Environmental Health and Primary Health Care: Towards a New Workforce Model

Submitted by

Elizabeth Gayle Hanna
MPH, BA, RCCN, RN

A Thesis submitted in total fulfilment of the requirements for the degree of

Doctor of Philosophy

School of Public health
Faculty of Health Sciences
La Trobe University,
Bundoora, Victoria 3086
Australia

June 2005
ACKNOWLEDGEMENTS

This has been a joyous and enriching personal journey, and I wish to thank many for their special contributions. They are:

- Dr Bob Crossman, who set me on this path of discovery, and kept his undying faith in me throughout,
- My post graduate La Trobe University, Shepparton Campus nursing students, who freely gave their personal stories to highlight that AgVet exposure was a serious health issue, the significance of which is inadequately recognised,
- All those who participated in the study, who also gave their time and shared their personal experiences,
- My supervisors, Professor Vivian Lin, fabulous mentor (who comes highly recommended), and friend, whose patience and astute mind shepparded me to not stray into tangential areas, and her lightening fast turn around time regardless of her location on the planet, and Dr Tom Keating without whose practical support this research would not have been possible to conduct while living on a farm,
- All those who provided me a home in Melbourne, friendship, solace and support, in my times of need, especially Jenny Plummer and Beth Woodward,
- All my friends and colleagues, for their encouragement and belief in my cause, and
- Fergus McCowan whose impassioned, enthusiastic and spiritual support saw me through the final stages.

A journey such as this is in many ways self indulgent, involving a self-imposed penury (horribly inconvenient to all who know me), a degree of self–obsession meant a lack of consideration, and returning the support and friendship offered by others. For this I apologise, and give my most sincere and indeed heartfelt (in its true meaning) thanks to all patiently waited for the end to arrive. Completion is a joyous day. Thank you. I sincerely hope this research sparks a new direction for Australia in reducing health harm from chemical exposure, and your part in this shall forever be recognized.

I dedicate this thesis to the people whose health and lives have been affected by their exposure to AgVets, while their calls for help have been unheard.

This study would also not have been possible without funding support form the Victorian Department of Human Services, Hume Region, La Trobe University, and NH&MRC Scholarship.
FOREWARD

The principal factor driving this study was hearing community concerns regarding widespread health problems, believed to be associated with exposure to Agricultural and Veterinary (AgVet) chemicals. Further to this, community members reported dissatisfaction with their experience when attempting to bring these issues to the attention of local primary health care providers, principally their general practitioners. The belief was frequently expressed that current health services lacked environmental health expertise. Also commonly reported was the view that government agencies should take a more active role in investigating and rectifying the issue. The high degree of frustration surrounding this issue was universal, and the consistency was remarkable. It became increasingly evident that these concerns were broadly held across the communities, and warranted investigation to determine firstly whether these fears were founded, and secondly, to examine existing primary health care infrastructure in terms of its ability to effectively identify and address emerging chronic environmental health hazards.

This information was initially drawn to the attention of the study’s principal investigator, whilst lecturing postgraduate Registered Nurses in the Shepparton region. Over a seven year period, 20 to 30 percent of each cohort of students reported that they either had moved house, or had contemplated relocating due to health complaints among their own families, which they believed were due to the proximity of their home to the orchards, and resulting exposure to AgVet chemicals. These nurses found it alarming that they could not navigate their way through the health care system to find satisfaction in health care, although on average, they had been working within the health sector for over twenty years. Their primary complaint was being unable to find a general practitioner who could answer their questions, and provide relevant advice or treatment. It became apparent that with little diagnostic activity, reporting and monitoring was not occurring. Hence it could not be known to what extent a systematic problem existed.

Further confirmation that community concern about health risks associated with exposure to agricultural chemicals was widespread about occurred through membership on various health agency boards of management, and other regional health committees throughout the north east Victoria. Residents of the Ovens and King Valleys shared similar intense concerns to those living near the Goulburn Valley orchards. The prevailing sentiment was one of anger at the apparent lack of interest from their doctors and response from the Department of Human Services.
A brief literature review revealed that several studies had investigated water quality (river water, groundwater, and rainwater tanks) in these two locations, and both regions showed pesticide contamination. The community's concerns appeared valid and this provided the impetus for this investigation.

This study therefore represents an investigation of community driven concerns, a “bottom up” approach to a reported public health problem. Accordingly, the ultimate objective is to identify strategies to address these concerns, and where required, recommend potential solutions. As a first step, the study aims to provide evidence regarding the nature and determine the extent of concern for the issues identified by community, and illustrate any shortfalls within the existing system infrastructure. The intent is to synthesize this information in order to highlight components within our health system where improvements are needed in order to serve the community better.
TABLE OF CONTENTS

ACKNOWLEDGEMENTS .................................................................................................................. i
FOREWORD ........................................................................................................................................ ii
TABLE OF CONTENTS ......................................................................................................................... iv
SUMMARY ........................................................................................................................................... ix
STATEMENT OF AUTHORSHIP ...................................................................................................... xi
ABBREVIATIONS ............................................................................................................................. xii
GLOSSARY .......................................................................................................................................... xv

CHAPTER 1........................................................................................................................................... 1
INTRODUCTION ................................................................................................................................. 1
Introduction ........................................................................................................................................... 1
Environmental Health: Its Place in Public Health Practice ............................................................... 2
Agricultural and Veterinary Chemicals: An Emerging Environmental Exposure Hazard ............... 5
  Environmental chemical exposures ................................................................................................. 6
  Chemical exposure links to poor health .......................................................................................... 7
International Response to Chemical Hazards .................................................................................. 9
Australia’s Response to Chemical Hazards ...................................................................................... 10
Concept of Risk .................................................................................................................................. 12
Rationale for the Study: Project Significance ................................................................................... 13
The Research Problem ..................................................................................................................... 14
  Research question ............................................................................................................................ 15
  Research objectives .......................................................................................................................... 15
Methodology ....................................................................................................................................... 16
Conclusion .......................................................................................................................................... 17

Chapter 2........................................................................................................................................... 19
Exposure to Agvets: .......................................................................................................................... 19
A review of Human health effects ...................................................................................................... 19
Introduction .......................................................................................................................................... 19
Literature Search Strategy .................................................................................................................. 19
Global reliance in Agricultural and Veterinary Chemicals ............................................................... 20
  Drivers of pesticide utilization ......................................................................................................... 22
AgVet Chemicals in the Environment ............................................................................................... 23
  Pesticides: What they are, how they work ...................................................................................... 23
  Pesticides in the environment .......................................................................................................... 24
  Replacement by ‘safer’ AgVets due known health hazards .............................................................. 25
  Pesticide exposure pathways .......................................................................................................... 27
Toxic impacts of pesticides ............................................................................................................... 28
  Chemicals in humans, our ‘Body Burden’ ......................................................................................... 31
Human Health Impacts of Exposure .................................................................................................. 31
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure through working directly with AgVets</td>
<td>178</td>
</tr>
<tr>
<td>Exposure via spray drift</td>
<td>180</td>
</tr>
<tr>
<td>Exposure through water supply</td>
<td>182</td>
</tr>
<tr>
<td>Knowledge of Exposure Health Risks</td>
<td>183</td>
</tr>
<tr>
<td>Health Conditions Reported</td>
<td>187</td>
</tr>
<tr>
<td>Perceived Link: AgVet Exposure and Family Ill-health</td>
<td>194</td>
</tr>
<tr>
<td>Satisfaction with Health Providers</td>
<td>198</td>
</tr>
<tr>
<td>Health Professional Preference</td>
<td>199</td>
</tr>
<tr>
<td>Survey of the CATI Interviewers</td>
<td>202</td>
</tr>
<tr>
<td>Discussion</td>
<td>203</td>
</tr>
<tr>
<td>Conclusion</td>
<td>208</td>
</tr>
<tr>
<td>Chapter 8</td>
<td>210</td>
</tr>
<tr>
<td>Primary Health Care delivery responding to community concerns</td>
<td></td>
</tr>
<tr>
<td>Introduction</td>
<td>210</td>
</tr>
<tr>
<td>Health Provider Participation</td>
<td>211</td>
</tr>
<tr>
<td>Provider Perspectives</td>
<td>212</td>
</tr>
<tr>
<td>Environmentally related ill-health within the region</td>
<td>214</td>
</tr>
<tr>
<td>Estimation of community environmental health concern</td>
<td>217</td>
</tr>
<tr>
<td>Understanding of regional agricultural activities, and associated chemical usage</td>
<td>219</td>
</tr>
<tr>
<td>Knowledge of chemicals usage and side effects</td>
<td>220</td>
</tr>
<tr>
<td>Environmental health practice</td>
<td>221</td>
</tr>
<tr>
<td>Referral practices and self-educational strategies adopted</td>
<td>222</td>
</tr>
<tr>
<td>Provider preferred workforce model</td>
<td>223</td>
</tr>
<tr>
<td>Discussion: Primary Health Care Provider Perspectives on Environmental Health Delivery</td>
<td>224</td>
</tr>
<tr>
<td>Perceived Importance of the Environment: Divergence Between Community and Health Provider Beliefs</td>
<td>228</td>
</tr>
<tr>
<td>Conclusion</td>
<td>230</td>
</tr>
<tr>
<td>Chapter 9</td>
<td>233</td>
</tr>
<tr>
<td>Conclusion: Synthesis and Recommendations</td>
<td>233</td>
</tr>
<tr>
<td>Introduction</td>
<td>233</td>
</tr>
<tr>
<td>Study Findings</td>
<td>233</td>
</tr>
<tr>
<td>AgVet exposures pose a health risk to Australians</td>
<td>234</td>
</tr>
<tr>
<td>Australia’s policy framework fails to prevent risks</td>
<td>236</td>
</tr>
<tr>
<td>Australia lacks skills in environmental health practice</td>
<td>238</td>
</tr>
<tr>
<td>Community – Provider Perspective Discordance</td>
<td>239</td>
</tr>
<tr>
<td>Public Health Infrastructure</td>
<td>240</td>
</tr>
<tr>
<td>Primary Health Care Skills and Competencies Required</td>
<td>243</td>
</tr>
<tr>
<td>Workforce Model</td>
<td>245</td>
</tr>
<tr>
<td>Strengths and Weaknesses of the Study</td>
<td>248</td>
</tr>
<tr>
<td>Further Research</td>
<td>248</td>
</tr>
<tr>
<td>Conclusion</td>
<td>250</td>
</tr>
</tbody>
</table>
SUMMARY

