference. However, measuring soluble fibre by difference between two separate fibre analyses leads to accumulation of errors.

Hot pH 7 phosphate buffer is used in the Englyst procedure to extract soluble fibre. As it removes pectic substances more effectively than pH 5 acetate buffer used in extracting PSACNCS, PSACNSS values are likely to be higher than PSACNCS values, and PSACNSI lower than PSACNC + PSACNCI.

DMSO[14] used to gelatinise starch for digestion in the Englyst method, may also increase the solubility of NSPs during analysis, inflating PSACNSS at the expense of PSACNSI. The absence of resistant starch may also give PSACNS and PSACNSI fibre values that are lower than for corresponding total fibre and insoluble fibre components above.

<PSACNS> AND <PSACNSI> are the methods used routinely for fibre analysis for the New Zealand Food Composition Database. In spite of New Zealand's food legislation dictating Prosky <FIBTG> (Department of Health, 1993), the Food Composition programme switched to the Englyst method in 1992 upon the recommendation put forward by the Nutrition Taskforce (1991), based on the "greater nutritional relevance" of measuring both the soluble and insoluble fractions of non-starch polysaccharides.

PSNSGII, PSNSGIS

<PSNSGII> and <PSNSGIS> are non-starch polysaccharides soluble and insoluble respectively under simulated human gastrointestinal conditions (Monro, 1993). Soluble non-starch polysaccharides <PSNSGIS> are extracted under physiological conditions, before digesting starch. <PSNSGII> remaining in the residue is then measured as NSP and by the Englyst method, and <PSNSGIS> calculated by the difference between PSNSGII and

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14 Dimethylsulfoxide

PSACNS measured in a duplicate of the sample. The procedure can be put at the front end of any total fibre method to give a "nutritionally valid" measure of soluble fibre.

This modification to the Englyst procedure circumvents effects of non-physiological conditions (e.g. heat, DMSO, phosphate buffer) during starch removal on polysaccharide distribution between soluble and insoluble fractions, and allows effects of food processing/cooking and maturity on fibre solubility to be measured.

<PSNSGIS> values may be lower than the soluble fibre values from other methods, particularly for uncooked pectin-rich materials. This method will not see widespread adoption in the near future, but it brings the food composition community another step closer to addressing the long-neglected issue of physiological relevance and bioavailability of the components measured.

FIB-

This does not refer to any particular method or fibre preparation. <FIB-> identifies values representing unknown fibre components, or those from unknown methods. Use of <FIB-> is particularly relevant when tagging undocumented data sets. <FIB-> is also used when a single fibre value is needed from a larger data set; it can represent any of several known methods which would also be represented by their specific tags. Choice of value is based on such considerations as nutritional validity, soundness of method related to the food matrix, and recovery of proximates.

LIGN

<LIGN> seldom refers to true lignin, the accurate measurement of which is difficult, and therefore quantitation of this component is not attempted in most fibre methods. Instead, the weight of residue remaining after 12M H_2SO_4 hydrolysis of the insoluble fibre residue ("Klason lignin") is used as an approximation to true lignin. Klason lignin may contain

non-specific residual substances, that can inflate total and insoluble fibre values from gravimetric methods.

Most foods contain little true lignin, and the Klason lignin obtained from them may contain a high proportion of non-lignin residuals. If lignin is suspected of being a significant component it can, like resistant starch, be measured separately from cell wall polysaccharides measured as NSP.

STARES

Resistant starch <STARES> plus NSP adds up to non-digestible polysaccharide. Therefore, <STARES> should never be added to values for fibre preparations containing non-digestible polysaccharide, such as <FIBTG> and <FIBTS>. Conversely, where starch is measured as available carbohydrate, and fibre as NSP, the resistant starch component will be missed.

Resistant starch is a minor component in most foods, but it may contribute significantly to non-digestible polysaccharides in starchy foods that contain little cell wall material, particularly when the physical structure of the food or starch, or retrogradation of starch as a result of food processing, renders it indigestible.

Resistant starch has been a contentious issue. Gravimetric methods have been criticised (Englyst & Cummings, 1990) for not measuring cell wall NSPs free from resistant starch, as the concept of dietary fibre was originally intended to equate to plant cell walls in food, and inclusion of resistant starch may make fibre values vulnerable to food processing. Others (Prosky & deVries, 1992) argue that when starch behaves as dietary fibre (non-digestible polysaccharide) it should be classed as a fibre component, particularly as it has the physiological properties of fibre.

Starch resistant to gelatinisation and enzymatic hydrolysis during fibre analysis is not, however, the same as that resistant to digestion in the human intestine. Therefore, the detection of resistant starch in fibre preparations does not necessarily correspond to physiological behaviour.

Englyst (Englyst and Cummings, 1990) prefers measuring resistant starch as an important food constituent in its own right, with fibre measured independently as non-starch polysaccharide, so that it can act as a valid index of plant cell walls in a food. Methods are available for measuring resistant starch separately (Englyst *et al.*, 1987).

4.4.4 Protein

Protein is rarely analysed directly. The most common method for expressing protein is by direct analysis of nitrogen, and multiplication of this value with a selected nitrogen conversion factor that represents the average nitrogen content of proteins found in particular foods. This is not straightforward. This mode of expression gives rise to more ambiguity because the nitrogen values used can be total nitrogen <NT>, amino nitrogen <NAM>, or protein nitrogen <NPRO>. Total nitrogen is protein nitrogen and non-protein nitrogen together, therefore for some foods high in non-protein nitrogen (yeasts, cartilagenous fish) the protein value would be grossly misleading. And because non-protein nitrogen contains nitrogenous substances that are not amino-acid-based, and therefore cannot be used by the body for protein synthesis. Some food composition authorities have called for the use of <NAM> in food composition data programmes (Greenfield & Southgate, 1992), although not specified by tagname. INFOODS did not pass this judgment, but simply required identification of the N type by use of the correct tagname. When no indication is given in food tables as to the form of N, the best guess is that it is <NT> since most laboratories can easily and inexpensively perform a Kjeldalh nitrogen analysis. Recommendations for generation and presentation of data from different procedures, independently of calling for tagname use will lead to greater ambiguity.

The nitrogen conversion factor can be the standard conversion factor 6.25, or specific factors as used and/or recommended by FAO/WHO (1970), Jones (1941), and USDA (1975-1994).

The specific factors can range from a low of 5.18 for almonds to a high of 6.40 for casein. The New Zealand Food Composition Database reports a nitrogen value for almonds of 4.05 g/ 100g. By the specific factor method, the correct protein value would be 21 g/100 g; by using 6.25 as the factor, the correct protein value would be 25.3 g/100 g.

Heidelbaugh *et al.* (1975) assessed three different calculation methods for protein for 68 different foods and found variations in percentage differences up to 40 percent.

Protein calculated as total nitrogen times the standard 6.25 is dictated by the EC Directive (1990), whereas Codex Alimentarius prescribes calculations with at least one different reference nitrogen conversion factor, that is 5.7 for durum wheat semolina and durum wheat flour. The United States Nutrition Labeling and Education Act (NLEA) (Food and Drug Administration, 1993) requires the full range of specific factors, whereas New Zealand's legislation is not prescriptive so all methods are used.

4.4.5 Fat

Fat is most frequently measured by a solvent/gravimetric method of analysis. The variations between these methods can be significant. Fat extraction is a particularly tricky analytical procedure to standardise because there are so many acceptable modifications in the analytical steps. In the first INFOODS volume, only two fat tagnames had been specified — <FAT> which is total fat, and <FATCE> which is total fat derived by analysis using continuous extraction. Neither of these alerts the users, generators or compilers of food composition data to the possibility of different correct values with each modification to solvent system, extraction time or pre-treatment steps.

In the United States, since the enactment of the NLEA (Food and Drug Administration, 1993) the lack of international harmonisation, compatibility and standardisation has presented problems for food industry personnel and people managing food composition databases all over the world. The most problematic of the nutrients is fat, as defined by the NLEA. <FATNLEA> is the newest tagname for fat, defined as triglyceride equivalents of fatty acids. Fat defined in this way, analysed as individual fatty acids and then calculated as if they were all triglycerides, is required on virtually all labels of food sold in the USA (Sullivan & Carpenter, 1993).

The differences between values obtained by the NLEA methods and an solvent extraction/gravimetric method can be significant for many reasons, including the presence of fatty acids from non-triglyceride lipids and the unavailability of standards for identifying/quantifying all known fatty acids. In most commercial laboratories, the cost of a gravimetric fat analysis is about 25% of the cost of a comprehensive fatty acid analysis, which is needed for determining fat as the triglyceride equivalent of fatty acids, as required by the NLEA.

In addition to methodological disharmony creating ambiguity for fat data, a further variable emerges with correction factors. Some food data sets present a fat value which has been corrected because of the presence of fat which is not digested and/or absorbed. In the case of fish containing appreciable amounts of wax esters, one of these fat compounds, the portion of the fat that is wax esters is subtracted from the total fat value. For orange roughy, 93 percent of the measured total fat is wax esters. Figure 4.1 shows the values reported for fat for orange roughy based on three different methods. INFOODS has not provided for the contingency of subtracting non-metabolisable fat from the total reported in food composition tables and data sets, nor has the CAId.

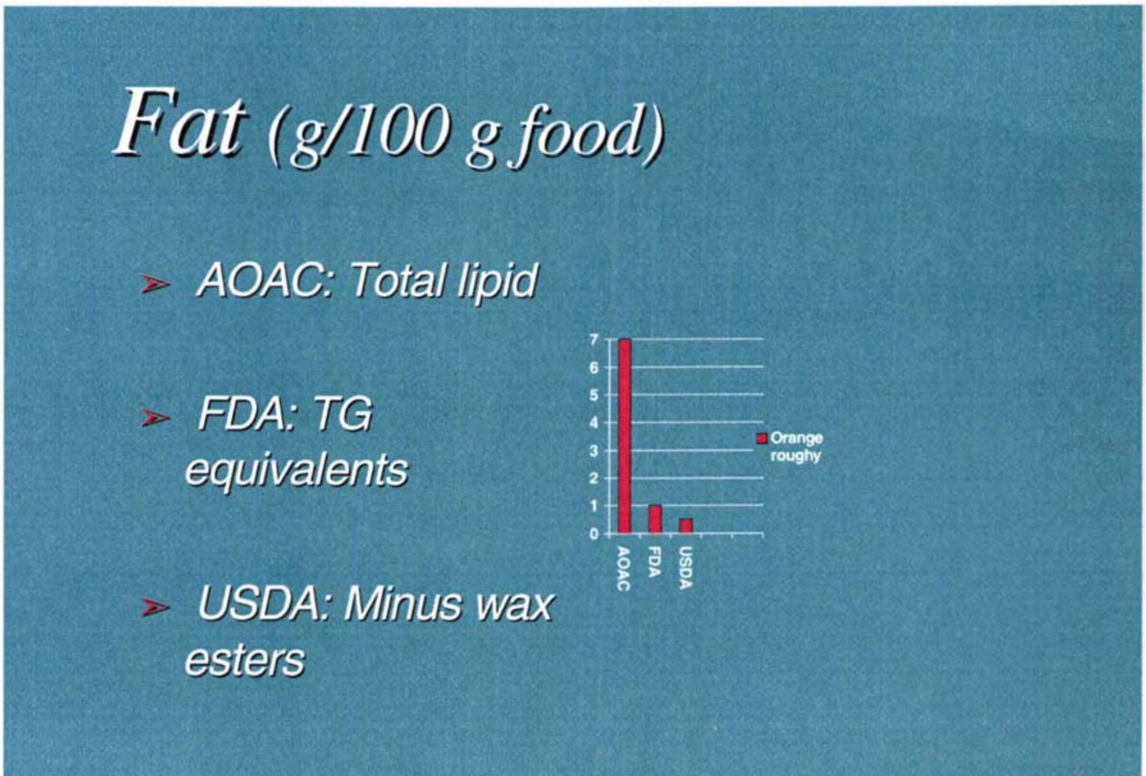

Figure 4.1 Values reported for fat for orange roughy based on three different methods of lipid analysis.

4.4.6 Energy

Energy is rarely measured directly. When it is, the tagname <ENERA> would represent gross energy, determined by direct analysis using bomb calorimetry. Instead energy is most frequently calculated from the data for the main energy-yielding components of foods: protein, carbohydrate, fat and alcohol.