Public health was once synonymous with environmental health, but the two fields diverged as living conditions improved. Environmental factors are again harming human health. Increasing global reliance on agricultural and veterinary chemicals over recent decades has emerged as a serious public health concern as evidence of their toxicity accumulates, prompting international efforts to minimize, monitor and manage exposure risks. Direct involvement of the primary health care workforce is seen as critical to this process, yet little data exists on the health burden on Australian rural communities imposed by these chemicals.

The study presented here attempts to explore the impact of these chemicals on two rural communities, and ascertain the how the existing primary health care system responds to exposure issues. The client – provider interface is not an entity acting in isolation from other frameworks. It has evolved against a background of legislation and provider training. Other factors also impinge, such as the structure and focus of the health sector, and Australia's systematic approach to environmental and chemical management. Examination of this underlying infrastructure in Australia provided the background against which the issue of exposure to agricultural and veterinary chemicals was explored. A brief summary of international developments in this area served to provide insight as to what interventions may be introduced to address this issue.

A CATI survey of 1050 households sought the perspectives from two Victorian agricultural communities to gather self-reported exposure and health data, whether respondents perceived their health problems were linked to exposure. Respondents were also asked to comment on their experiences encountering primary health care providers, and which services they prefer to seek for health advice. Perspectives were then sought from all primary health care providers servicing these communities on their level of expertise in diagnosing, and managing exposure related illness, via face-to-face interviews, focus groups and paper surveys.

These rural communities have a long history of hazardous exposure to toxic AgVets. Awareness of toxicity risks is growing, yet further scope exists to improve safe handling of chemicals. High levels of illnesses known be associated with AgVet exposure exist in these communities. Many believe their own ill-health is linked to exposure, and they express strong dissatisfaction with the apparent lack of
environmental health expertise especially among their GPs. Health providers demonstrated limited understanding of the health impacts of AgVet exposure.

The lack of expertise in the existing primary health care workforce means that these conditions are not being identified, and the absence of health intelligence hampers health planning. In Australia, the health, environment and primary industries sectors function in effect, as distinct silos, with little cross-fertilisation. The United States has combined its agricultural chemical legislative authority with a focus on human health, where there are direct links between programs designed to protect human health, and biomonitoring. The U.S. also has developed environmental health expertise at the primary health care level to address community needs as they arise. Strategies are required to connect environmental, chemical management and health portfolios in Australia, with respect to the emerging environmental issue of chemical exposure. There is a need also in Australia to inject environmental health capacity into the primary health care practice.
STATEMENT OF AUTHORSHIP

Except where reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis submitted for the award of any other degree or diploma.

No other person’s work has been used without due acknowledgement in the main text of the thesis.

The thesis has not been submitted for the award of any degree or diploma in any other tertiary institution.

The La Trobe University Human Ethics Committee approved all research procedures reported in the thesis.

........................................

..............................
## ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4,5-T</td>
<td>2,4,5-trichlorophenoxyacetic acid</td>
</tr>
<tr>
<td>2,4-D</td>
<td>2,4-dichlorophenoxyacetic acid (a systematic post-emergence herbicide)</td>
</tr>
<tr>
<td>ABARE</td>
<td>Australian Bureau of Agricultural and Resource Economics</td>
</tr>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>AMC</td>
<td>Australian Medical Council</td>
</tr>
<tr>
<td>AML</td>
<td>Acute Myeloid Leukaemia</td>
</tr>
<tr>
<td>AgVet</td>
<td>Agricultural and Veterinary chemicals</td>
</tr>
<tr>
<td>AIEH</td>
<td>Australian Institute of Environmental Health</td>
</tr>
<tr>
<td>ATSDR</td>
<td>Agency for Toxic Substances and Disease Registry (USA)</td>
</tr>
<tr>
<td>API</td>
<td>Acute Pesticide Intoxications</td>
</tr>
<tr>
<td>APVMA</td>
<td>Australian Pesticide and Veterinary Management Authority</td>
</tr>
<tr>
<td>AVCARE</td>
<td>The National Association of Crop Protection and Animal Health (a peak industry body)</td>
</tr>
<tr>
<td>BEACH</td>
<td>Bettering the Evaluation and Care of Health</td>
</tr>
<tr>
<td>CAM</td>
<td>Complementary and Alternative Medicine</td>
</tr>
<tr>
<td>CATI</td>
<td>Computer Assisted Telephone Interview</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention (USA)</td>
</tr>
<tr>
<td>CFS</td>
<td>Chronic Fatigue Syndrome</td>
</tr>
<tr>
<td>CHC</td>
<td>Community Health Centres</td>
</tr>
<tr>
<td>CSB</td>
<td>Chemical Standards Branch (Victoria)</td>
</tr>
<tr>
<td>DDE</td>
<td>1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene</td>
</tr>
<tr>
<td>DDT</td>
<td>1,1,1-trichloro-2 bis(4-chlorophenyl)ethylene, Dichlorodiphenyl trichloroethane (a lipophilic organochlorine)</td>
</tr>
<tr>
<td>DoHA</td>
<td>Department of Health and Ageing (AUS)</td>
</tr>
<tr>
<td>DHS</td>
<td>Victorian Department of Human Services</td>
</tr>
<tr>
<td>DHHS</td>
<td>Federal Department of Health and Human Services (USA)</td>
</tr>
<tr>
<td>DPI</td>
<td>Victorian Department of Primary Industries</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EDC</td>
<td>Endocrine Disrupting Chemicals</td>
</tr>
<tr>
<td>EHO</td>
<td>Environmental Health Officers</td>
</tr>
<tr>
<td>enHealth</td>
<td>National Environmental Health Council</td>
</tr>
<tr>
<td>EPA</td>
<td>Environment Protection Authority</td>
</tr>
<tr>
<td>EPHC</td>
<td>Environment Protection and Heritage Council</td>
</tr>
<tr>
<td>EPHT</td>
<td>Environmental Public Health Tracking Program</td>
</tr>
<tr>
<td>EWP</td>
<td>Electronic White Pages</td>
</tr>
<tr>
<td>FSANZ</td>
<td>Food Standards Australia and New Zealand</td>
</tr>
<tr>
<td>GATT</td>
<td>General Agreement on Tariffs and Trade</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information Systems</td>
</tr>
<tr>
<td>GP</td>
<td>General Practitioners</td>
</tr>
<tr>
<td>GVGP</td>
<td>Goulburn Valley Division of General Practitioners</td>
</tr>
<tr>
<td>HCB</td>
<td>hexachlorobenzene</td>
</tr>
<tr>
<td>HGP</td>
<td>Hormone Growth Promotants</td>
</tr>
<tr>
<td>IFCS</td>
<td>Intergovernmental Forum on Chemical Safety</td>
</tr>
<tr>
<td>ILO</td>
<td>International Labour Organization</td>
</tr>
<tr>
<td>IOM</td>
<td>Institute of Medicine (USA)</td>
</tr>
<tr>
<td>IPCS</td>
<td>International Programme on Chemical Safety</td>
</tr>
<tr>
<td>LD</td>
<td>Lethal Doses</td>
</tr>
<tr>
<td>LD50</td>
<td>Median Lethal Doses (concentration of active ingredient in milligrams per kilogram of body weight, required to kill 50 per cent of test animals in a laboratory)</td>
</tr>
<tr>
<td>MCS</td>
<td>Multiple Chemical Sensitivity</td>
</tr>
<tr>
<td>MSDS</td>
<td>Material Safety Data Sheets</td>
</tr>
<tr>
<td>MRL</td>
<td>Minimum Residue Limits</td>
</tr>
<tr>
<td>NDP</td>
<td>National Dioxins Program</td>
</tr>
<tr>
<td>NDS</td>
<td>National Data Set of Compensation-based Statistics</td>
</tr>
<tr>
<td>NEVDGP</td>
<td>North Eastern Victoria Division of General Practice</td>
</tr>
<tr>
<td>NEHF</td>
<td>National Environmental Health Forum</td>
</tr>
<tr>
<td>NEHS</td>
<td>National Environmental Health Strategy</td>
</tr>
<tr>
<td>NEPC</td>
<td>National Environmental protection Council (comprised of Commonwealth, States and Territories Ministers)</td>
</tr>
<tr>
<td>NHMRC</td>
<td>National Health and Medical Research Council</td>
</tr>
<tr>
<td>NICNAS</td>
<td>National Industrial Chemical Notification and Assessment Scheme</td>
</tr>
<tr>
<td>NIEHS</td>
<td>National Institute of Environmental Health Science (USA)</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute for Occupational Safety and Health (USA)</td>
</tr>
<tr>
<td>NHL</td>
<td>NON-HODGKIN’S LYMPHOMA</td>
</tr>
<tr>
<td>NOHSC</td>
<td>National Occupational Health &amp; Safety Commission</td>
</tr>
<tr>
<td>NPHP</td>
<td>National Public Health Partnership</td>
</tr>
<tr>
<td>OC</td>
<td>Organochlorines</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
</tr>
<tr>
<td>OHN</td>
<td>Occupational Health and Safety Nurses</td>
</tr>
<tr>
<td>OHS</td>
<td>Occupational Health and Safety</td>
</tr>
<tr>
<td>OP</td>
<td>Organophosphate</td>
</tr>
<tr>
<td>PCBs</td>
<td>Polychlorinated Biphenyls</td>
</tr>
<tr>
<td>PCP</td>
<td>Primary Care Partnership</td>
</tr>
<tr>
<td>PHERP</td>
<td>Public Health Education and Research Program</td>
</tr>
<tr>
<td>PHC</td>
<td>Primary Health Care</td>
</tr>
<tr>
<td>PISP</td>
<td>Pesticide Illness Surveillance Program (California, USA)</td>
</tr>
<tr>
<td>POP</td>
<td>Persistent Organic Pollutants</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
</tr>
<tr>
<td>REACH</td>
<td>Registration, Evaluation, Authorisation of Chemicals (EU)</td>
</tr>
<tr>
<td>SAICM</td>
<td>Strategic Approach to International Chemicals Management</td>
</tr>
<tr>
<td>SES</td>
<td>Socio-economic status</td>
</tr>
<tr>
<td>SENSOR</td>
<td>Sentinel Event Notification System for Occupational Risks</td>
</tr>
<tr>
<td>TCM</td>
<td>Traditional Chinese Medicine</td>
</tr>
<tr>
<td>TGA</td>
<td>Therapeutic Goods Administration</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>UNCED</td>
<td>United Nations Conference on Environment and Development (UNCED)</td>
</tr>
<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
</tr>
<tr>
<td>WCED</td>
<td>World Commission on Environment and Development</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WSSD</td>
<td>World Summit on Sustainable Development</td>
</tr>
</tbody>
</table>
GLOSSARY