The tagname <ENERC> represents total metabolisable energy, calculated from the energy-producing food components, with kilojoules as the default units. In addition to a value for the quantity of total metabolisable energy, <ENERC> includes a description or listing of the conversion factors used to calculate this energy value from the proximate quantities. The conversion factors are listed either with keywords that identify a set of factors, or by using secondary tagnames within <ENERC>. The secondary tagnames are useful and necessary when some additional energy-yielding components plus factors are included in the energy calculations, such as organic acids (Livesey, 1989), polyols (Livesey, 1992; FASEB, 1994), and fractions of dietary fibre which yield energy from short-chain fatty acid production and absorption after colonic fermentation (Livesey, 1990).

Most of the disharmony and ambiguity in energy data *per se* relates to these conventions for these energy conversion factors. For example, one convention specifies the same factor for each component regardless of the food: energy in kilocalories (kcal) is $\sum$ g total protein x 4, g fat x 9, g carbohydrate in monosaccharide equivalents x 3.75 and g alcohol x 7, with a single keyword <STDA>. Energy in kilojoules (kJ) is $\sum$ g total protein x 17, g fat x 37, g carbohydrate x 16, g alcohol x 29, with a single keyword <KJA>. Several other keyword are also provided within the INFOODS tagname system.

Also frequently used is the convention of a specific range of different factors for each component. If none of the above keywords apply, the actual conversion factors used to calculate the total metabolisable energy should be listed using the following secondary tagnames: <XP> conversion factor for calculating energy from protein, <XCT> conversion factor for calculating energy from total carbohydrate, <XCA> conversion factor for calculating energy from available carbohydrate, <XF> conversion factor for calculating energy from fat, <XA> conversion factor for calculating energy from alcohol. To eliminate the possibility of ambiguity, <ENERC> may not be used without either one of the keywords specified above or a set of specific conversion factors.

Another energy tagname, <ENER->, method of determination unknown, should be used if it is not known whether the energy value represents gross energy or total metabolisable energy. It should also be used if it is known that the energy value was calculated from the proximate components but the conversion factors used are unknown. This provision flags to the user that these energy values may not be valid for the intended use, or comparable with other data or data sets.

The provision for secondary tagnames for factors associated with energy is fundamental to the goal of eliminating ambiguity in food composition data. Energy data, used for any number of reasons, it is often used or compared independently of the data for energy-yielding constituents. Misinterpretation of data used in comparisons of energy values is very common because most data users do not realise the range of factors that can be used.

Factors to calculate energy contributed by protein can range from a low of 1.82 for bran, to a standard value of 4 for all foods, to a high of 4.36 for eggs. The United States uses the range of factors, i.e., the low factor of 1.82 for bran, and the high factor of 4.36 for egss, while Britain uses the single factor of 4. Figure 4.2 illustrates the differences graphically.

Factors to calculate energy contributed by fat can range from a low of 8.37 for most grains (as used in the USA), to a standard value of 9 for all foods (as used in Britain), to a high of 9.02 for eggs (as used in the USA). The differences made in the energy values by the selection of factors is illustrated in Figure 4.3, while the difference in energy from fat related to selection of the lipid method of analysis/expression is illustrated in Figure 4.4.

Factors to calculate energy contributed by carbohydrate can range from a low of 1.33 for chocolate (again, as used in the USA), to a standard value of 3.75 for available carbohydrate in monosaccharide equivalents <CHOAVLM>, and 4 for total carbohydrate <CHOCDF> for all foods, to a high of 4.12 for distilled spirits (USA). Figure 4.5 illustrates the difference in energy values between Britain and the USA using chocolate as the example.

The values for components in Figures 4.2, 4.3, 4.5, in g/100g edible portion are:

	UK	USA
Bran, protein	14.1	15
Eggs, protein	12.5	12
Brown rice, fat	2.8	2.9
Whole wheat, fat	2.2	2
Chocolate, carbohydrate	11.5	11.3

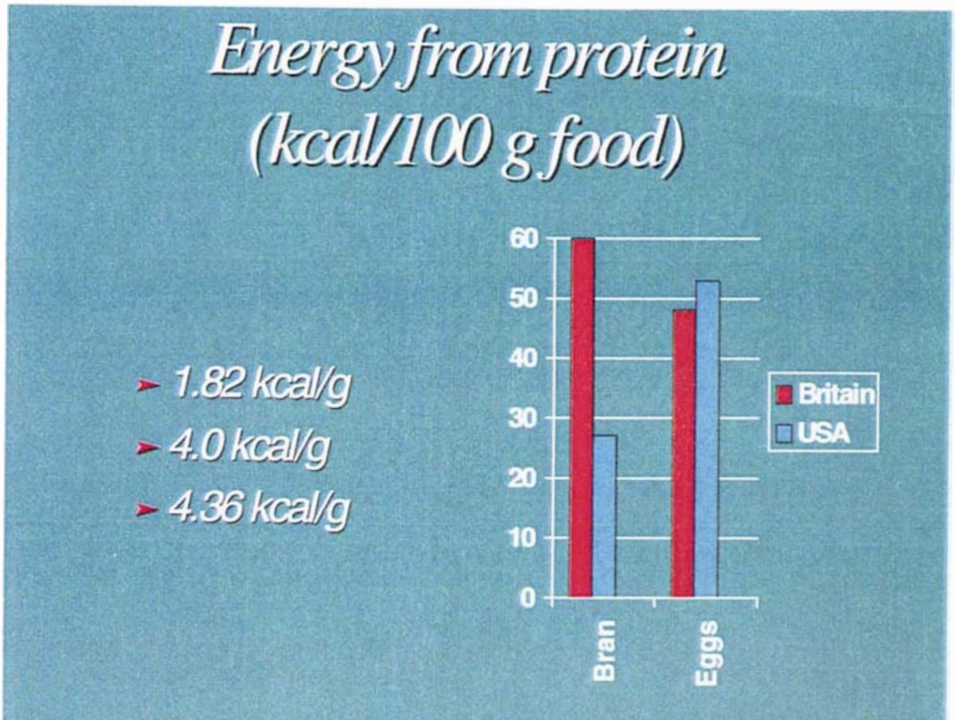

Figure 4.2 Some examples of the difference in energy with the selection of different energy factors for protein.

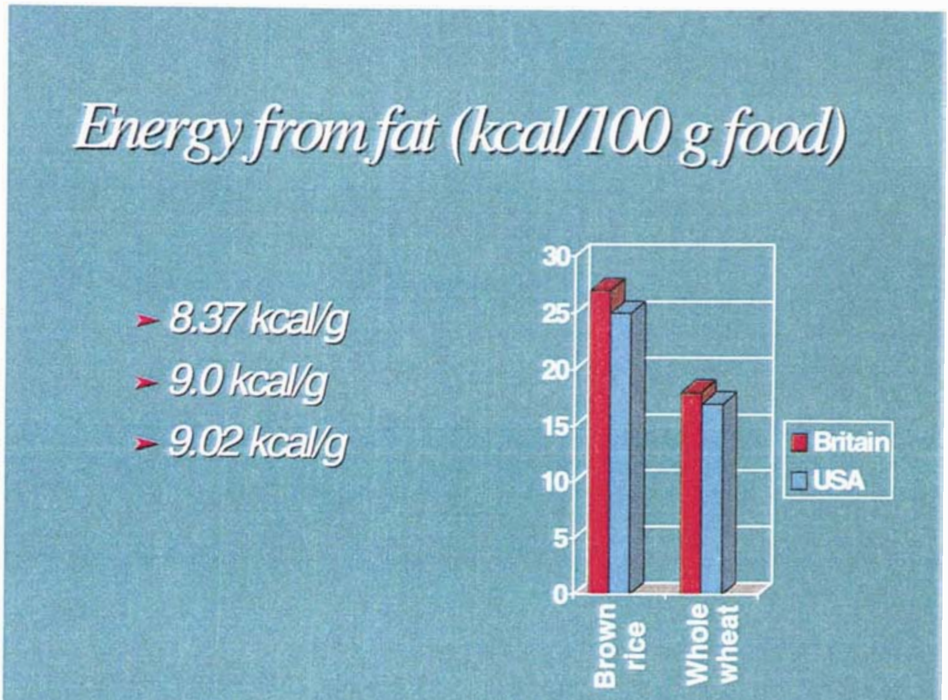

Figure 4.3 Some examples of the differences in energy from the selection of different factors for energy from fat.

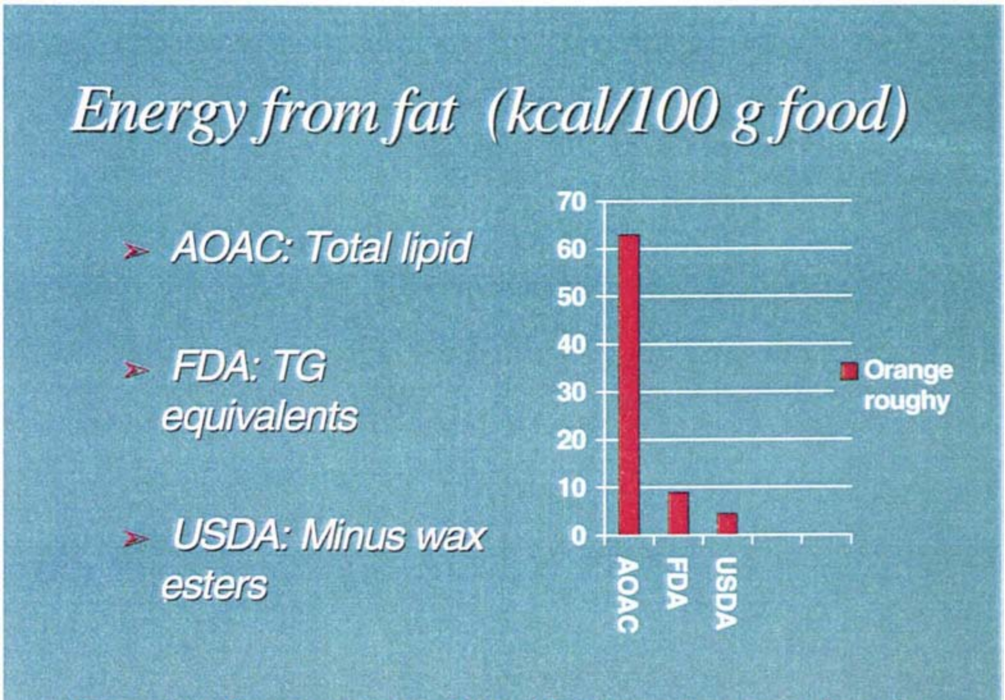

Figure 4.4 Some examples of the differences in energy from fat from selection of different methods of analysis/expression for fat.

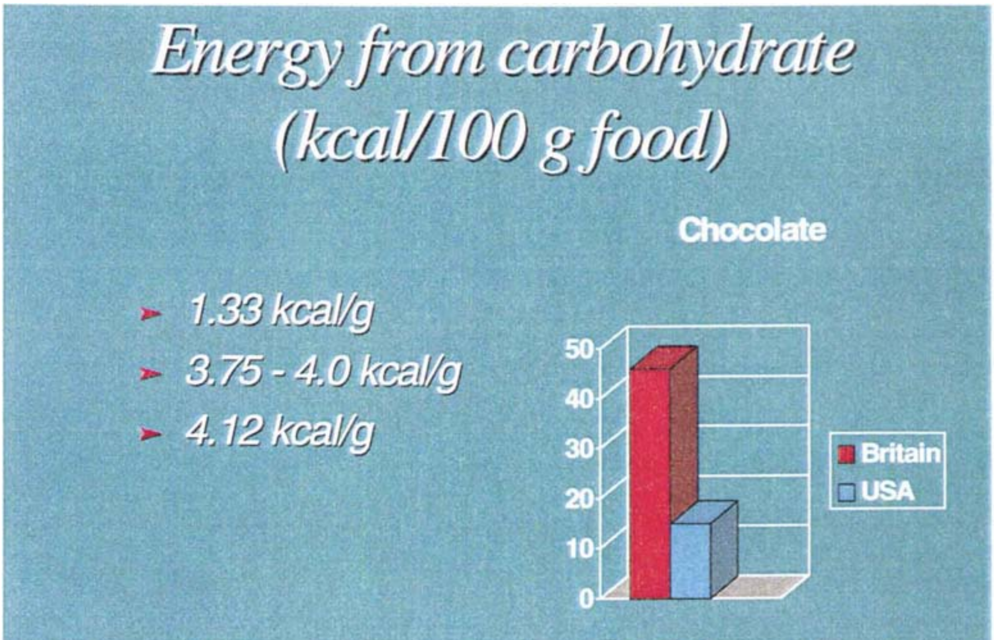

Figure 4.5 Chocolate as an example of the differences in energy from the selection of different factors for energy from carbohydrate.