active constituent – in relation to AgVet products, an active constituent is a substance that is primarily responsible (alone or in combination with other active constituents) for the biological effect of the product/s.

acute effects – effects that occur rapidly following exposure and are of short duration


AgVet - Agricultural and Veterinary Chemical- are substances or products which are covered by the Agricultural and Veterinary Chemicals Code Act 1994. Agricultural chemicals include herbicides, insecticides and fungicides used in agriculture; insect repellents for use on humans; household and garden products for pest and weed control; and some pool chemicals such as those used to kill bacteria and algae. Veterinary product chemical definitions include animal therapeutic products; allergenic substances; medicated blocks and licks; and enzymes for animals.

aquifer – a deposit of rock that yields economic supplies of water to wells or springs as a result of its porosity or permeability.

attributable burden - the proportion of current disease or injury burden that results from past exposure

avoidable burden - the proportion of future disease or injury burden that is avoidable if current and future exposure levels are reduced to those specified by some alternative, or counterfactual, distribution.

Bahia Declaration on Chemical Safety – Declaration by the IFCS in October 2000, reaffirming the commitment of participants to the Rio declaration. Key goals include: the improvement of chemical safety at all levels and the prevention or reduction of adverse health and environment effects of chemicals throughout their life-cycle.

bioaccumulation – the uptake of substances from the environment, their concentration, and retention by organisms. It includes the process by which a pesticide becomes concentrated in living organisms, and the build-up of a chemical in organisms at concentrations greater than the levels in their environment.

bioavailability – the extent to which a chemical substance to which the body is exposed (by ingestion, inhalation, injection, or skin contact) reaches the systematic circulation, and the rate at which this occurs.

biodegradable – able to be decomposed readily by the action of micro-organisms.

biological monitoring – determination of chemicals or metabolites in the tissues and biological fluids of organisms

biomarkers – measurement of a chemical or metabolite in biological tissue or fluid as a surrogate for biological effects.
ChemClear – proposed industry scheme to manage unwanted farm chemicals following completion of the ChemCollect program (see below).

ChemCollect – a joint, one-off State/Territory and Commonwealth Governments scheme to collect and safely dispose of unwanted and de-registered farm chemicals, including organochlorine pesticides. It ran progressively from November 2000 until December 2002.

chemical management system - the combination of tools and approaches employed to assess and reduce the risks of chemical use to human health and the environment. It can include: legislation, assessment methods, standards, codes of practice, education and training, financial incentives.

chronic effects – effects that develop slowly and have a long duration. They are often, but not always, irreversible. Some irreversible effects may appear a long time after the chemical substance was present in the sensitive tissue. In such cases, the latent period (or time to occurrence of an observable effect) may be very long, particularly if the exposure is low (who 1989).

community health services - services to meet the main health needs of their defined community, using multidisciplinary workforce to provide accessible, comprehensive programs to all sections of the community, with particular attention to vulnerable groups. It involves community participation in health care decision making, and they form part of the primary health care service network.

content validity – whether the measurement tool, and the items it contains, are representative of the content domain the researcher intends to measure

cost-benefit analysis – the systematic documentation of relevant benefits and costs over time; quantified in monetary terms where possible or qualitatively assessed in the absence of quantitative data

dose-response assessment relates the probability of a health effect to the dose of pollutant or amount of exposure

DrumMUSTER – national program for the collecting and recycling of empty, cleaned, non returnable rigid metal and plastic farm chemical containers.

ecotoxic – harmful to ecosystems and/or the organisms within them.

ecotoxicology – the field of science dealing with the adverse effects of chemicals, physical agents, and natural products on populations and communities of plants, animals and human beings.

endocrine disruptor – substance that interferes with the working of the endocrine (hormone) system. Observed effects of endocrine disruption have included masculinisation, feminisation, and birth defects, reproductive or immune dysfunction.

EnHealth Council – the national peak environment body established as a subcommittee of the National Public Health Partnership. The enHealth Council is responsible for coordinating the implementation of the national environmental Health Strategy, setting priorities, and advising Commonwealth, state, territory and local governments on environmental health issues.
environmental health  - (World Health Organization) “Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychological factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially have an adverse effect on the health of present and future generations.”

environmental health - (enHealth Council) “… about creating and maintaining environments that promote good public health. It covers the assessment, correction, control and prevention of environmental factors that adversely affect health, as well as the enhancement of those aspects of the environment that improve human health.”

environmental health care – see environmental health practice

environmental health practice - The focus of this practice is on individuals and communities, but can also include activities to reduce hazards in the physical environment. assessing, correcting, controlling and preventing hazardous environmental exposures that could potentially have an adverse effect on the health of individuals or populations. This can be through the practice of conducting assessments (environmental assessments, risk assessments, clinical health assessments, or biomonitoring), correcting hazardous situations, or unhealthy or risky behaviours, and preventing hazardous exposures by offering prevention (primary, secondary or tertiary).

environmental health service – health protection undertaken by EHOs, focussing on the physical environment: assessing, correcting, controlling and preventing those factors in the environment that can potentially have an adverse effect on the health of present and future generations.

environmental health hazard – an environmental factor with the potential to cause adverse health effects. Examples of environmental health hazards include: allergens, antibiotic agents in animals destined for human consumption, chemicals, drought, electromagnetic fields, explosive material, radiation, toxins, viruses, and more.

environmental oestrogens are chemicals in the environment which act like the female sex hormone, oestrogen (estradiol). Oestrogenic chemicals may occur normally in nature and may be found in plants and our diet. Others are synthetic. These are mostly found in plastics or insecticides such as PCB’s DDT, Dioxins, and furans.

exposure – contact of a chemical, physical, or biological agent with the outer boundary of an organism, for example, inhalation, ingestion, or dermal contact

exposure assessment – the estimation (qualitative or quantitative) of the magnitude, frequency, duration, route and extent of exposure to one or more contaminated media for the general population, for different subgroups, or for individuals

food additive – Any non-nutritive substances added intentionally to food, generally in small quantities, to improve its appearance, flavour, texture, or storage properties, with the exception of substances which are added to food exclusively for their nutritive properties, but including animal feed adjuncts which may result in residues in human food, and other contaminants (WHO 1989).

gentotoxic – toxicity resulting in modification of DNA

hazard – the capacity of an agent to produce a particular type of adverse effects to people or the environment under conditions of exposure.
hazard identification identifies the types of health effect that can be caused, based on toxicological data from laboratory or epidemiological studies: for example, chemical x causes liver damage.

hazardous chemicals/substances – substances that are toxic, persistent and liable to bioaccumulate or which give rise to an equivalent level of concern

health care - preventative, diagnostic, therapeutic, rehabilitative, maintenance or palliative care, services, procedures or counselling provided by health professionals. It can be directed at individuals or groups in the community.

health care provider = health professional – an individual trained to have the skills and competencies recognized to provide health care. (Here, the term ‘health provider’ does not include an agency, department, unit, or other entity that delivers a health-related service.)

health sector - an umbrella term that includes health care providers, and supporting service staff, institutions providing health care services, professional organisations, and also government administrative and funding bodies.

health risk assessment - the process of estimating the potential impact of a chemical, biological, physical, or social agent on a specific human population system under a specific set of conditions and for a certain timeframe.

heavy metals – a term loosely applied to a whole range of elements, not all of them metals, which may contaminate the environment. Heavy metals include antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, germanium, lead, mercury, molybdenum, nickel, selenium and zinc.

industrial chemicals – a chemical that has an industrial use, whether or not it has an excluded use. An excluded use is use as an agricultural chemical or veterinary chemical, a therapeutic use, or use as a food or food additive. Industrial chemicals include dyes, solvents, adhesives, plastics, laboratory chemicals, paints as well as chemicals used in cleaning products, cosmetics and toiletries.

integrated assessment – a method of analysis that combines the results and models from the physical, biological, economic, and social sciences, and the interactions between these components, in a consistent framework to evaluate the status and consequences of environmental change and the policy responses to it.

intersectoral collaboration – different professional groups or departments working cooperatively to achieve the one goal.

leaching – the movement of a substance downward or out of the soil as the result of water movement, or wash-out of various substances from soil by infiltrating water.

lethal doses (LD50), doses which are determined by the concentration of active ingredient in milligrams per kilogram of body weight, required to kill 50 per cent of test animals in a laboratory.

Montreal Protocol on Substances that Deplete the Ozone Layer 1987 – An international instrument to control substances responsible for depleting the ozone layer. It sets out strategies for controlling the consumption of CFCs, halogens, and other deleterious chemicals and imposes staged reduction programs.
**multi-level determinants** - simultaneous influences on health that occur within individuals, systems, communities, and environments

**pesticide** - agricultural and household chemicals such as insecticides, herbicides and fungicides. They are by definition biocidal, and are designed for the specific purpose of destroying organisms which share many human biological pathways.

**persistence** – a measure of the length of time a compound will remain in the environment before being broken down or degraded into other and less hazardous substances. Persistent substances can become distributed world-wide, particularly in the marine environment or in the atmosphere.

**Persistent Organic Pollutants (POPs)** - chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife.

**pollutant** – any undesirable solid, liquid or gaseous matter, in a gaseous, liquid, or solid medium.

**population attributable risk** -- the proportion of disease in a population that results from a particular risk to health.

**precautionary principle** - in order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

**primary care** - is often used in Australia interchangeably with primary medical care as its focus is on clinical services provided predominantly by GPs.

**primary health care** (PHC) - is a level of care, and a philosophical approach to health care. It incorporates five principles as defined in the WHO Alma Ata declaration: equitable distribution of health services, community involvement, emphasis on disease prevention, use of appropriate technology, and an approach that involves a range of sectors (housing, agriculture, water supply). The ‘primary’ has multiple meanings: first point of access to the health care sector, early stage of addressing health problems, basic (as in accessible and affordable care), and essential (as in being the foundation of the health system). PHC incorporates primary care, but has a broader focus as it extends also to community health services.

**primary prevention** – involves intervening in systems to address risk factors for disease (and to eliminate exposure to harmful agents (before diagnosis and to develop measures designed to promote general optimum health. It can be divided into two types: health promotion, and specific protection

**Prior Informed Consent** – The principle that international shipment of a chemical that is banned or severely restricted in order to protect human health and the environment should not proceed without the agreement, where agreement exists, or contrary to the decision of, the designated authority in the importing country.
public health – (as defined by Winslow in 1920) is the science and art of preventing disease, prolonging life, and promoting physical and mental health, and efficiency through organised community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organisation of medical and nursing services for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community, a standard of living adequate for the maintenance of health.

registration – the process by which authorities review and assess a product and approve its sale or use for specific purposes.

relative risk -- the likelihood of an adverse health outcome in people exposed to a particular risk, compared with people who are not exposed. For example, if people who smoke for a certain time are, on average, 15 times more likely to develop lung cancer than those who do not smoke, their relative risk is 15.

Rio - United Nations Conference on Environment and Development, where the Rio Declaration on Environment and Development was formed.

risk – the probability, that in a certain timeframe, an adverse outcome will occur in a person, group of people, plants, animals and/or the ecology of a specified area that is exposed to a particular dose or concentration of a hazardous agent, combined with the magnitude of the consequence of that adverse effect.

risk assessment – the identification of environmental health hazards, their adverse effects, target populations, and conditions of exposure. It typically involves a combination of hazard identification, risk estimation, exposure, and risk characterisation.

risk characterization combines the exposure and dose--response assessments to calculate the estimated health risks, such as the number of people predicted to experience a particular disease, for a particular population. This typically includes estimation and communication of uncertainties.

risk management – the managerial, decision-making and control process to deal with those environmental agents for which risk evaluation has identified that the risk is too high.

Rotterdam Convention – Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (or PIC). This international treaty was drawn up to give importing countries the power to make informed decisions as to which chemicals they will receive and which they will exclude because they cannot be managed safely. If a country agrees to import chemicals, the Convention promotes their safe use through labelling standards, technical assistance, and other forms of support.

secondary prevention – the targeting of people at risk, or in the early stage of a health condition in order to prevent the condition from developing or becoming worse

Stockholm Convention on Persistent Organic Pollutants – International treaty to protect human health and the environment from persistent organic pollutants (POPs). It requires the reduction of persistent, bioaccumulating chemicals with adverse health/environmental effects. Governments implementing the Convention are required to take measures to eliminate or reduce the release of POPs into the environment and to consider these characteristics when assessing chemicals.
**surveillance** – the continuous monitoring of data about all aspects of occurrence and spread of disease or health condition in order to enable effective interventions being undertaken

**tertiary prevention** – the targeting of people with a health condition to reduce the impact of the condition and optimise health-related quality of life

**thematic analysis** – a mode of analysis that seeks out the meaning within data sets by placing various patterns together. The themes reflect the issues inherent within the data texts

**therapeutic chemicals/substances** – medicines and medical devices for use in connection with preventing, diagnosing, curing or alleviating a disease, ailment, defect or injury in humans.

**toxicity** – a physiological or biological property which defines the ability of a chemical to do harm, or produce injury, to a living organism by other than mechanical means.

**validity** - an expression to the degree to which a measurement measures what it purports to measure.

**veterinary medicines** include all veterinary chemical products such as vaccines, antibiotics, growth promotants, worming treatments, and flea and tick washes, and other parasiticides for both domestic and production animals.
CHAPTER 1
INTRODUCTION

Introduction

Ancient civilizations understood that the natural environment was a powerful health determinant. The environmental crisis generated by the industrial revolution bought widespread disease and human misery, and highlighted the capacity for anthropogenic destruction of environmental living conditions to harm human health. This awareness sparked the public health movement. Concerns about environmental impacts then gradually faded from contemporary public health landscape in more recent modern times (of the technological age), and the focus of the two fields, environmental health and public health diverged.

Environmental factors are again emerging to pose serious health threats. Expanding population growth and associated intensification of human economic activity over recent decades, have significantly altered the human – environment interface, and placed stress on the earth’s capacity to provide a healthy environment. Climate change, water quality and sufficiency, genetically modified foods, urban environments, pollution and exposure to hazardous chemicals are but some of the emerging contemporary environmental concerns. These have prompted both high-level strategic international responses, as well as a questioning of the adequacy, in terms of environmental health competence, of the primary health care workforce and infrastructure at the local level. In Australia, we do not know how well prepared is the primary health care workforce, or how surveillance systems are able to effectively respond to environmental health problems.

The human – environment interface is complex, and involves multiple parameters. The geographical environment, human activities and perspectives underpinning individual behaviours, government strategic management frameworks, and health sector preparedness all intersect at this interface. Narrowing the focus to a single issue allows for clarity to explore the intersection of these various parameters. The issue of agricultural and veterinary chemicals, their uses and risks, was selected as the lens through which the question of how well Australia is responding to emerging environment health problems is examined. In rural Australia, agriculturalists have adopted a range of measures to deal with the harsh environment, and increasing reliance on agricultural and veterinary chemicals (hereafter referred to as AgVets), is one such measure. Rural health status is worse than urban. The environment
is a key health determinant, and recognition of the risks of AgVet may in part, help explain the increasing
differential between the health status of rural and urban Australians.

The evolution of understanding about the connection between the environment and health sets the
context for this thesis. This introductory chapter begins by reviewing the historical place of environmental
health in public health thinking and practice, and describes the background to the problem of emerging
environmental health issues. Significance of AgVet exposure as an emerging human health problem is
then outlined. Comparisons with international responses to address chemical exposure problems serves
as a frame of reference against which to consider the adequacy of the Australian infrastructure, and
primary health care workforce model, in addressing this environmental exposure hazard. Infrastructure
components explored are the Australian chemical regulatory framework, existing data capture and
routine surveillance of environmental health indicators, and environmental health skills and training of
health practitioners.