Nearly all the problems associated with lack of standardisation and harmonisation with energy factors are compounded with the different methods and expressions for carbohydrates, protein and fat, already described. This is easily illustrated with the orange roughy example under **fat**. The energy values, numerically, represent an even greater range of correct values than the fat values. Measured by the AOAC total lipid method, the fat content is 7 g/100 g; by the FDA method of triglyceride equivalents, the fat contents is 1 g/100 g; and using the correction factor for the wax ester component, as the USDA does, the fat content is 0.5 g/100 g. Using the factor 9 kcal/g, the energy from fat could be as high as 63 kcal with the AOAC fat, or as low as 4.5 kcal with the USDA fat. That would be 265 kJ and 40.5 kJ respectively.

An editorial in the Journal of Food Composition and Analysis, the subject of energy content was discussed (Stewart, 1994). The editor said:

> "The factors used to convert the weights of the proximates to total caloric content need to be reexamined. Neither traditional 4-9-4 nor the Atwater factors would seem appropriate for estimating the caloric content of the modern food supply. Given the fundamental importance of caloric intake for the resolution of current important public health problems, it would seem that more attention should be paid to the assay methods . . ."

Figure 4.6 shows an example of the use of energy data in an international context (FAO, 1996/Tech). The factors and/or keywords have not been provided, and this report and others like it, are being used by many people in the many sectors identified in Chapter 1, to assess national food security (Nawani,1994), to develop nutrition policy (New Zealand Public Health Commission, 1995), to compare survey results (Prentice, 1996; FAO, 1996/Tech 10), to seek foreign aid (FAO, 1996/Tech 11), and to rank countries against one another (FAO, 1996/Tech 9).

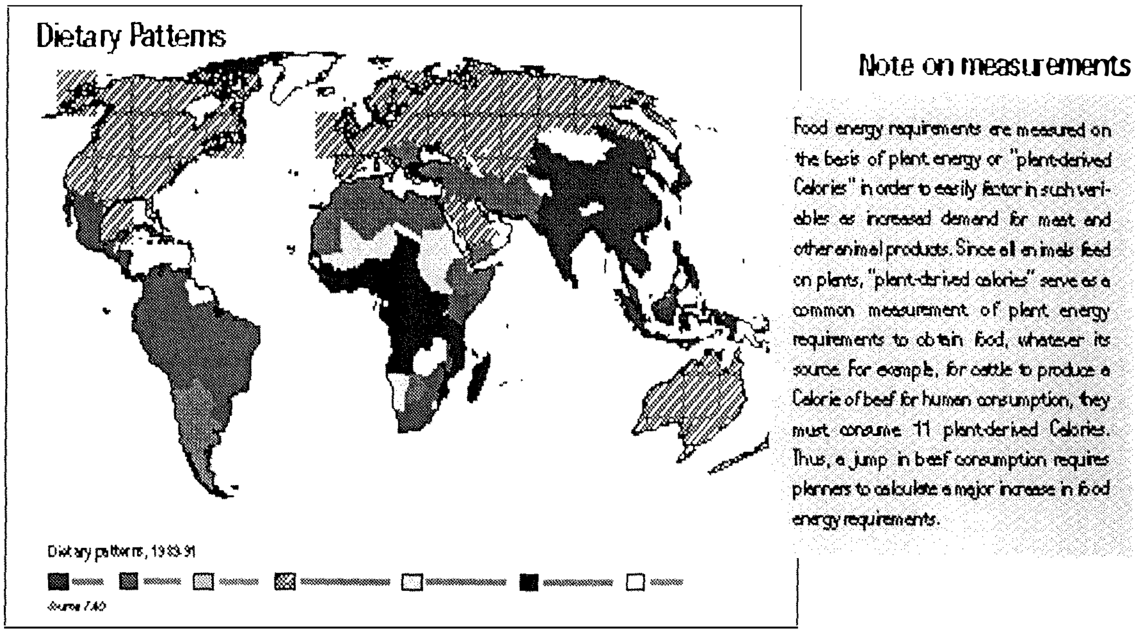

Figure 4.6: Assessment of energy intakes for international comparisons.(FAO, 1996).

4.5 CONCLUSION AND RECOMMENDATIONS

Standardisation of nutrient analysis methods for the purpose of harmonising nutrition labelling and food composition data bases nationally should be a reasonable goal. And given the implications for regional and international food trade, and international research projects that depend on food composition data, harmonisation beyond national borders should also be a reasonable goal. Acknowledging that few countries have achieved even a national goal of harmonisation, compatibility or standardisation it seems unlikely that international or regional goals can be achieved in the near future. A practical, immediate, realisable goal should therefore be to eliminate ambiguity and misinterpretation of food component information by adopting and using INFOODS tagnames (Klensin *et al.*, 1989).

The above results and discussion have stressed the point that simple and commonly-used terms for food components cover a diverse range of food entities. Because food composition data are fundamental to clinical, epidemiological and agricultural research; nutrition, public health and agricultural policy development; and many other endeavours, nutrient data must be generated, compiled and presented without ambiguity. Carbohydrates have a particularly extreme potential for creating ambiguity. While the problem of widespread use of a multiplicity of methods will not change with the adoption of INFOODS tagnames, the problem of ambiguity will be largely eliminated.

The use of tagnames is important in printed materials, but even more so in electronic data files where expanded descriptions, methods of analyses and other important information are in separate files, often without direct links to the food records (USDA, 1993; NZICFR, 1995).

Tagname use for all food components is a requirement for the INFOODS data interchange scheme (Klensin, 1992), as well as for proper interpretation of the food data. Experience in New Zealand with electronic interchange of data files with and without tagnames has been a beneficial exercise in demonstrating the value of tagnames for this purpose (Burlingame, 1991; Burlingame *et al*., 1994a).

Up until New Zealand began experimenting with and validating the use of tagnames in databases and datafiles, the concept was entirely theoretical and academic as a model. In this research programme, the model was not only validated, but an initial quantitative approach of the impact of standards and harmonisation was undertaken for the first time in this context.

Since New Zealand first adopted tagnames and incorporated them into the Food Composition Database in 1991 (Cook *et al*., 1992), this author has been promoting their use. Their value has been demonstrated in the retrospective evaluation and updating of existing food composition systems, as was done in New Zealand (Burlingame, 1991, 1993d), Australia (Lewis, 1996), the United States (Haytowitz, 1996), and with an international data file (Murphy, 1996; WorldFood, 1997); and in the prospective design and implementation of new systems (Matenga-Smith, 1996; Alexander, 1995).

Tagnames are not prescriptive in nature, in that only in a few rare cases is one tagname described as "obsolete" or "not recommended". Judgments about the suitability of one measurement over another are not made. Therefore, issues related to the limitations of analytical measurements and the relevance of data to human health must still be addressed. The next goal for INFOODS and the international food composition community should be a set of recommendations as to the most appropriate of the methods (tagnames) to use for a given set of circumstances.

The overall assessment of the INFOODS system and CAIds is:

- tagnames adequately and appropriately serve the purpose of identifying food components for national usage and (especially) for data interchange;

- CAIds provide the best single appropriate basis for developing standards and guidelines for other aspects of documentation related to component/method/value in a food composition data system.

Under the auspices of INFOODS and/or Codex, an international component identification committee should be convened to:

- debate some general principles (several of which were listed by the original tagname committee as requiring further attention),

- extend the categories of tagnames to include other non-nutrient constituents in foods (e.g. contaminants),

- extend the "identification" principle into recommendations on "preferred methods and modes of expression" for national and regional data base developers,

- develop internationally-acceptable standards (with codes or tags) for simply and clearly documenting methods of analysis (both the empirical and rational), sources of data, references, etc., with involvement of the experienced food composition programme managers, and in particular EUROFOODS people with CAId experience, with liaison with Codex Alimentarius Committee on Methods of Analysis and Sampling.

5. HARMONISATION FOR FOOD LEGISLATION AND FOOD TRADE REGULATIONS

5.1 INTRODUCTION

As established in the first chapter of this thesis, food regulation and trade have emerged in recent years as one of the more important and demanding of the sectors involved in food composition activities.

The technical food composition harmonisation issues related to food trade include identification of foods, food ingredients and processes; identification of components and methodological standards; units of measures and serving sizes; and compositional standards. Food composition-related disharmony in the trade sector can lead to, and has led to, serious problems that affect the reputations of companies and countries; costly legal disputes related to charges of fraud, with penalties that include fines and imprisonment (The Press On-Line, 1997); restrictions in market access; and ill-will between nations that can have effects in other arenas.

In many countries, food composition programme managers seeking to maintain or increase funding for their programmes are finding that highlighting the trade implications to funding decision-makers is more convincing in their advocacy than the more conventional approach focussing on implications related to health and agriculture. Giving credence to this trend is the fact that trade was selected as the theme for the 3rd International Food Data Conference[1].

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1 The conference was subsequently cancelled, but a session on food composition and food trade was incorporated into the 15th International Congress of Nutrition in July 1997.

In this chapter on trade and regulatory issues related to managing food composition programmes the following will be presented:

- Identification of agencies and agreements involved in food trade;
- an analysis of their food composition-related rules, regulations and activities;
- case studies illustrating areas of disharmony and incompatibility, and the consequences;
- a set of recommendations for aligning the technical and administrative aspects of food composition and trade.

5.2 METHODS AND MATERIALS

5.2.1 Analysis of information

Much of the material used in the Chapter comes from analysis of the information resources outlined in Chapter 1. Additional information comes from analysis of codes, regulations and official documents in printed and electronic form, and materials obtained from the Ministry of Health through the Official Information Act (New Zealand Government, 1988). All documents, including the multilateral and bilateral trade agreements, were examined for the purpose of finding actual and potential implications for food composition information.

5.2.2 Case studies

Three case studies were used to determine the nature and the consequences of disharmony in food trade as it relates to compositional issues.

Plumrose ham prosecution by the NZ Commerce Commission is the first case study. The issues relate to the prosecution's challenge that this food was sold with nutrition claims that were in violation of the NZ Food Regulations, 1984 and amendments, and the defence claims related to the name of the food and therefore its "usual" composition, and the definition and composition of its "normal" counterpart. The author had direct involvement in this case from its early discussion phase when a member of the public brought the complaint to the Commerce Commission, through to the actual court proceedings as a witness for the prosecution.

Spreadable butter is the second case study. This study examines the criminal charges in the United Kingdom and the World Trade Organization's involvement in the dispute over the trade violations in the sale of New Zealand Anchor Butter. The case specifically relates to food nomenclature and terminology (i.e. what is butter) as defined by the compositional standards for butter and production requirements in the United Kingdom, the European Union and New Zealand; and methods of analysis for determining the content of the components for which there are compositional standards (water and fat, in the case of butter). Further details on this legal case were obtained from telephone and personal interviews with Ministry of Health, Dairy Board and dairy company officials, from newspaper reports, and via the Official Information Act process (New Zealand Government, 1988).

The third case study involves the Nestles Coffee Mate, sold in New Zealand with a non-compliant nutrition label. The author initiated the prescribed complaints' procedure by filing a complaint, observing the events that took place, and interviewing the product manager at the conclusion of the process to find out the consequences and the response of the company.

5.3 RESULTS AND DISCUSSION

Managers of national programmes and regional data centres have identified six types of trade sector environments that have actual or potential consequences or that impact upon their food composition activities:

- their national food standards and food legislation;
- the national and regional food standards and legislation of their significant export markets (e.g. NLEA[2], EC Directive);
- their nation's involvement in bilateral and/or multilateral trade agreements (e.g. NAFTA[3], SAARC[4], ASEAN[5], Joint Standards for New Zealand and Australia);
- international food standards and international food legislation (Codex Alimentarius);
- The World Trade Organization.