Final sections of this chapter outline features of the study designed to examine how well Australia is
responding to the rising health concerns of AgVet exposure. Areas covered include a brief summary of
the rationale for the study, the research problem, research question, plus an outline of the methodology
applied. Perspectives were sought from rural communities and the primary health care workforce
attending those communities. A modern reflexive society connects inputs from the community, health
and government sectors to devise solutions to reduce risk. The study described in this thesis
synthesizes the perspectives of these three sectors to generate a model to address emerging
environmental problems. Environmental health management in Australia has been described as
fragmented, thereby increasing the vulnerability of Australians to environmental risks, and this thesis will
contribute to getting it right.

**Environmental Health: Its Place in Public Health Practice**

Observers announce that the relationship of the environment to public health is back in the spotlight
(Rosenstock L 2003). Two major 2002 publications emphasized linkages and relationships between
human health and the environment. The Institute of Medicine reports, "The Future of the Public's Health
in the 21st Century" (Institute of Medicine 2002), and "Who Will Keep the Public Healthy? Educating
Public Health Professionals for the Next Century" (Gebbie K, Rosenstock L et al. 2002), embrace
ecological conceptual frameworks and approaches that place the environment “where it rightfully belongs, central to public health research, practice, and policy” (Rosenstock L 2003).

When Rosenstock speaks of environmental health being “back in the spotlight”, she refers to the dislodgment of environmental health from its historical place at the forefront of public health thinking in the U.S. The environment, as a health determinant, had slipped into a perceived insignificance, as non-communicable diseases and sedentary lifestyles captured the public health imagination (Quinn MM 2003). Now, a new set of environmental conditions, and a deeper understanding of their consequences, are steering the environment back into public health focus in the U.S, and also across Europe. However, the question “Where lies environmental health in relation to public health practice in Australia?” returns a different answer. The two fields operate as distinct silos. Tony McMichael laments this exclusion of environmental perspective from health disciplines.

“There has been longstanding difficulty in achieving constructive engagement between the various key disciplines. Their discourses rarely mesh. In particular, few disciplines have yet internalized the relevance of the idea of environmental limits to their central intellectual discourse.”

(McMichael AJ 2003)

The significance that local environmental capacity holds for human health was evident from when humans established regular supplies of food and water through the advent of agriculture. By trading a nomadic existence for settlements and congregations of large numbers of people in close proximity to each other (McMichael AJ 2001), differentiation between what constituted healthy and unhealthy environments became readily apparent. The Minoans and Cretans demonstrated an understanding of the need for waste removal by constructing drainage systems and water closets as early as 3000 BC (Harper AC, Holman CDJ et al. 1994). The Romans had installed underground sewers by 6th century BC, aqueducts provided good water, and burials within the city walls were forbidden (Harper AC, Holman CDJ et al. 1994). It is important to note that these fundamental actions of environmental health must have been based on observations of the links to poor health, as they were introduced long prior to the identification of scientific causes, or an understanding of the biological basis for disease (Rotberg RI 2000). In effect, these activities are demonstrations of the precautionary principle in action.

Ancient understanding went deeper than merely recognition of the need for clean water, removal of wastes and rotting flesh. Many cultures also observed distinct patterns occurring in the health of people exposed to different environments; early Greeks and Roman physicians noted the poor health status of people who worked at certain trades (McCunney RJ 1994). Human interest in toxins generated an early knowledge about either the health giving, or toxic properties of regional plants. The earliest surviving
attempt to classify plants according to their toxic and therapeutic effects is ascribed to Dioscorides, a Greek employed by the Roman Emperor Nero circa 50 AD. (Hodgson E and Levi PE 1997).

Interest shifted from toxins to germs with the discovery of the germ theory in 1878 (Pasteur L (translated by Ernst HC) 1878; Abedon AT 1998). The first public health revolution was, in essence, an environmental health revolution, and evidence that the environment has subsequently faded from the public health radar exists in the term used for that paradigm, ‘the old public health’ (Kickbusch I 2003). The first Public Health Act was enacted in 1848 in the United Kingdom, in response to the environmental crisis occurring in the overcrowded and squalid conditions created by the rapid urbanisation during the industrialisation era, as documented by Chadwick’s seminal 1842 report titled ‘The Sanitary Condition of the Labouring Population of Great Britain’ (Godlee F and Walker A 1992). London’s population had increased seven-fold from 1790 to 1850. Growth and development had outgrown infrastructure, and infectious diseases, such as cholera, smallpox, and tuberculosis rebounded (Epstein PR 1997). Exploitative employment practices, with child labour, and hazardous workplaces exacerbated the health impacts of squalid living conditions (Yassi A, Kjellstrom T et al. 2001).

Chadwick’s report linked the significant health problems of the labouring classes to their unsafe human-induced environmental conditions, and identified relevant solutions to redress these, which were essentially, ensuring the provision of clean, water and effective waste disposal systems (Lawson JS and Bauman AE 2001). Notably, this precautionary enactment also occurred prior to an understanding of the underlying science, and John Snow’s now famous observations of the 1854 London Cholera outbreak, leading to the subsequent removal of the Broad Street pump.

The question arises then, ‘when and why was environmental health dislodged from its central place on the public health agenda?’ The answer lies in three great success stories. The first was improved living environments such as housing, hygiene, and food and water supplies, which were associated with technological advancements. The second, related to the first, is the growth in domestic wealth, at least for the industrialized world fortunate enough to be able to incorporate these advances into their daily lives. The third was the advancement of health knowledge and public health care services, such as vaccinations and antibiotics. These three factors led to significant extension of life expectancy by reducing early deaths from malnutrition, and exposure to squalid environments and contagious diseases. With these improvements in living conditions or living environments, public health attention then turned its focus to the contribution of individual behaviours, to non-communicable disease and premature death. This has been dubbed the ‘second public health revolution’ (Kickbusch I 2003).
Agricultural and Veterinary Chemicals: An Emerging Environmental Exposure Hazard

Access to a reliable and varied source of food has been a fundamental necessity for good health through the ages (McKeown T 1979; Diamond J 1998; McMichael AJ 2001). This entails having access to all food groups, in sufficient quantity, wholesome in quality (fresh and nutritious), and which are widely available and affordable. To ensure affordability, foodstuff production has evolved into an efficient industry with economies of scale, yield reliability, and fast transportation to markets. All year supply is managed through refrigeration and storage processes to prevent diminishing produce quality. Chemicals are applied throughout these pathways to achieve this aim. The global use of pesticides has played a significant role in this process, and therefore can be credited with a proportion of the greater human longevity seen over recent decades. AgVets increase yield or production, and as agriculture is a competitive industry, pesticides in particular have become highly valued by farmers as a vital tool enabling Australian agriculture to survive and prosper in competitive world markets.

Agricultural and veterinary chemicals involve all those agents that are used for animal health and horticultural production. ‘Pesticides’ include agricultural and household chemicals such as repellents, insecticides, herbicides and fungicides. They are by definition biocidal, and are designed for the specific purpose of destroying organisms which share many human biological pathways (Melville J 1989). It is inevitable that contact with these agents also harms human health. Veterinary medicines include all veterinary chemical products such as vaccines, antibiotics, growth promotants, worming treatments, and flea and tick washes, and other parasiticides for both domestic and production animals (APVMA 2003).

Pesticidal control of vector borne disease, such as malaria, has also bought significant global health benefits. Initially pesticides were hailed as ‘miracle chemicals’, capable of ensuring global food sustainability, and reducing disease burden (Radcliffe JC 2002). Over recent years however, evidence has emerged on the human health costs, and ecosystem damage, bought about by chronic exposure (Bowers WJ, Nakai JS et al. 2004). These costs are now being weighed against their benefits, and the once revered reputation of pesticides has diminished (Smith C 2003).

The principal forms of pesticides used extensively in Australia can be categorised into insecticides, herbicides, fungicides and growth promotants. Based on sales data, reliance on pesticides is increasing, forming a higher proportion of input costs despite growing awareness of their hazardous nature. In a review of pesticide use in Australia for the Australian Academy of Science (Radcliffe JC 2002), Radcliffe
documents the exponential rise in AgVet utilisation since their introduction in the late 1940s, and states the Australian crop protection market expanded from just over $1100 million on 1996 to just under $1600 million in 1999. This represents a 40% increase or just over 10% per year.

Currently, the most extensively used pesticide in Australia today is glyphosate, a broad spectrum, non-selective posto emergence herbicide with high activity on virtually all annual and perennial plants. Annual sales approach 15,000 tonnes per annum. The next most widely used herbicides are atrazine and simazine, the herbicide 2,4-D and its derivatives are plant cell growth disrupting chemicals. The most widely used group of insecticides in recent years have been the organophosphates, which include parathion methyl, chlorpyriphos, dimethoate, profenfos and diazinon (Radcliffe JC 2002). These replace the highly toxic organochlorines, but many of these newer agents are also extremely hazardous to human health.

**Environmental chemical exposures**

The exponential rise in the development and widespread application of chemicals means that chemicals now pervade all environments on the planet (Pimental P, Tort M et al. 1998). Body burdens of chemicals such as dioxins, methyl mercury, polychlorinated biphenyls (PCBs), and a range of the “usual suspects” are the increasingly represented norm rather than the exception in studies in the U.S. population (de Rosa C 2003; Stokstad E 2004).