5.3.1 Australia and New Zealand Closer Economic Relations Trade Agreement

Subsequent to the start of this thesis, acts of parliament and bilateral agreements have made it necessary to view the New Zealand national food regulations in conjunction with those of Australia. As part of the 1995 review of Closer Economic Relations (CER) a framework for the harmonisation of food standards was agreed. The Agreement on Joint Food Standards created a single regulatory agency to develop joint food standards for Australia and New Zealand: ANZFA, the Australia New Zealand Food Authority.

The Agreement provided that in the transition to a complete Australia New Zealand Food Standards Code, which is expected to take until 1999, a system of dual standards and mutual recognition will operate. This is to allow for the immediate removal of any technical barriers to trade in the food sector, from 1 July 1996 or soon thereafter. In New

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[2] Nutrition Labeling and Education Act, USA

[3] North American Free Trade Agreement

[4] South Asian Association for Regional Cooperation

[5] Association of South East Asian Nations

Zealand, two sets of requirements will be in place — the Australian Food Standards Code and the New Zealand Food Regulations 1984 — and a food will have to comply with one or other of these. In Australia, it is proposed that where a food is imported from New Zealand and complies with New Zealand Food Regulations, that food will be deemed to comply with the Australian requirements. Dual standards may also apply to a limited number of foods in Australia (MFAT, 1997).

Many of the regulations are specifically food composition-related. Aside from nutrition labelling legislation that is almost entirely food composition-related, food components are frequently used as part of the definition of a food. Fat as a food component[6] is mentioned nearly 40 times in the New Zealand regulations and nearly 20 times in the Australian regulations (ANZFA, 1997). Examples are shown in Figure 5.1.

Some of these are simple compositional requirements, with minimums and/or maximums stated (e.g. beverage whitener, yoghurt). Others are more complex and stipulate compositional conditions and requirements that must be met before other options can be considered, e.g. for biscuits, for which the fat content dictates the option of adding vitamins and minerals to the product.

The fat standards for some foods are identical, for example ice cream in both Australia and New Zealand has been defined as having no less than 10% fat. There are many differences, some subtle and some significant, in other standards. For example, the standards for cows' milk in Australia only specifies a minimum fat content (cows' milk shall contain not less than 3.25% milk fat), while in New Zealand it specifies a minimum and a maximum (3.25-3.5%). The regulations for skim milk or non-fat milk in New Zealand specify "Shall not contain more than 0.5% milk fat:", while the Australian regulations state, "Skim milk shall contain not more than 1.5 g/kg milk fat;" [Note: this equals 0.15%]

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6 Fat as a component distinguishes it from fat as a food and/or category of foods, which is also mentioned in the legislation.

NZ 121. [9] Ice cream, (3) It shall contain not less than 10% milk fat.

NZ 95. (2) Standardised cows' milk shall contain not less than 3.25% and not more than 3.5% milk fat, nor less than 8.5% non-fat milk solid.

NZ 45. Flour confectionery (4A) [12] Biscuits containing not more than 20% fat and not more than 5% sugar may contain vitamins and minerals in accordance with the provisions of regulation 20A of these regulations.

AUST. P3 SPIRITS AND LIQUEURS SPIRITS AND LIQUEURS

(ii) Cream liqueur - (A) shall contain not less than 20 g/L at 20°C of milk fat;

AUST. H8 YOGHURT AND YOGHURT PRODUCTS

(i) shall contain -

(A) in the case of yoghurt, not less than 30 g/kg of milk fat;

(B) [4] in the case of reduced fat yoghurt, not more than 20 g/kg nor less than 5 g/kg of milk fat;

(C) [4,14] in the case of skim milk yoghurt, less than 5 g/kg of milk fat;

NZ 88. Margarine (2) Margarine shall contain not less than 80% fat and not more than 16% water.

AUST. M2 PEANUT BUTTER OR PEANUT PASTE

(c) shall not contain more than -

(i) 550 g/kg of fat and oil;

AUST. G4 BEVERAGE WHITENER

(2) Beverage whitener shall contain not less than 350 g/kg of fat.

Figure 5.1. Examples of fat composition-related standards and specifications in the Australian and New Zealand Food Regulations

Several other nutrients are specified as compositional requirements for food standards in the legislation, again omitting nutrition labelling requirements. Some examples using protein, fibre, ash and starch are shown if Figure 5.2.

Interpretations and definitions are also included in the food regulations, and there are inconsistencies between the two sets, and well as ambiguities within sets. Carbohydrate provides an example for the contradictions and ambiguities within the regulations. New Zealand provides the following definition:

" Carbohydrate" -

(a) Means any carbohydrate substance that is capable of being metabolised, and includes glycerol and any other sugar alcohol; and

(b) May be calculated by subtracting the percentages of water, protein, fat, and ash from 100:

Sections (a) and (b) represent two different ways of presenting carbohydrate data, with the implied INFOODS tagnames being <CHOAVL> and <CHOCDF> respectively.

NZ 71. Meat pie (3) The protein content of the filling shall be not less than 4% of the total weight of the pie, and not less than 80% of the protein content of the filling shall be derived from meat.

NZ 60. Canned meat (2) It shall contain not less than 90% meat and shall have a protein content of not less than 13%.

AUST B1 CEREALS, LEGUMES, FLOURS, MEALS AND BREAD

(b) Wholemeal -

(B) not less than 22 g/kg crude fibre, calculated on a water-free basis and determined by the prescribed method;

NZ 163. Cocoa paste, cocoa mass, or cocoa slab

(3) The water-free and fat-free residue shall not contain added starch, nor more than 7% crude fibre, nor more than 8% total ash, nor more than 5.5% ash that is insoluble in water.

AUST J1 SPICES

(15) Mustard is the ground seed of *Sinapis alba*, *Brassica juncea* or *Brassica nigra*.

It shall not contain more than -

(a) 80 g/kg of ash;

(b) 25 g/kg of starch.

Figure 5.2. Examples of protein, fibre, ash and starch composition in the Australian and New Zealand Food Regulations

Australia defines carbohydrate with less ambiguity: "' carbohydrate' means carbohydrate by difference, calculated by subtracting the percentages of water, protein, fat and ash, from 100;". Clearly, the tagname <CHOCDF> applies. However in another section of the regulations, related to energy from carbohydrates in infant formula, the following is specified:

R7 INFANT FORMULA

- 'energy value' means energy expressed in kilojoules set out opposite and in relation to each of the following dietary sources -

  1 g carbohydrate, expressed as monosaccharide, yields 16 kJ

This is a curious anomaly since carbohydrate by difference cannot be expressed as the monosaccharide equivalent, unless it were known to be a single carbohydrate component, such as lactose. However, the infant formula legislation permits up to 20 mg/100 kJ of carbohydrate other than lactose. The implied INFOODS tagname for carbohydrate in infant formula would be <CHOAVLM> for the energy calculation. Since this regulation does not specifically relate to presentation of carbohydrate content on the label, the presumption is that that the label value would have to be calculated as <CHOCDF>. This would be in spite of the fact that the manufacturer would have the better, more accurate analytical information in order to calculate the energy contribution from carbohydrate.

Dietary fibre is another area of disharmony, between Australia and NZ and within the Australian regulations. Methodologically, the differences are minor. The NZ regulations state the following: NZ 2. Interpretation: " Dietary fibre" means edible plant material not hydrolysed by the endogenous enzymes of the human digestive tract and as determined by the AOAC method (Prosky method - JAOAC 67, No. 6, 1044-1052, (1984)). And the Australian regulations say: AUST (ia) [12] The declaration of fibre in a nutrition information panel must be a declaration of dietary fibre, with the method of analysis described as “Section 985.29, AOAC, 15th Edition, 1990. These are basically the same method of analysis, with the INFOODS tagname being <FIBTG>. Nevertheless, crude fibre <FIBC> is specified in the Australian standards for cereals and legumes, cocoa and cocoa products and spices; and in the New Zealand standards for cocoa paste, cocoa mass, or cocoa slab, and wholemeal or wholemeal flour. Thus, food manufacturers would be measuring fibre as <FIBC> for their product quality control and fibre as <FIBTG> for their food labels.

Protein is another area where difference in compositional requirements and procedures show up. New Zealand has only one specification for calculating protein:

> NZ 77. Calculation of protein content
>
> For the purposes of regulations 56 to 76 of these regulations [meat and fish], protein shall be calculated as 6.25 times the organically bound nitrogen.

Australia has four specific standards for calculation of protein.

> AUST, peanuts: 200 g/kg of protein calculated by multiplying the nitrogen content by a factor of 5.46;
>
> AUST, flour: The proportion of protein in starch reduced flour shall be calculated by multiplying the proportion of nitrogen present by 5.7.
>
> AUST, infant formula: in the case of a product in which the major source of protein is cows' milk, by multiplying the nitrogen content by 6.38; in any other case, by multiplying the nitrogen content by 6.25.
>
> AUST, canned foods for infants and young children: protein content shall be calculated as N x 6.25

These examples illustrate the dependency of food legislation on food composition. ANZFA in Australia is the agency for both food legislation and food composition work, while in NZ the ANZFA office houses a small administration staff with no specific technical duties or expertise. Food composition is still undertaken by the NZ Institute for Crop & Food Research. Managing the harmonisation of food composition issues between New Zealand and Australia has not been part of the ANZFA agenda, and direct personal communications between the Crop & Food Research and the food composition group at ANZFA in Canberra has been sporadic.

5.3.2 Export Markets -- United States of America and the NLEA

The market with the most prescriptive and explicit requirements for food composition in the trading of food products is the United States, particularly since the May 1994 implementation of the Food and Drug Administration's (FDA) Nutrition Labeling and Education Act (FDA, 1993). The US, however, has nearly a thirty year history of legislating food composition data for food labels. In 1969, The White House Conference on Food, Nutrition, and Health recommended that the government develop a system for identifying the nutritional qualities of food. In 1973, the FDA issued regulations requiring nutrition labeling for food containing one or more added nutrients or whose label or advertising includes claims about the food's nutritional properties or its usefulness in the daily diet. Nutrition labeling stayed voluntary for almost all other foods. With the passing of each year, nutrition labeling was further studied, developed and legislated, culminating in the NLEA, which also undergoes continual development, refinement and interpretation.

The mandatory (boldface) and voluntary components currently required, and the order in which they must appear are shown in Table 5.1.

total calories

calories from fat

calories from saturated fat

total fat

saturated fat

polyunsaturated fat

monounsaturated fat

cholesterol

sodium

potassium

total carbohydrate

dietary fiber

soluble fiber

insoluble fiber

sugars

sugar alcohol (for example, the sugar substitutes xylitol, mannitol and sorbitol)

other carbohydrate (the difference between total carbohydrate and the sum of dietary fiber, sugars, and sugar alcohol if declared)

protein

vitamin A

percent of vitamin A present as beta-carotene

vitamin C

calcium

iron

other essential vitamins and minerals

Table 5.1: Food components required for the NLEA's Nutrition Facts panel.

If a claim is made about any of the optional components, or if a food is fortified or enriched with any of them, nutrition information for these components becomes mandatory. These mandatory and voluntary components are the only ones allowed on the nutrition panel, and other food components can only appear in other parts of a food label.

Although FDA specifies the laboratory methods that will be used for compliance testing, it does not prescribe methods of analysis for the labeled values. Some of the "compliance testing" methods are listed below (Code of the Federal Register, 1997a):

- To determine the total fat content of a food, add the weight in grams of all "lipid fatty acids" in the food (e.g., lauric, palmitic, stearic fatty acids) and express as triglycerides.

- Total fat = Weight of all individual fatty acids + weight of one unit of glycerol for each three fatty acids.

- "Total carbohydrate" is calculated by subtracting the weight of crude protein, total fat, moisture, and ash from the total weight ("wet weight") of the sample of food.

- To calculate "sugars" for the nutrition label, determine the weight in grams of all free monosaccharides and disaccharides in the sample of food.

The other nutrients declared on the nutrition label are defined in 21 CFR 101.9(c).

5.3.3 Bilateral and multilateral trade agreements

The recent trend towards the negotiation of free trade areas has potentially important implications for agriculture. Agricultural trade will increasingly be influenced by the treatment of agriculture within free-trade areas and other regional trade associations. Such blocs will have to deal internally with many of the same issues as faced the GATT and now the WTO. This will tend to reinforce the move to less trade-disruptive domestic policies. Moreover, independent trade policies become difficult to maintain in a trade bloc, even if there is no common external tariff. This could lead to harmonisation of external policies. As a consequence, the inclusion of agriculture in free-trade areas could be an important part of overall trade liberalisation in years to come (Josling, 1993).

The origins of European food trade harmonisation are found in the Treaty of Rome (European Union, 1957). In all its original articles and amendments, no mention can be found of Codex Alimentarius. Article 229 comes the closest to acknowledging a trading world outside of Europe: "It shall be for the Commission to ensure the maintenance of all appropriate relations with the organs of the United Nations, of its specialised agencies and of the General Agreement on Tariffs and Trade," and "The Commission shall also maintain such relations as are appropriate with all international organisations."

The next significant event in Europe was the effect that the Single European Act (European Union, 1987) had on food legislation. Policy initiatives within the food industry were directed at three key areas: health, labelling, and official control. The development of the EU markets without barriers and harmonised food regulations is an elaborate, bureaucratic model, but one to which other regional trade groupings look (Jukes, 1995).

With the establishment of the European Single Market, problems connected with free trade in food products can be identified and to a large extent resolved. Some of the important food trade issues are harmonisation between national, community and international legislation; problems of incompatibility between national and EU laws; rules on food composition and labelling; rules on storage, packaging and advertising; and recognising individual characteristics, including compositional characteristics, of certain regional products. Overall, the rules permit more freedom to trade in foods, and are a basis for bringing down barriers. Problems may result, however, from the power that member countries have to prevent products with particular characteristics being imported (Capelli, 1993).

5.3.4 Codex Alimentarius

The Codex Alimentarius is a code of food standards for all nations. It has been developed by an international commission established in 1962 when the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) recognised the need for international standards to guide the world's growing food industry and to protect the health of consumers. The purpose of Codex Alimentarius is : ".... to guide and promote the elaboration and establishment of definitions and requirements for foods, to assist in their harmonisation and, in doing so, to facilitate international trade" (FAO, 1997). The coverage of Codex includes provisions for (1) food hygiene, (2) food additives, (3) pesticide residues, (4) contaminants, (5) labelling and presentation, and (6) methods of analysis and sampling. Thus there is significant overlap between the goals of INFOODS, discussed in earlier sections of this thesis, and the goals of Codex. Items 5 and 6 have particular relevance to INFOODS.

As early as 1979, a Code of Ethics for International Trade in Food was prepared and added to the Preamble to the Codex Alimentarius Commission (Codex, 1995). Among the things recognised in the document are the following:

- Food is a vital and critical item of international trade and its quality is influenced primarily by prevailing commercial practices and such food legislation...in operation in particular countries;

- ensurance of safe, sound and wholesome food and protection from unfair trade practices;

- unfair trade practices... about the improvement of food quality and nutritional status everywhere;

- food legislation not sufficiently developed in many countries...;

- The GATT Agreement on Technical Barriers to Trade represents an appropriate instrument for the regulation of international trade;

In spite of its 35 year history, Codex Alimentarius has not had a significant impact on food standards' development in the industrialised world. This is illustrated by the many specific requirements that differ between national and regional food regulations and the Codex standards. The European food laws, and recent reports calling for greater harmonisation within Europe (European Commission, 1997), fail to make reference to Codex. The New Zealand food regulations and food code make only four references to Codex, while the Australian food standards only make reference to one of the Codex committees. In the United States' Code of the Federal Regulations (CFR) Title 21 Food and Drugs, Codex is only mentioned in four contexts, each related to a future review the Codex standards so that they may be either adopted, modified or rejected for the United States (Code of the Federal Register, 1997 b, c, d, e). Trade does not appear relevant in any Title 21 documents, nor does Codex Alimentarius receive mention in any Title 15 documents, all relating to Commerce and Foreign Trade (Code of the Federal Register, 1997f).

Codex has not been aggressive in promoting its standards and encouraging their adoption in highly developed countries. However, one of the "Specific Requirements" in the Code of Ethics for International Trade in Food (Codex, 1995), agreed to by all member states, says that: "Appropriate and adequate national food standards should be established and enforced taking into account that uniform consumer protection and the orderly marketing of food can be better achieved through the acceptance of food standards elaborated by the Codex Alimentarius Commission or the adaptation of national standards to such international recommendations." An example of part of the Codex standard for Milk and Milk Products is shown in Table 5.2.

Application of the Code

Governments are requested to inform the Director-General of FAO or the Director-General of WHO whether they intend to apply the provisions of the Code of Principles as set out below. Governments which so declare their willingness to apply the Code are further requested to state whether they can indicate the date by which they will be able to bring their national requirements into conformity with its provisions, as well as the steps they will require to take in order to achieve this position.

Preamble

The purpose of this Code of Principles is to protect the consumer of milk and milk products and to assist the dairy industry on both the national and international levels by:

ENSURING the precise use of the term "milk" and the terms used for the different milk products;

AVOIDING confusion arising from the mixing of milk and/or milk products with non-milk fats and/or non-milk proteins;

PROHIBITING the use of misleading names and information for products which are not milk or milk products and which might thereby be confused with milk or milk products; and

ESTABLISHING (a) definitions and designations; (b) minimum standards of composition; and (c) standard methods of sampling and analysis for milk and milk products.

Table 5.2: Codex Alimentarius: Code of Principles Concerning Milk and Milk Products

5.3.5 World Trade Organization

The World Trade Organization (WTO) was established on 1 January 1995 as the legal and institutional foundation of the multilateral trading system. It provides the principal contractual obligations determining how governments frame and implement domestic trade legislation and regulations. And it is the platform on which trade relations among countries evolve through collective debate, negotiation and adjudication. The WTO is the embodiment of the results of the Uruguay Round trade negotiations and the successor to the General Agreement on Tariffs and Trade (GATT). It is made up of 131 member countries, 30 observer countries, 8 observers to the General Council.

The essential functions of the WTO are:

- administering and implementing the multilateral and plurilateral trade agreements which together make up the WTO;
- acting as a forum for multilateral trade negotiations;
- seeking to resolve trade disputes;
- overseeing national trade policies; and
- cooperating with other international institutions involved in global economic policy-making (WTO, 1997a).

Several policies and agreements under the WTO have direct relevance to and/or potential implications for food composition activities. The most pertinent of these will be discussed in detail: the Agreement on Technical Barriers to Trade (TBT) (WTO, 1997b), and the Sanitary and Phytosanitary Agreement (SPS) (WTO, 1997c).

The Agreement on Technical Barriers to Trade (TBT)

The original TBT Agreement took effect on 1 January 1980. At the end of 1994, before it was superseded by the WTO TBT Agreement (which is applicable to all WTO Members), only 45 countries were party to the Agreement[7]. New Zealand was among them; a fact that will be significant in the butter case study to be discussed later in this chapter.

The WTO TBT, which came into force on 1 January 1995, is an agreement signed by all 131 Member countries, that covers all technical regulations, voluntary standards and the procedures. In terms of food, the TBT covers labelling requirements, nutrition claims and concerns, quality, packaging regulations, methods of analysis and sampling procedures, food processing technologies, and nutrient and ingredient standards.

The prologue to the TBT sets out a concise set of seven reminders to members as to what they should be *desiring* and *recognizing* in the international trading arena. Fundamental to this agreement, and the first point that requires *recognizing* is "the important contribution that international standards...can make in this regard by ...facilitating the conduct of international trade." Among the free- and fair-trading practices that members should be *desiring* is to "ensure that technical regulations and standards, including...labelling requirements...do not create unnecessary obstacles to international trade."

The first of the general provisions specifies that "general terms for standardisation and procedures for assessment of conformity shall normally have the meaning given to them by definitions adopted within the United Nations system and by international standardising bodies..." In food trade, this could readily be interpreted to mean Codex Alimentarius,

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7 Australia, Austria, Brazil, Canada, Chile, the Czech Republic, the Slovak Federal Republic, Egypt, the European Community and its twelve member states (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom), Finland, Hong Kong, Hungary, India, Indonesia, Israel, Japan, the Republic of Korea, Malaysia, Mexico, Morocco, New Zealand, Norway, Pakistan, Philippines, Romania, Rwanda, Singapore, Slovenia, Sweden, Switzerland, Thailand, Tunisia, the United States and Yugoslavia.

although Codex is never named specifically. Indeed, people paraphrasing this provision have said that WTO has endorsed Codex Alimentarius as the food standards organisation for the world.

However, a senior officer with Codex replies to this assertion with caution: "This is a gross over-simplification of a very complex issue which has led to a great deal of misunderstanding and even alarm in some quarters," (Randall, 1997). The Codex officer explains further that where technical regulations such as food standards are required, members shall use international standards where they exist, except where the use of international standards would be inappropriate or ineffective for an open-ended list of reasons. He stresses that it is important to recognise that there is no requirement to impose the international standard — it is used only when a national standard covering the same food is required. If a member country decides to write a national standard for these products, it should use the Codex Standard, or relevant parts of it, for the purpose. However, he does qualify that statement by saying that a country could be called into question by WTO if it prohibits the entry of these products on the basis of a technical or food safety regulation that is different from the international standard.

The butter case study, found later in this chapter, will address the possible ramifications of the TBT as it relates to harmonisation of the butter standards between NZ and Europe.

A further provision in the TBT relates to Members providing "differential and more favourable treatment to developing country Members." The provision specifies the requirement that Members should recognise that developing country Members should not be expected to use international standards as the basis for their technical regulations or standards, including test methods, which are not appropriate to their development, financial and trade needs. In food trade this could be applied to provision of nutrient data on food labels, or the provision of data by specified methods of analysis. The United States Food and Drug Administration has the national mandate for food regulations, and with the enactment of the Nutrition Labeling and Eduction Act (Food and Drug Administration, 1993), all foods traded in the USA must have a Nutrition Facts label. Exemptions are not given to developing countries in spite of the fact that the analytical methodology (analysts' skills and instrumentation) for determining some of these nutrients are very expensive. Some of the implications of this provision will be discussed in the context of the Coffee Mate case study.

The Sanitary and Phytosanitary Agreement (SPS)

The SPS also entered into force with the establishment of the World Trade Organization on 1 January 1995. It concerns the application of food safety and animal and plant health regulations. Although the SPS relates more to food *per se* than the TBT which covers a vast range of goods, the relationship to **food composition** activities is less applicable. Nevertheless, there are some significant elements for food composition programme managers to note. The SPS reaffirms the philosophical framework reminding members that they should be "recognizing the important contribution that international standards, guidelines and recommendations can make [to facilitating international trade]." It also specifically endorses Codex Alimentarius as the international standards organisation for food, in four separate clauses:

> Prologue. *Desiring* to further the use of harmonized sanitary and phytosanitary measures between Members, on the basis of international standards, guidelines and recommendations developed by the relevant international organizations, including the Codex Alimentarius Commission, the International Office of Epizootics, and the relevant international and regional organizations operating within the framework of the International Plant Protection Convention, without requiring Members to change their appropriate level of protection of human, animal or plant life or health;

> Article 3.4. Members shall play a full part, within the limits of their resources, in the relevant international organizations and their subsidiary

bodies, in particular the Codex Alimentarius Commission, the International Office of Epizootics, and the international and regional organizations operating within the framework of the International Plant Protection Convention, to promote within these organizations the development and periodic review of standards, guidelines and recommendations with respect to all aspects of sanitary and phytosanitary measures.

Article 12.3. The Committee [on Sanitary and Phytosanitary Measures] shall maintain close contact with the relevant international organizations in the field of sanitary and phytosanitary protection, especially with the Codex Alimentarius Commission, the International Office of Epizootics, and the Secretariat of the International Plant Protection Convention, with the objective of securing the best available scientific and technical advice for the administration of this Agreement and in order to ensure that unnecessary duplication of effort is avoided.

Annex A, 3 (a). [International standards, guidelines and recommendations] for food safety, the standards, guidelines and recommendations established by the Codex Alimentarius Commission relating to food additives, veterinary drug and pesticide residues, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice...(WTO, 1997c).

At the SPS Committee meeting in October 1996, the committee restated the belief that effective implementation of the Agreement requires coordination and cooperation with relevant international intergovernmental organisations which develop standards, guidelines and recommendations with respect to sanitary and phytosanitary measures, and in particular, the Codex Alimentarius Commission was named. A working relationship has been established with Codex, and Codex officials contribute regularly to the work of the SPS Committee. Although Codex standards and guidelines have never been deemed obligatory, pursuing the SPS within the scope of the World Trade Organization, they carry legal binding status until given greater elaboration or until challenged.