Conservative estimates suggest that more than 10 million chemicals have been identified, 100,000 chemicals are registered for use in Europe (European Commission 2003), and 10,000 individual substances are involved in the production of a car (Diamond J 1998). These 100,000 registered chemicals include pesticides, industrial manufacturing products, pharmaceuticals, the by-products of these substances and more, with 3,000 more being introduced each year (Weiss B and Landrigan PJ 2000). Of these new agents, only 43% have received even minimal toxicologic assessment, and Landrigen states a mere 23% have been tested to determine whether they have the potential to cause developmental damage (Landrigen PJ 2000), whereas others claim this figure is as low as 14% (Bowers WJ, Nakai JS et al. 2004). Around 30,000 of these products have never undergone serious public testing. Continued utilisation of these untested chemicals therefore constitutes, in effect, a vast toxicologic experiment on society, and especially upon children (Weiss B and Landrigan PJ 2000).
This widespread use of chemicals, and their presence in food and in the environment is generating an increasing concern that exposure to these chemicals, acting individually and in combination, may be associated with an increasing array of serious health problems (Carpenter DO, Arcaro KF et al. 1998; EPHC National Chemicals Taskforce 2003). Of all chemicals groupings, AgVets comprise some of the most hazardous agents in current, and past, usage (Harden F, Müller J et al. 2005).

**Chemical exposure links to poor health**

Numerous studies establishing a link between an increased risk of cancer and particular working environments were published between 1950 and 1975 (Monson R 1996). However, the first cases of occupational cancer were identified in the late 18th century, when a high incidence of scrotal cancers was found occurring among chimney sweeps, and later, high rates of bladder cancers were noted among workers exposed to dyes in the 19th century (Stewart BW and Kleihues P 2003). Currently, worldwide, 12% of deaths are from cancer, and in industrialized countries, more than one in four will die from the disease (World Health Organization 2002). The global burden of cancer continues to increase, beyond the expected increase from the effect of ageing of populations. The doubling of risk in affluent societies is attributed to the combination of the earlier onset of the tobacco epidemic, the earlier exposure to occupational carcinogens, and the western diet and life style (Brundtland GH 2003).

Environmental exposures to chemicals have also been implicated as contributing to the rise of many other human disorders. The Agency for Toxic Substances and Disease Registry (ATSDR) reported that 76% of the top 50 substances in the 1997 priority list of Hazardous Substances were capable of causing cancer, 54% produced neurotoxic effects, and 56% caused developmental effects in offspring (Hansen H, De Rosa CT et al. 1998). Australian rural populations experience elevated rates in all these health problems (Australian Institute of Health and Welfare 1998).

The World Health Organisation (WHO) estimates that pesticides are causing each year about 300,000 cases of illness and 20,000 deaths worldwide, including only the acute effects (Committee on the Environment and Public Health and Consumer Policy 2002). Long term health effects resulting from chronic exposure is poorly monitored, but it is recognized that effects are diverse, frequently severely incapacitating, and widely felt (Kay D, Prüss A et al. 2000). The Ontario College of Family Physicians conducted a systematic review of the impact of pesticide exposure on human health, and found substantial evidence linking exposure with a range of serious effects, including a range of cancers (Sanborn M, Cole D et al. 2004), and these are detailed in Chapter 2.
Australia has one of the highest rates of asthma in the world, and rates continue to rise (Australian Academy of Science 2004). Asthma is a complex disease that is still not fully understood (Landrigen PJ, Schechter CB et al. 2002). Between 1982 and 1992, the prevalence of recent wheeze increased 1.5 fold to about 25% in children aged 8-10, and the prevalence of airway hyper responsiveness increased twofold to almost 20% of children in that age group. That research concluded that the increased airway abnormalities identified were due either to higher allergen levels, or exposure to environmental factors (Peat JK, Van Den Berg RH et al. 1994). The study noted that numbers of house dust mites increased fivefold during study, however asthma incidence does not follow house mite density (Australian Academy of Science 2004), which suggests causation from other environmental factors. Pesticides are known to cause asthma (Midtling JE 1999).

It has now been established that over 350 substances encountered in the workplace cause adverse effects on the airways and lung parenchyma, resulting in occupational asthma. An increasing proportion of these are respirable organic dusts and chemicals (Hendrick DJ, Burge PS et al. 2002). Several recent epidemiological studies have contributed to a better understanding of the effect of the interaction between cigarette smoke and occupational exposures in the causation of benign and malignant airway disease. This expansion in knowledge of possible occupational and environmental causes of interstitial lung diseases presents a new challenge to health care provision and health surveillance. These diseases were previously thought to be idiopathic. The amassing evidence of this anthropogenic causation of disease states demands an adjustment in approach to disease management and prevention strategies is required by health providers and policy planners.

That the WHO and other leading health experts stress that AgVet exposure comprises a significant health risk makes the issue of AgVet exposure a serious public health concern warranting closer examination in the Australian context.
International Response to Chemical Hazards

Whilst environmental tragedies of climate change, species extinction and deforestation have marked every period of human history, the rapidity of today's environmental degradation driven by population growth and industrialization is creating an unprecedented global crisis (The World Commission on Environment and Development and Commission for the Future 1990; WHO 1997; UNEP 2002). In 1992 the *World Scientists' Warning to Humanity* was endorsed by more than 1600 scientists from 70 countries, among them 104 Nobel laureates, including most of the science prize recipients. The warning cited clear evidence that for the first time, human beings are altering the basic operations of the Earth's atmosphere, geosphere and biosphere (Union of Concerned Scientists 1992).

In 1962 Rachel Carson alerted Americans to the dangers for migratory birds caused by pesticide runoff (Carson R 1962). The title of her book, *Silent Spring*, made reference to the absence of the chorus of birds in springtime. Carson highlighted the far reaching impacts of heavy reliance of pesticides by drawing attention to bioaccumulation within species distant from the point of application, and of the resulting resurgence of plant-eating insects that had evolved a resistance to pesticides (Epstein PR 1997). Prior to that publication, the environment did not feature highly on the American public agenda. Smog had caused some problems, conservationism was in its infancy, and excluding obscure scientific journals, virtually no public dialogue existed about the dangers of DDT and other chemicals (Gore A 1994)

Carson’s landmark book is credited with generating the environmental movement. This and other important publications following in the 1960s further fuelled the rising global environmental consciousness (Boulding KE 1966; Mishan EJ 1967; Meadows DH, Meadows DL et al. 1972). Throughout the 1970s and 1980s, there was a rapid growth in community-based environment organisations. The movement gained sufficient momentum to influence government decisions in many countries (Diesendorf M and Hamilton C 1997), and led to an institutionalisation of environmental concern in business and governments (Gore A 2000).

In June 1972 the United Nations hosted the Conference on the Human Environment in Stockholm, the first of a series of international conferences to have a broad agenda covering virtually all aspects of the environment and human actions affecting it (Aplin G, Beggs P et al. 1999). The 1972 conference adopted a declaration on the Human Environment and Action Plan containing 109 recommendations. These were the precursors to the Earth Summit in Rio de Janeiro, from which came the Rio Declaration

This rise in international environmental attention occurred amidst an ongoing series of environmental ‘disasters’, and ever-increasing scientific evidence of the gradual creep of environmental degradation. With global human population now exceeding 6 billion, and intensification of industrial activity, the environment is now displaying signs of stress (Yassi A, Kjellstrom T et al. 2001). The long standing human – environment interface has metamorphosed to pose a new range of hazards to human health, quite distinct from those prompting that 1848 Public Health Act (United Nations Environment Programme 2002). Amidst such dire warnings, continued separation of the primary health care workforce from environmental health practice leaves communities vulnerable, and invariably it is the disadvantaged who bare the brunt of environmental injustice (Satterfield TA, Mertz CK et al. 2004).

That these environmental pollution catastrophes have not occurred on Australian soil meant their direct impact on the lives of Australians has been minimal. At the disaster sites, however, community outrage has erupted once the devastating effects began to be realized, and the shortfalls in health system responses became apparent. This widespread community concern prompted an urgent need for government action (Gochfield M 1998), as people demanded political commitment to avert future scenarios, and ensure that their health systems were able to cope with such incidents (Bryant RL and Bailey S 1997). Populations adopted an environmental consciousness, and the flow-on effect was a community expectation that national health care systems are capable of responding effectively to disasters, and are able to also promptly identify and manage less catastrophic events, such as the insidious effects of slow contamination. By comparison to international responses, it appears that Australians have been slow to recognize that we live in a new era of environmental hazards (Karlen A 1995).

**Australia’s Response to Chemical Hazards**

A key feature of Agenda 21 is the precautionary principle, which states:

"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”

Europe and the United States have adopted the precautionary principal, Australia has not. Chapter 3 outlines responses to emerging environmental health problems taken by Europe and the United States, and outlines the Australian chemical management infrastructure.

Despite exponential rise in utilisation of AgVets, weaknesses existing in the AgVet chemical management framework in Australia exacerbate human exposure risks according to several recent reports. The Radcliffe Report revealed that due to a lack of a detailed surveillance system on the extent of AgVet utilisation in Australia, it is difficult to determine past and current trends in application of pesticides, (Radcliffe JC 2002). No data exists on the quantities of the active ingredient (that chemical component of the pesticides formulation which is biologically active), or the formulated products (the form in which the pesticide is prepared for commercial sale to potential users) that are applied (Allen Consulting Group 2002). Also unavailable is any mapping data on where AgVets are applied. Communities have a right to know what chemicals exist in their local environment.