Just like the TBT, the SPS explicitly permits governments to choose not to use the Codex standards in favour of their own national standards. However, if the national requirements result in a greater restriction of trade, a country may be asked to provide scientific justification, demonstrating that the relevant Codex standard would not result in the level of health protection the country considered appropriate.

The specific technical issues of relevance to food composition, and where Codex has WTO endorsement under the SPS, is in the area of methods of analysis and sampling, as mentioned in Annex A, 3 (a). The greater significance, however, is the identification of Codex Alimentarius by name in the food-related WTO agreement(s), giving Codex more authority than it has ever had.

5.3.6 Others

ISO 9000 standard series, Hazard Analysis Critical Control Point (HACCP), certification, accreditation, and the Global Approach of the EU Commission all have food composition implications and a significant impact on food business and official food control. However, none was clearly recognised as a coherent tool to harmonise in the area of food composition.

ISO 9000 deals with contractual obligations between private parties related to attest compliance with given requirements of quality management systems for food processing, or of food consignments for trade and third country export. Its application is voluntary. HACCP is mandatory by EC-food law to control food-borne hazards to consumer health and will become a globally valid Codex Alimentarius standard (Codex, 1995). The Global Approach of the EU-Commission was developed to improve the quality of industry products by standardisation of requirements, testing of compliance with given standards and certification by CE- or adequate label. The basic elements of the Global Approach were transferred to food by EC-Council regulations 2092/91/ EEC. With these regulations the EU-Council created a new private control system (under governmental supervision), which is raising conflicts to the official food control (Hey, 1996).

Having now identified the various agencies and agreements with food composition-related trade implications, the case studies will now illustrate the actual and potential impact of the lack of harmony in the management of these processes.

5.3.7 Case Study 1: Cold-spreadable butter

The name of a food carries significant information related to national, regional and international regulations. Often, what a food is and therefore what it can be named, is specified in food standards of individual countries, and regions with trading bloc agreements. When, where, and how much can be traded is often dependent on what the food is.

Recent examples in butter trade have helped to illustrate the importance of harmonising food identification with their compositional standards and processing requirements. Charges of fraud were brought against the New Zealand Dairy Board and one of its subsidiary companies, related to what can be called butter, how it is manufacturered, and its fat content (The Press On-Line, 1997).

In New Zealand, semi-soft or cold-spreadable butter, is traded as butter. The New Zealand Food Regulations specify the following (Ministry of Health, 1995):

> Butter shall be a product in the form of a plastic emulsion, this is of the type water-in-oil, prepared from any one or more of the following:
>
> (a) Pasteurised cream:
>
> (b) Pasteurised milk:

(c) Butter oil, anhydrous butter oil, anhydrous milk fat:

(d) Whey.

Because semi-soft butter is made from anhydrous milk fat, using (often) a fractionation process (Kaylegian & Lindsay, 1992), it qualifies to be called butter in New Zealand. This is not the case in Europe where food standards require that butter must be made directly from only pasteurised cream or milk (EC Directive, 1994), i.e., rather than indirectly from anhydrous milk fat which was made from cream or milk. Compositionally, the EC Directive states: "a milkfat content of not less than 80% but less than 90%, a maximum water content of 16%...". The Codex standard states that "Butter is a fatty product exclusively derived from milk", and with explicitly defined compositional characteristics, including a minimum milkfat of 80% and maximum water of 16%.

This is a particularly ironic example of the importance of harmonising food nomenclature and terminology in the area of food trade and food standards, because New Zealand and Europe had harmonised standards for butter until recently. New Zealand changed, but Europe did not. The Food Regulations through to October 1994 specified clearly in Regulation 111, clause 1, that "Butter shall be the clean, non-rancid, solid product obtained by the churning of milk or cream, with or without the addition of salt and lactic acid cultures." There are four more clauses in this regulation, but none contradicts or exempts any part of clause 1. In October 1994 Amendment No. 9 was issued, allowing butter to be made from anhydrous milk fat.

The packaging for semi-soft butter in New Zealand— Fernleaf, marketed by Anchor Butter Company, Ltd., Auckland — conveys the following information on the side of the package: "Fernleaf Semi-Soft Butter: Softer because it's churned twice."

In slightly smaller print below it continues:

> Fernleaf Semi-Soft is pure and natural New Zealand butter. The improved

> softness is simply the result of a new butter churning method. Fernleaf Semi-Soft has the same, natural creamy butter taste that has made New Zealand butter world famous. Fernleaf Semi-Soft Butter has been developed for improved spreadability and in its convenient tub is ideal for table use. Because Fernleaf Semi-Soft is pure and natural, refrigerate until in use. When in use store in your cupboard, pantry or butter conditioner.

From this information it would be reasonable to believe that this butter was made from fresh cream or milk, and that, aside from being twice-churned it should be no different from regular butter. Personal communication with a product manager for Anchor Butter Company, and further communication with the manager of the NZ Dairy Advisory Bureau, confirmed that the product was made from anhydrous milk fat, with a mechanical fractionation process applied. Food composition data do show a different composition of fatty acids, with semi-soft butter being higher in unsaturated fatty acids and trans fatty acids; regular butter is higher in the saturated fatty acids (Crop & Food Research, 1997). Both features fit the expectation of mechanical separation based on melting points, since "hard" and "soft" fractions of butter relate partially to degree of saturation.

Semi-soft butter is a record in the New Zealand food composition database, in the dairy group. Its first facet is BUTTER. It is further described as "semi-soft". This butter record is not treated differently from unsalted butter, or salted butter. By the EC Directive, however, it should **not** be treated as butter, but as a butter-type product. Additional descriptor facets will be added to this record in the New Zealand Food Composition Database to show that it is made from anhydrous milk fat and has undergone a fractionation step to separate the hard from the soft fractions.

New Zealand was among the governments which were members of the 1979 TBT Agreement that had agreed to use relevant international standards except when they considered that these standards would not adequately protect health. They also agreed to notify other governments, through the GATT Secretariat, of any technical regulations which were not based on international standards. All attempts to ascertain whether or not New Zealand complied with the notification requirement when they changed the butter standards in October 1994, including requests through the Minister of Health and the Ministry of Health (the agency operating the Food Standards Committtee as the previous Department of Health), through the Minister of International Trade, and through the Dairy Board's offices of Regulatory Affairs, External Policy, and Public Relations, have turned up no documentation. The presumption by all is that New Zealand probably did not comply.

One of the issues in this case was in reference to the fat content of butter, with the charge that New Zealand's butter exceeded the maximum allowance for New Zealand's butter quota, as set by EC Council Regulation 858/81. The permitted range for quota purposes was 80-82% fat and some of New Zealand's factory quality measurements, audited by the British, showed fat content of 80-84%. The method of analysis used in the factory was one that determines water, non-fat solids, and fat, on the same test portion (AOAC, 1984), which is a very crude measurement in which the fat value is obtained by difference. Because this method is never used in food composition work, there is no INFOODS tagname. Other methods of fat analysis would have produced different results for each batch analysed, and no competent analyst would ever be prepared to say that the result of an analytical measurement represented an absolute amount of that component in that food. Non-prescription of methods of analysis, and the fact that no chemist would testify regarding the fat content reported by the factory, led the British officials to drop this charge five months after the arrest of the six New Zealand dairy industry officials in April 1997 (personal communications).

5.3.8 Case Study 2: Plumrose Light Deli Ham

Another recent legal case, this time heard in New Zealand's court system, related to ham. The Commerce Commission contracted Crop & Food Research to conduct analyses on several brands of ham and to prepare a report interpreting the data against the nutrition claims made (Burlingame & Milligan, 1995). A total of six hams were analysed for fat content, using the Folch method. Three products made nutrition claims related to fat content; three other products carried no claims. Claims related to fat content were evaluated against the Food Standards (Ministry of Health, 1995) which state that a food must contain at least one-third less fat when compared with its normal counterpart, in order to make a lower fat-related claim. After analyses of the three hams without claims, and comparisons with ham data in food composition tables from New Zealand (Burlingame *et al.*, 1994), the United States (USDA, 1993), and the United Kingdom (Paul & Southgate, 1991), the authors judged that the normal counterpart, other hams, averaged[8] 11.27% fat, thus making a claim permissible if a ham had less that 7.5% fat. The report concluded that one of the hams was in breach of the regulations. The specific nutrient claims made by the company, and printed on the can, were as follows:

> Light Deli Ham 90% fat free;
>
> Enjoy healthier eating with Plumrose Deli Ham. This quality ham is 90% fat free yet still delivers full Deli Ham flavour (author's note: 90% fat free equals 10% fat).

Upon receipt of the report, the Commerce Commission filed charges against Pacific Dunlop Holding (NZ) Limited, the New Zealand distributor of Plumrose ham, for misleading advertising, specifically for "...being a person in trade, engaged in conduct liable to mislead the public as to the characteristics of goods...".

The company argued its defence on the basis of food identification, specifically "food group" classification (the concept of which is discussed in Section 3.3.1 of this thesis). The contention from the company was that even though it was called ham, it was really a canned pork product that should be compared to other canned meat products — Spam and corned

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8 An arithmetic mean was used for the comparison. The median and mode were both lower.

beef — not to other hams. These products are much higher in fat, and therefore the comparison would have been favourable, and the fat claim would have complied with the regulations.

The judge disagreed with the company's argument:

> I cannot agree with that contention...In my view Plumrose canned ham products could only be compared to either fresh ham which might be purchased from a supermarket delicatessen or vacuum-package hams...As in my view the labelling of the Plumrose Deli Ham conveyed the overall impression that, in a comparative sense, it was a low fat product, that claim was both unjustified and misleading" (Abbott, 1997).

Other factors were examined which may have had an impact on the trial's outcome. The most significant was the potenital effect of different methods of fat determination on the fat content, since neither the New Zealand nor the Australian food regulations or codes prescribe a method for fat analysis. None was found to vary the results by a margin sufficient for the product to be in compliance.

Although a final ruling for the penalty in this case was deferred, in his conclusion, the judge suggested the following:

> "...my provisional view is that, in view of the "test case" nature of the prosecution, the appropriate outcome on the charge which I have found to have been proved would be an order that Pacific Dunlop Holdings pay a contribution toward the costs which the Commission has incurred in respect of the prosecution, without there being any additional penalty by way of a fine" (Abbott, 1997).

The company has dropped the nutrition claim from its packaging and continues to call the product ham.

5.3.9 Case Study 3: A United States label in New Zealand

Managers of food composition programmes where commercial contract work is undertake are often questioned by clients about the high cost of nutrient composition analyses. Companies frequently query the possibility of preparing a single label that will comply with the regulations in both their domestic and export markets. This became an urgent and troubling issue in New Zealand, when the United States implemented its Nutrition Labelling and Education Act (NLEA). This piece of legislation required that food composition data be presented on almost all food labels, in a particular format. Prior to this legislation, nutrition labelling had been, with a few exception, voluntary. The Ministry of Health (MoH) was questioned several times about this issue, whether food companies could use the NLEA label in NZ, and MoH always replied that the NLEA labels did not comply with the NZ regulations, and therefore were not permitted on foods sold in NZ. When questioned about the penalties for not complying, the answer was equivocal. No one had tested the legislation in this way.

To determine the ramifications of not complying, this researcher purchased a product in a local supermarket with the NLEA label— Nestle's Coffee Mate. A letter was written to the Palmerston North Area Health Board, "complaining" about the violation. A letter was received from a local Health Protection Officer, who said that the matter was referred to Auckland, since the Nestle was located there. Within four weeks a reply was received from an Auckland Health Protection Officer to say that the company had been notified regarding the non-compliance of the label, and they had been advised to change the label. This completed the investigation of the reported violation. This researcher then interviewed the product manager at Nestle to find out what action would be taken by the company. The product managers stated that if they took any action at all it would be to discontinue that product in New Zealand. One year later the consumer affairs officer confirmed that the product was withdrawn from the New Zealand market.

NLEA labels continue to appear on foods on New Zealand supermarket shelves. A follow-up letter of inquiry to the Ministry of Health was answered in July 1997 to confirm that no company or individual had been fined or prosecuted for having an NLEA label.

5.4 CONCLUSIONS

Regardless of the issues or context, managing any form of "globalisation" is not easy. The European experience shows that trying to eliminate national food idiosyncrasies in the interest of smoothing food trade is not alway met with approval. Nevertheless, there are some areas of general consensus when it comes to food composition and trade. Of relevance here is the consensus that the most appropriate system of governance would be "rules based" standards, with harmonisation where possible, and mutual recognition when harmonisation is either untenable or a long way off. This fits with prescriptive standards for some of the technical issues in food composition harmonisation. A second point of consensus is that the cornerstone of the WTO's trade agenda is inclusiveness, with the dilemma being how to maintain a common set of rules among countries with quite different cultural, social and political systems. And gaining wider attention is the issue of standards, some of which relate explicitly to food composition. Cable (Cable, 1996) addresses this specifically when he says:

> Experience with deeper forms of integration, as in the European Union, shows that beyond the obvious and explicit trade barriers, there are formidable barriers created by national standards. These in turn often draw on long-standing traditions — like national dishes or systems of weights and measures — which are embedded in national cultures. In the Single Market, and more modestly in the GATT, attempts have been made to overcome these barriers. There is, however, an unresolved argument as to how far standards need to be harmonised globally or regionally, and how

much should be left to national governments (or proprietary systems). A related issue is whether integration involves a 'mutual recognition' or different standards or the setting of common minimum standards by supranational bodies. Deepening global integration will make these questions progressively more urgent.

The key international agencies involved, where affiliation must be sought by INFOODS, are World Trade Organization and Codex Alimentarius. By linking INFOODS more tightly with Codex, the harmonisation aspects of food composition that affect international food trade will be able to be identified and dealt with specifically and effectively.

With more local relevance are the joint food standards in operation under the broad umbrella of CER (Closer Economic Relations Trade Agreement), where the preparation of joint standards should be undertaken with more consultation and liaison between NZ's food composition programme and ANZFA in Canberra. This will help eliminate some of the incompatibilities that currently exist between food composition requirements and legislation, and will make the food composition information more useful to food industry in there preparation of food labels and in their endeavours to comply with the compositional standards in place.

6. EPILOGUE

Food composition issues are most frequently addressed at the discipline level, as nutrition science, analytical chemistry, epidemiology, public health, dietetics, biometrics and more. These disciplines are well represented at food composition conferences, in the relevant literature, and in the curricula of tertiary level food composition courses of study. The aim of this thesis was to put food composition into a less familiar context for food composition research, that of management. This was done by examining the organisational framework concept conceived by INFOODS; extending the concept into the next stages of elaboration, specifically as they relate to harmonisation issues; and by proposing management solutions that could be implemented at the national, regional and international levels.

From the earliest days of INFOODS there were few relevant standards, little adherence to the few standards that were available, and little acknowledgment that this situation was even problematic. Much progress has been achieved since that time. During the several years of the research and writing for this thesis, many noteworthy developments have occurred for the food composition professional community. Nevertheless, more progress is still required.

In this thesis four general categories of management problems have been characterised: technical, infrastructural, sectoral and affiliation. Even the seemingly least relevant of these -- the technical food composition issues -- has been assessed with new significance and relevance in the management context. The harmonisation issue that emerged as a result of this study were able to be applied, to varying degrees, to all four of the categories.

The chapter on managing New Zealand's national food composition programme dealt with many of the infrastructural, sectoral and affiliation issues that were identified in the first chapter, and acknowledged some of the technical issues and their significance. It was found when exploring the relationship between the national programme, the regional data centre (OCEANIAFOODS), and the international community that a national programme cannot be an independent entity operating with autonomy. The national programme must position itself within a regional and international context to be most effective.

The next two chapters were devoted to the two most pressing technical issues, food identification and component identification, and their significance in managing food composition activities. Much progress has been made in this area, illustrated by the fact that some of the research undertaken for this thesis was considered innovative and original in the early to mid-1990's when it was first presented, but is now fairly routine and commonplace (e.g. the imaging work).

One of the most substantial contributions made to the professional food composition community by INFOODS was the component identification system. The technical solution was provided with the creation of INFOODS tagnames, and the usefulness of these tagnames was rigorously examined and endorsed in this thesis. Nevertheless, the same technical issue is being addressed by other organisations (e.g. component identification by the CAIds and the Codex Committee on Sampling and Methods of Analysis), without due consideration (or perhaps knowledge) of the existing system.

Other technical issues remain unsatisfactorily resolved in the international context. For example, food nomenclature, terminology and description have commanded a huge amount of attention and resources, and yet an adequate international system has still not been developed. As identified in this thesis, in both the technical chapter on food identification and the sector chapter on trade, linking food names, or identifying codes, with international food regulations and food standards, should be the next approach in constructing a system that would have widespread acceptance and usefulness. A solid trade application and link would also demonstrate to food composition programme managers, and those who control resource allocation to national food composition programmes, the economic benefits of this harmonisation effort.

Of the technical issues which were not addressed in depth in this thesis which still require attention from coordinated input from the international food composition community, data quality is perhaps the most pressing. This combines elements of sample collection and preparation, laboratory quality control, and all aspects of appropriate documentation.

The final chapter looked specifically at trade, as the most compelling of the sectors with involvement in food composition activities, and food regulations which affect trade practices. One of the case studies presented, butter, illustrated the importance of food composition harmonisation issues in very tangible ways. This case is still being heard before the WTO and European courts, and New Zealand's court costs in defending itself are estimated to "start at $10 million" to protect New Zealand's $376 million butter trade with Europe (The Press On-line, 1997). Two sets of charges, one related to the fat composition of the butter, were dropped. Another set of charges relates to food standards (processing technologies and ingredients) and food nomenclature/terminology (i.e., what is allowed to be called butter). This case will be fascinating to watch as it unfolds in 1998.

This thesis has demonstrated that the applications and implications for food composition activities, and the scattering of responsibilities in so many areas, makes coordination of activities at the national, regional, and international levels essential. Yet, INFOODS currently is operated as an exceedingly small "virtual" secretariat, mostly via electronic interactions, with a total of 0.3 of a full time equivalent person. There is great difficulty therefore in trying to cope with urgent national and regional matters, mostly in developing countries, and still bring some continuity to the international community. If INFOODS was resourced to one full time equivalent, the impact could be much more measurable and progress could be achieved at a faster pace. If INFOODS is not resourced adequately in the near future, then FAO, or possibly the FAO/WHO Codex Alimentarius Commission should be encouraged to incorporate food composition explicitly in their brief and bring about some of the necessary standards, building upon INFOODS work, and work toward achieving more national and regional implementation of those standards.

In so many areas of endeavor, development of standards has been essential for the proper functioning of equipment, organisations, communities/countries, and has facilitated communications and interactions that would not have otherwise been possible. In mid-October 1997, as the final words were being put to this thesis, the world was about to celebrate World Standards Day. It began as a celebration of the birth of the International Organization for Standardization (ISO), which held its first meeting in London on October 14, 1946, with participation from 25 countries. ISO now has 123 member nations and has evolved into the global clearinghouse for all standards activities. World Standards Day is described as follows (ANSI, 1997):

> The goal of World Standards Day is to raise awareness of the importance of global standardization to the world economy and to promote its role in helping meet the needs of business, industry, government, and consumers worldwide. The international event pays tribute to the thousands of volunteers around the world who participate in standardization activities. Since its initial celebration in 1970, member countries commemorate World Standards Day by organizing special gatherings and events, ranging from conferences, exhibitions, and seminars to film shows, TV and radio interviews, and full "standards weeks" around mid-October. The 1997 World Standards Day theme is "International Standards and Global Trade".

Although not specifically mentioned in any of the ISO standards committees, this thesis has shown that food composition is among the areas of activity which will benefit greatly from global standardisation.

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APPENDIX 1. INFOODS Regional Data Centres

The INFOODS Regional Data Centres are listed with the Data Centre coordinating country underlined and bolded. Where sub-regional Data Centres operate, the subregion is also underlined and bolded. Some Regional Data Centres in the early organisation phase, have not defined the coordinating country.

AFROFOODS (four subregions)

ECSAFOODS - Eastern, Central and Southern Africa (18 countries)
WAFOODS - Western Africa (5 countries)
OCAFOODS - Francophone Western and Central Africa (23 countries)
NAFOODS - Northern Africa (5 countries)

ECSAFOODS

Botswana, Eritrea, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, **Zimbabwe**

WAFOODS

Gambia, **Ghana**, Liberia, Nigeria, Sierra Leone

OCAFOODS

Angola, Benin, Burkina Faso, Burundi, Cameroon, Cap-Vert, Congo, Cote D'Ivoire, Djibouti, Gabon, Guinee, Guinee-Bissau, Guinee-Equatoriale, Madagascar, Mali, Niger, Republique Centrafricaine, Rwanda, Sao Tome y Principe, **Senegal**, Tchad, Togo, Zaire

NAFOODS

Algeria, Libya, Mauritania, Morocco, **Tunisia**

ASEANFOODS

Brunei, Indonesia, Laos, Malaysia, Philippines, Singapore, **Thailand**, Vietnam

CARICOMFOODS

Anguilla, Antigua & Barbados, Bahamas, Barbuda, Belize, British Virgin Islands, Cayman Islands, Dominica, Grenada, Guyana, **Jamaica**, Montserrat, St. Kitts & Nevis, St. Lucia, St. Vincent & The Grenadines, Trinidad & Tobago, Turks & Caicos Islands, Suriname (Bermuda)

CARKFOODS

Afghanistan, Azerbaijan, Kazakstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan, Uzbekistan

EUROFOODS (two subregions)

Western Europe, and Central and Eastern Europe

Western Europe:
Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Luxembourg, The **Netherlands**, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom

CEECFOODS
Croatia, Hungary, Poland, **Slovakia**, Bulgaria, Czech Republic, Estonia, Lithuania, Romania, Russia, Albania, Belarus, Slovenia.

LATINFOODS (two subregions)

CAPFOODS- Central America and Panama
SAFOODS - South America

CAPFOODS
Belize, Costa Rica, El Salvador, **Guatemala**, Honduras, Nicaragua, Panama

SAFOODS
Argentina, Aruba, Bolivia, Bonaire, Brazil, **Chile**, Colombia, Ecuador, Paraguay, Peru, Suriname, Uruguay, Venezuela

MASIAFOODS

China, Korea, Hong Kong, Taiwan, (Japan)

MEFOODS & GULFOODS

Cyprus, Egypt, Jordan, Lebanon, Palestine, Syria and the Arab Gulf Countries

NORAMFOODS

Canada, Mexico, **United States of America**

OCEANIAFOODS (24 Countries)

American Samoa, Australia, Cook Islands, Federated States of Micronesia, **Fiji**, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Northern Mariana Islands, New Caledonia, Palau, Papua New Guinea, Pitcairn Islands, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna, Western Samoa

SAARCFOODS

Bangladesh, Bhutan, India, Maldives, Nepal, **Pakistan**, Sri Lanka

APPENDIX 2. FOCUS GROUP QUESTION GUIDE

FOCUS GROUP DISCUSSION FORMAT

Thank you for consenting to participate in this focus group. The session will be tape recorded, but individuals' privacy will be respected when the content of the tape is evaluated.

Name ____

Position ____

Signature ____

What is your understanding of INFOODS?

Are you aware of the books, the journal, the newsletter, the WWW Server, the consultations, the fellowships/workshops/conferences?

How would you assess the multiagency activities with INFOODS' involvement (FAO/IUNS, etc.)?

What is your understanding of the INFOODS Regional Data Center concept?
  Do you believe this concept is workable for you and your organisation?
    Your country?
    Your region?

Do you think the implementation of INFOODS' Regional Data Centre concept has been successful?

If success has been absent (e.g., based on review of schedules, resolutions, working papers), what is the reason and does it relate to individual agencies, countries, the region, or INFOODS?

Do you believe your most pressing need is in data generation, data compilation or data dissemination?

Your country has data generators and data compilers, and a regional data centre has been established. What successes have you observed or experienced?

What failures?

Do you think the successes have been influenced by the INFOODS Project?

On the data dissemination side, what food composition products do you think are essential for your country/region?

Printed food composition tables?

Data files for use in spreadsheets and dbms?

Applications packages that incorporate data and menu-driven features for diet/recipe/food evaluations?

What kind of intervention, advice, resources, etc., are needed and where should they come from?

Overall do you believe INFOODS is effective in its activities and why?