The Australian Pesticide and Veterinary Management Authority (APVMA) is the national body which registers and regulates AgVets up to the point of sale. APVMA decisions to allow specific AgVets onto the Australian register are based on assessments of the level of safety when they are used in accordance with the guidelines. There is currently little information about the degree of safe usage of these chemicals, or of the impact on the health of individuals involved, and studies indicate that strict compliance with such guidelines is rare (Franklin RC, Brown P et al. 2001). Ensuring adherence to specified guidelines for safe application falls under State jurisdiction. The Radcliffe report also identified shortfalls in compliance monitoring systems managed by the various state-based authorities (Radcliffe JC 2002). The inference was that in the absence of effective monitoring, widespread unsafe usage of these hazardous agents is very possible. This further exacerbates health risks for rural communities.

Australia’s health intelligence system is complex and rates well in comparison with other countries (Australian Medical Workforce Advisory Committee and Australian Institute of Health and Welfare 1998). National data is collated for a wide range of notifiable diseases, and registries exist for birth disorders and cancers, including mesothelioma (NOHSC 2002). However information relating to environmental health remains scant. National surveillance exists for inpatient data, and emergency presentations, but these do not capture information useful for tracking exposure related conditions. Occupational health and safety data omit chronic exposures and are biased towards conditions requiring several days away from the paid labour force. This usually excludes farmers. Environmental health monitoring in Australia is therefore extremely limited.
The absence of environmental health surveillance exacerbates the need for an astute primary health care workforce, and drives the need to develop a primary health care workforce model which can address the emerging problems of environmental exposure impacts on human health. To date, efforts towards maintaining environmental health in Australia have remained fragmented. ‘Environmental health’ is broadly interpreted as environmental protection, and separate to public health (Leggat P 2003). The work is the domain of Environmental Health Officers (EHOs) employed through local governments. EHOs are responsible for managing roads, cemeteries, sanitation, drainage and waste removal, operating within this paradigm of environmental protection. Within the health sector, the focus of environmental health activity in Australia remains largely restricted to occupational health and safety issues, with safety forming the principal component. Diseases resulting from workplace chemical exposure has been largely overlooked (Franklin RC, Brown P et al. 2001). Environmental health training within health curricula is minimal, as will be discussed in Chapter 4.

Concept of Risk

The concept of risk has attracted broad attention from several sectors (psychology, engineering, finance, public health and others), emerging as a distinct field of enquiry, and focus of several journals. To give justice to the components of risk associated with exposure to AgVet chemicals would require a dedicated risk study in order to explore all inherent facets impinging on this issue. However, whether AgVet exposure is viewed as hazardous by users, community members and health providers is central to this thesis, as is the degree of risk that AgVet users and their neighbours are willing to accept. Interview questions gave significant emphasis to their perceptions of risk.

Also integral to this study is the risk assessment approach adopted by the institutions responsible for protecting the public’s health from chemical hazards. The APVMA authorizes which AgVets may be used, on which crops, and sets the national guidelines and concentrations for use. The Chemical Standards Branch (CSB) of the Department of Primary Industries (DPI) is the Victorian authority which governs compliance with the APVMA standards. The role of health departments is to determine what health services shall be offered to address specific health care needs. Ulrich Beck challenges the notion that the activities of institutions responsible for public protection, such as these three key players, are based on their assessment of risk. In his description of a new “Risk Society”, Beck speaks of ‘organized irresponsibility’ on the part of institutions, which in this case would also include chemical manufacturers who produce, and others who legitimize hazards which they cannot control, and nobody takes
responsibility (Beck U 1998). Beck elaborates on his thesis of ‘organized irresponsibility’ by further arguing that dangers are produced by industry, externalized by economics, individualized by the legal system, legitimized by the sciences and then made to appear harmless by politics. Consequently, the paradox emerges that when threats and hazards become more dangerous and more obvious, they simultaneously slip through the net of proofs of systems designed to attempt to capture them. The response of the APVMA, CSB, and health sector to the issue of AgVet exposure will be briefly examined.

**Rationale for the Study: Project Significance**

The World Health Organization (WHO) estimates that globally, 23% of all disability is currently due to “environmental exposures”, and for industrialized countries, this figure is estimated to be 20% (Smith KR and Desai M 2002), and warns the world is facing an unprecedented health and environmental crisis (Hallstrom N 2000).

The Victorian Department of Human Services (DHS) predicted changes in health patterns between 1996 and 2016, this Victorian Burden of Diseases Study (Vos T and Begg S 1999), implicated social, economic, lifestyle, environmental and behavioural characteristics acting in concert as the principal causative factors of Victoria’s ill-health. Both this and the Social Health Atlas study acknowledged limitations in their analysis due to the scale of their studies, as aggregation of data in these large population studies results in loss of area or ‘locality’ effect (Glover J, Harris K et al. 1999). Therefore local ‘hot spots’ of disease clusters could not be identified, additionally, these studies did not include any specific questions relating to environmental impact on human health.

The Victorian Burden of Disease study predicted that the major disease burdens in the future will be from chronic non-communicable disease (Mathers C, Vos T et al. 1999). The study concurred that continued environmental changes will increase health risks, and stressed that cooperation is required between the health, environment and economic sectors to minimize health risks due to environmental hazards. Whilst many isolated studies have now demonstrated a burden of risk exists (Ashford N and Miller C 1998; Mathers C, Vos T et al. 1999), little data exists to provide evidence of the prevalence of the actual burden of chemically induced ill-health in Australia. The National Environmental Health Strategy (NEHS) also recognizes that the actual environmental impact on health of Australian populations remains unknown (enHealth Council 1999).
The Health Risk Perception in Australia study conducted for the enHealth Council, revealed 71% of the Australian population believes their existing environmental health risks are moderate or greater (Starr G, Langley A et al. 2000). The NEHS stressed the potentially substantial impact of the environmental burden will be disproportionately distributed towards the most disadvantaged in our society (enHealth Council 1999).

Australia’s rural and remote populations experience poorer health than their metropolitan counterparts as measured across several health conditions (Australian Institute of Health and Welfare 1998). The proportion of Victorians living in areas defined as ‘rural’ (population < 10,000) is 14%, but unlike the rest of Victoria, life expectancy in these areas has declined in recent years for both males and females (Public Health and Development Division 1999). The reason for this trend is currently unknown, and therefore warrants investigation.

A proportion of the lower life expectancy rural Australians can be attributed to known risk factors of tobacco and alcohol consumption, diets high in dairy products, and in general, figures reflecting lower socio economic status across other parts of Australia (Australian Institute of Health and Welfare 1998). Another component is attributed to the higher proportion of indigenous peoples residing in rural areas. However these do not explain the full differential (Australian Institute of Health and Welfare 1998). Some other factors are clearly at work. Given the increasing evidence linking exposure to AgVet chemicals with serious health consequences, it is possible that chronic exposure to AgVet chemicals is a significant contributing factor to the deterioration of rural health. Australia’s preparedness, in terms of having a skilled primary health care workforce, and effective system of monitoring of environmental health issues, has been questioned.

**The Research Problem**

Australia has, to date, been relatively fortunate compared to other countries in that Australia has experienced few anthropogenic environmental disasters. Environmental catastrophes such as Love Canal or pollution of the Great Lakes in the US, or events elsewhere such as Saveso, Minamata, Chernobyl, and Bhopal have not occurred on Australian soil. Therefore no overt political driver has hitherto forced an examination of the primary health care workforce, and public health infrastructure with reference to environmental health. It is, however, significant to note that the countries which have
experienced such disasters have responded by mobilising their public health workforce and infrastructure to address emerging environmental issues (Gebbie K 1999).

Australia currently faces multiple environmental pressures, and preparedness may be compromised by shortfalls existing in its primary health care workforce to respond to a wide range of environmental health issues. The unique characteristics of the Australian continent demand intensive intervention to remain self sufficient in food, and to maintain international competitiveness of its large agricultural sector. Reliance on AgVet chemicals can therefore be expected to persist. The poorer health status of rural Australians cannot be explained by known health determinants, but we do know that exposure to AgVets is associated with a range of harmful health effects. Therefore exposure to AgVets was selected as an exemplar to highlight any modifications required by the primary health care infrastructure.

**Research question**

The research question asks how well does the Australian primary health care system address emerging environmentally induced ill health?

**Research objectives**

This research question raises a series of subsidiary questions, and they form the main research objectives.

- Does environmental health fit into public health and the primary health care system?
- Does evidence exist to indicate that exposure to AgVets constitutes a serious health risk?
- Is the AgVet exposure level of rural Australians potentially hazardous to their health?
- Do rural people attribute their own ill-health to AgVets exposure?
- What has been their experience when interacting with the existing primary health care system?
- How does the existing primary health care workforce perceive environmental health problems facing their patients and clients?
- What health intelligence exists in Australia about environmental exposure to chemicals and AgVets in particular?
- How does the AgVet chemical management framework protect Australians?
The final object of the study was to identify strategies which may enable the primary health care system to effectively identify and respond to emerging environmental health issues. In addition to determining how the Australian primary health care system currently addresses environmental health issues, this study also sought to make recommendations as to what workforce model would fit with Australia’s existing infrastructure. Community members were asked whether they would consider seeking advice and health care from a range of health provider options. Health providers were also asked to suggest a suitable workforce model.