APPENDIX 3. REGIONAL DATA CENTRE COORDINATOR QUESTIONNAIRE

E-mail Version

IT SHOULD TAKE NO MORE THAN FIVE MINUTES TO COMPLETE

FOOD NOMENCLATURE AND TERMINOLOGY

To respond by email simply use your REPLY command, include this message in the reply, key in your answers (A-I) below, and send back by return email. Thank you for your kind participation.

BACKGROUND

Your response to this questionnaire will assist in the effort to develop and/or refine an appropriate international system for identifying and describing foods, food processes, food ingredients and other features of a food, for the purpose of their appropriate identification in food composition databases and tables. Currently in use are systems based on (1) codes, which are language-independent; (2) text-based facets, which are language-based, including multiple character sets (eg Mandarin), and (3) images as graphics' files.

As regional data centre coordinators you have had experience and/or have given thought to the issues of "naming", "describing", "identifying" foods at both the national and regional levels.

INSTRUCTIONS

The table below lists nine criteria that have been established as important by a small group of food composition database managers. We now need your input to establish the international ranking for each based on what you would like to achieve and what you feel is important for identifying foods in tables and databases.

For ranking ***national*** importance, please base your responses on your own experience, your knowledge of the personnel involved in compiling data, and your understanding of the needs of your data users.

For ranking ***regional*** importance, please base your responses on your experience of compiling a regional database, or the future likelihood that you will receive data files from countries in your region for the purpose of compiling a regional database. This will entail assessment of which foods/processes are the same and which are different, and categorisation of the foods into the correct groups.

Please rank each criterion on the following scale:

0 = not important
1 = moderately important
2 = very important
3 = absolutely essential

If you haven't thought about it, or feel you cannot assess the importance, please leave blank and/or write a comment. Comments will also be useful for when assigning a rank of 3.

QUESTIONS

A. Language independence (Note: A low score — 0 or 1 — would indicate that English or a local language or two is more important; a high score — 2 or 3 — would indicate that an internationally-acceptable system based on codes or keys that are not reliant on language is more appropriate.)

National:
Regional:
Comment (optional):

B. Cultural/national independence (Note: A low score would indicate that you prefer a system that is relevant to your culture, national food standards, locally-understood food preparation methods, etc. A high score would indicate preference for a system that had some international standardisation for identifying foods, preparation methods, etc.

National:
Regional:
Comment (optional):

C. Compiler-friendliness (Note: Compiler-friendliness relates to the time it might take and the skill required to develop familiarity with an international system in order to use it effectively. If data compilers are highly skilled and committed, a low score would apply. If compiler-friendliness is important, a high score would be given).

National:
Regional:
Comment (optional):

D. Ease of database maintenance (Note: Ease of maintenance refers to resources required to manage a complicated vs simple system (if simplicity is essential, then ease of maintenance would receive a 3).

National:
Regional:
Comment (optional):

E. Ability to visually document foods (eg, the colour of foods, packaging, bar codes, etc)

National:
Regional:
Comment (optional):

F. Local usefulness in tables/databases

National:
Regional:
Comment (optional):

G. Usefulness in computer dietary assessment packages

National:
Regional:
Comment (optional):

H. Usefulness in international food trade

National:
Regional:
Comment (optional):

I. Other criterion:

APPENDIX 4. STATISTICAL ANALYSIS TABLES

Rankings of food database criteria.

"Do the criteria differ in importance?". K-W analysis does this without removing block effects first. It analyses first Criteria (to answer the first question with perhaps less precision) and then treats continents as a fixed effect in a fresh analysis to answer the question: "Do some authorities tend to make everything more important than others?". These 3 analyses are done for each table, regional and national. Here's the annotated output:

Friedman test for **National** by Criteria, blocked by Region

S = Friedman Statistic
DF = degrees of freedom
P = Probability

S = 10.49 DF = 7 P = 0.162
S = 16.80 DF = 7 P = 0.019 (adjusted for ties)

P<0.05 after adjusting for Continents

Criteria	N	Est Median	Sum of Ranks
1	7	1.500	18.0
2	7	2.250	24.0
3	7	3.000	37.0
4	7	3.125	38.0
5	7	2.375	25.5
6	7	2.750	34.5
7	7	3.000	35.0
8	7	3.000	40.0

Grand median = 2.625

Kruskal-Wallis Test for **National**

S = K-W Statistic

DF = degrees of freedom

P = Probability

H = 9.33 DF = 7 P = 0.229

H = 11.06 DF = 7 P = 0.136 (adjusted for ties)

Not significant, but not adjusted for regions

Criteria	N	Median	Ave Rank	Z
1	7	0.00E+00	16.7	-2.04
2	7	1.00E+00	20.7	-1.35
3	7	3.00E+00	33.0	0.78
4	7	3.00E+00	33.0	0.78
5	7	2.00E+00	24.3	-0.73
6	7	3.00E+00	31.4	0.51
7	7	3.00E+00	31.4	0.51
8	7	3.00E+00	37.4	1.55
Overall	56		28.5	

Kruskal-Wallis Test on **National**

Regions	N	Median	Ave Rank	Z
1	8	3.000	30.5	0.37
2	8	3.000	33.1	0.87
3	8	3.000	38.0	1.78
4	8	2.000	26.2	-0.42
5	8	1.500	19.9	-1.62

6	8	3.000	38.0	1.78
7	8	1.500	13.8	-2.76
Overall	56		28.5	

H = 15.12 DF = 6 P = 0.019
H = 17.92 DF = 6 P = 0.006 (adjusted for ties)

P<0.01 that authorities differ in overall importance ranking

GENSTAT output Kruskal-Wallis

Do the criteria differ in **regional** importance?

A Kruskal-Wallis Analysis of Variance is performed to test
for differences in scores ascribed to different criteria

Kruskal-Wallis One-Way Analysis of Variance

Value of H = 1.379
Adjusted for ties = 1.894

Sample Sizes:	7	7	7	7	7	7	7	7
Mean Ranks	26.4	24.1	31.6	31.6	26.4	27.9	30.1	30.1

Degrees of freedom = 7
Chi-square p-value = 0.97 **Not significant** but not adjusted for continents

H
1.894 The K-W Statistic

==

MINITAB session output

Friedman test on **Regional** by Criteria blocked by Region

S = 0.94 DF = 7 P = 0.996
S = 1.63 DF = 7 P = 0.977 (adjusted for ties)

Non sig difference among criteria corrected for regions

Critn	N	Est Median	Sum of Ranks
1	7	3.0000	29.0
2	7	3.0000	28.0
3	7	3.0000	34.0
4	7	3.0000	34.0
5	7	3.0000	29.5
6	7	3.0000	32.0
7	7	3.0000	32.0
8	7	3.0000	33.5

Grand median = 3.0000

MTB > Kruskal-Wallis 'Regional' 'Critn'.

Kruskal-Wallis Test on Regional

Critn	N	Median	Ave Rank	Z
1	7	3.000	26.4	-0.37
2	7	2.000	24.1	-0.76
3	7	3.000	31.6	0.53
4	7	3.000	31.6	0.53
5	7	3.000	26.4	-0.37
6	7	3.000	27.9	-0.11
7	7	3.000	30.1	0.27
8	7	3.000	30.1	0.27
Overall	56		28.5	

H = 1.38 DF = 7 P = 0.986
H = 1.89 DF = 7 P = 0.965 (adjusted for ties)

Not significant (as for Genstat)

MTB > Kruskal-Wallis 'Regional' 'Contnt'.

Kruskal-Wallis Test

Kruskal-Wallis Test on Regional

Contnt	N	Median	Ave Rank	Z
1	8	3.000	32.5	0.75
2	8	2.000	16.9	-2.18
3	8	3.000	35.8	1.36
4	8	3.000	35.8	1.36
5	8	2.000	22.8	-1.08
6	8	3.000	35.8	1.36
7	8	2.000	20.1	-1.57
Overall	56		28.5	

H = 12.39 DF = 6 P = 0.054

H = 17.03 DF = 6 P = 0.009 (adjusted for ties) **P<0.01 that authorities differ in overall importance ranking**

APPENDIX 5. PUBLICATIONS AND PRESENTATIONS RELATED TO THIS THESIS

The following papers based directly on this thesis work have been peer-reviewed and published in international journals; and all but the third were presentations at international conferences:

Burlingame, B.A.; Cook, F.M.; Duxfield, G.M.; Milligan, G.C. (1995). Food data: Numbers, words and images. In H. Greenfield (Ed.), *Quality and accessibility of food-related data* (1st ed., Vol. 1, pp. 175-182). Arlington: AOAC International.

Burlingame, B.A. (1996). Development of food composition data base management systems: the New Zealand experience. *Food Chemistry*, **57**(1),127-131.

Monro, J.A.; Burlingame, B.A. (1996). Carbohydrates and related food components: INFOODS tagnames, meanings and uses. *Journal of Food Composition and Analysis*, **9**, 100-118.

Burlingame, B.A.; Lewis, J.; Aalbersberg, W.; Matenga-Smith, T. (1996). OCEANIAFOODS: National, regional and international activities. *Food Chemistry*, **57**(1),175-178.

The following papers based directly on this thesis work have been presented at New Zealand and overseas conferences and published in conference proceedings:

Burlingame, B.A. (1996). Nutrition labelling compliance in the international marketplace. *Southern Connection*: Joint conference of the NZ Institute of Food Science & Technology, and the NZ Biotechnology Association, p.40 (abstract).

Burlingame, B.A. (1991). Using International Nutrient Data. *Proceedings of the Sixteenth Nutrient Databank Conference, Nutrient Databases for the 1990's* (San Francisco), 143-144.

Burlingame, B.A. (1991). Data presentation and dissemination. *Proceedings of the 2nd*

OCEANIAFOODS Conference, Suva, 86-89.

Burlingame, B.A. (1993). Country Reports, New Zealand. *Proceedings of the third OCEANIAFOODS Conference, Dec 1991*, Auckland, 14-20.

Burlingame, B.A. (1993). International Interchange. *Proceedings of the third OCEANIAFOODS Conference, Dec 1991*, Auckland, 117-121.

Burlingame, B.A.; Favier, J.C.; Knowles, M.; Puwastien, P.; Rimestad, A. (1994). The mechanisms for developing, maintaining and updating international food composition data. *Report to FAO/UNU Rome and Tokyo*, 7p.

Burlingame, B.A. (1994). INFOODS: communication and information. In *AFROFOODS Organisational Meeting Report* (pp. 43-48). Accra: Food and Agriculture Organization.

Burlingame, B.A. (1994). The fundamental information requirement: Food composition data. In *Report of the regional expert consultation of the Asia-Pacific Network for Food and Nutrition on household food security with respect to desirable dietary pattern*, **23**, 85-87. Bangkok: Food and Agriculture Organization.

Burlingame, B.A.; Cook, F.M. (1994). Images in data bases. *Proceedings of the 19th National Nutrient Databank Conference* (St Louis), 45-49.

Burlingame, B.A. (1995). Food composition data systems in theory and practice. *Meeting on Food Composition Activities in the Middle Asian Region*, 29-38. Beijing: Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine.

Burlingame, B.A. (1995). OCEANIAFOODS as a regional data centre model. *Meeting on Food Composition Activities in the Middle Asian Region*, 39-45. Beijing: Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine.

Burlingame, B.A.; Gibson, J.J.; Milligan, G.C.; Monro, J.A.; Quigley, R.J.; Spriggs, T.W. (1996). Country Report: New Zealand. *Proceedings of the 4th OCEANIAFOODS Conference*, 16-24, Suva: The University of the South Pacific and The Fiji National

Food and Nutrition Committee.

Burlingame, B.A.; Scrimshaw, N.S. (1996). INFOODS activities with relevance to OCEANIAFOODS. *Proceedings of the 4th OCEANIAFOODS Conference*, 47-53, Suva: The University of the South Pacific and The Fiji National Food and Nutrition Committee.

Burlingame, B.A. (1997). Proximate methods and modes of expression: variability as a harmonization issue. *Proceedings of the 21st National Nutrient Databank Conference* (Baton Rouge), (in press).

Burlingame, B. A. (1997). Food Nomenclature and Terminology: Standards and Harmonisation for Food Composition Databases and Food Trade. *16th International Congress of Nutrition, Abstracts*, Montreal, Canada.

Burlingame, B. A. (1997). International food composition data harmonisation: A precondition for assessing food security. *16th International Congress of Nutrition, Abstracts*, Montreal, Canada.