**Methodology**

The public health approach to health problems looks at the underlying systems contributing to the disorder; this often involves the conduct of an integrated assessment. This method is defined as

> “... a method of analysis that combines the results and models from the physical, biological, economic, and social sciences, and the interactions between these components, in a consistent framework to evaluate the status and consequences of environmental impacts and the policy responses to it.”

(Cromar N 2004)

This thesis presents an examination of how Australia is responding to environmental health risks in general, and AgVet exposure in particular. The examination integrates physiological health impacts known to occur after exposure to AgVets, an assessment of the risk confronting Victorian rural communities, an assessment of the capacity of the primary healthcare workforce to address exposure concerns, the economic and social drivers which lead to the high utilisation of these agents, an evaluation of the existing infrastructures responsible for maintaining human health, and closes by suggesting policy responses. It is the integration of all the socio-political, behavioural, and environmental determinants that provides the deep contextual understanding of the nature of the problem.

A multi-method strategy was designed to address the research question. The project comprised five components.

- Literature review - An extensive literature review was conducted to explore the available evidence linking human health impacts with exposure to AgVets.

- Analysis of health data capture and routine reporting to the Department of Human Services - to ascertain the level of environmental health intelligence available to policy makers and planners.
• Examinations of existing Australian AgVet management frameworks and environmental health data capture systems in place, plus the rural socioeconomic and physical environment, and the primary health care system.

• Telephone survey - The two rural Victorian communities were surveyed via telephone interviews using CATI (Computer Assisted Telephone Interview) methodology via random digit dialling. A total of 1050 surveys were completed to ascertaining whether Australian rural communities were at risk from AgVet exposure, community exposure patterns, community understanding of health risks posed by AgVet exposure, personal protection behaviours, whether they attributed some of their own family’s ill-health to chemical use, and their experience of encounters with the primary health care system. Additional targeted interviews were held with specific groups such as tobacco growers, orchardists, and fruit pickers.

• Semi-structured interviews and focus groups were conducted with regional primary health care providers: general practitioners, community health staff, and private providers, such as naturopaths. Environmental health officers were also interviewed. Information was sought on familiarity of health care providers with AgVet chemicals used locally, understanding of their associated health impacts, plus professional engagement with exposure related ill-health.

Conclusion

Environmental health was once the core of public health, yet the two fields diverged as living conditions improved in industrialized nations. This lead to a waning of the view that the environment posed a major health threat. However, with increasing anthropogenic activity has resulted in new environmental health threats emerging. Exposure to AgVets is highly relevant to the health of Australians, making this issue a suitable candidate to be an exemplar for testing how Australia’s public health infrastructure and primary health care workforce respond to contemporary environmental health issues.

Workforce and programme planning must be evidenced based. The information gathered during this study will support health workforce and programme planning to ameliorate the negative health impacts of human exposures to AgVets, and provide a basis for improving the environmental health infrastructure within Australia. A lack of environmental health intelligence and engagement by the health care
workforce has been widely acknowledged, yet to date, few studies have explored this issue. This study therefore is a timely addition to the public health knowledge base.

To achieve this, an assessment of health needs is required, and to move towards a solution, a detailed exploration of background factors contributing to this complex problem is also necessary, so that the multiple components of this problem can be integrated and analysed in context. This background material is presented in the next three chapters.

The study therefore incorporates environmental and socioeconomic ingredients, plus an examination of the legislative and policy frameworks which drive the exposed patient – practitioner interaction. Health risks posed by exposure to AgVet chemicals are presented as a literature review in Chapter 2. An examination of environmental health services and infrastructure currently operating Australia, and reviews recent developments in Europe and the U.S. is given in Chapter 3. Chapter 4 presents a summary of factors fundamental to the current situation, such as rurality, the perceived need for AgVets, examination of current rural primary health care service infrastructure, and the environmental health skills of the existing workforce.

The methodological approach adopted to examine this research question is then described in detail in chapter 5, and chapter 6 profiles the communities studied, their agricultural activities, and their attending primary health care workforce. Analysis of the findings from the community survey is given in chapter 7. The provider’s perspectives are described in chapter 8, and the final chapter (9), synthesizes these results and offers recommendations.
CHAPTER 2
EXPOSURE TO AGVETS:
A REVIEW OF HUMAN HEALTH EFFECTS

Introduction

This study asks how well Australia’s primary health care workforce addresses environmental health problems. Australia is facing a range of environmental health threats, so testing of this question required an exemplar, and the impact of agricultural and veterinary chemicals (AgVet) exposure on human health was selected. Australia’s agricultural industry is significant to the economy, yet the producers suffer relatively poor health. Recent sales of AgVets in Australia have grown exponentially, and a growing body of evidence is emerging that links the application of AgVets with negative ecological and human health effects. The chapter begins by looking at global reliance on AgVets, and the forces driving the ongoing heavy utilisation of these agents, despite the widespread awareness of their hazardous nature. This is followed by an examination of AgVets, predominantly pesticides, their intended role, their fate in the environment, and pathways of human exposure. The current literature describing the toxicity of these agents is examined in some detail across a range of health conditions, giving attention to vulnerable groups, and certain classifications of chemicals of special significance. The chapter concludes with a review of the exposure events documented in Australia, and discussion of the implications.

Literature Search Strategy

The strategy adopted to search the available literature on human health hazards associated with exposure to AgVet chemicals occurred on several layers. Initial search strategy involved MEDLINE and other electronic databases such as CINAHL in addition to searches of published theses. This later expanded to include personalized alerts of new publications from organisations such as the American Public Health Association, and direct alerts from specific journals which focussed on environmental research.

The search was limited to publications in English, relating to human health, excluding those that reported contamination of Australian environments. Articles were retrieved from the La Trobe University Library resources, or interlibrary loans, and delivery service. Much of the literature is now published online. Articles that were not accessible through any of these methods were sought directly from the authors, which achieved a high rate of success. The field is relatively new so there was no need to place
recency limits on the search, although it was generally found that publications in the past 10 years were most suitable.

Literature relating to this issue now appears in many formats. The intent of this chapter was to present the studies assessing harm attributable to AgVet exposure. This necessitated accessing primary sources and research articles. Therefore articles were principally sourced from peer reviewed journals such as Environmental Health Perspectives (published jointly by the United States National Institute of Health, the National Institute of Environmental health, and the U.S. Department of Health and Human Services), and Toxicological Letters (published by Elsevier Science). Numerous other peer reviewed journals also generated material used in this search. Others sources included reports from various government departments and agencies were deemed as reliable sources of factual information, so were also frequently cited. These emanated internationally, such as the United Nations Environment Programme, Centers for Disease Control, and from Australian organisations such as the Australian Academy of Science.

The literature review benefited from the publication in April 2004 of two major systematic reviews of human health effects of exposure to pesticides. They were published by Alavanja (in the Annual Review of Public Health), and Sanborn (for the Ontario College of Family Physicians).

Articles purporting to demonstrate associations, or lack thereof, were evaluated on the basis of methodological rigour. Randomized controlled trials are rare in this field due obvious ethical restrictions preventing intentionally exposing subjects to these agents as they are intended biocidals. Instead, the literature largely consists of epidemiological studies of exposed populations using non-exposed similar populations as controls. These consisted of longitudinal studies, case controls and cohort studies. Some found no association of ill-health, although, as noted by the Sanborn and Alavanja systematic reviews, many of these were funded by chemical manufacturers, and had methodological flaws, and so were excluded.

**Global reliance in Agricultural and Veterinary Chemicals**

With only a 10% increase in the area of cultivated land, the world has doubled food production in the past 35 years, more than keeping pace with population growth (American Association for Advancement of Science). This enterprise, dubbed the “green revolution”, has largely been attributed to a combination of new crop varieties, increased chemical inputs to fields and the extension of land under irrigation. With
these gains in food security, world populations have continued to rise. Sustainability of this increased output has been questioned in light of the evidence of the associated environmental degradation, and rising human health concerns about the safety of the AgVet chemicals used (Pimental P, Tort M et al. 1998).

The chemical agents attracting most public health concern from AgVets are the pesticides, endocrine disrupting chemicals (which in the agricultural settings are mostly hormone growth promotants), and antibiotics. Of these three major groups listed above, it has been pesticides that have persistently attracted the greatest attention worldwide. Accordingly, emphasis throughout this study is given to the impact of pesticides on human health, although the principles of health risks giving rise to a need for monitoring and appropriate health sector response remain applicable to the other chemical categories.

Antimicrobials are administered to feedlot livestock as growth promotants, rather than to specifically treat disease. These have been implicated in contributing to the rise in antibiotic resistance in human infections (Aarestrup FM, Seyfarth AM et al. 2001; Helig S, Lee P et al. 2002). Compared to their use in the U.S., Australia places greater restrictions to their range of use, and further limitations were introduced in 2004 (APVMA 2004; APVMA 2004). The mechanism of risk presentation to human health lies via a complex pathway involving herd immunity, resistance and microbial mutation. Risk minimization relates primarily to limiting registration of these agents for broad-scale non-therapeutic usage. As there is little role here for the primary health care workforce, these agents are considered outside the scope of this study. The hormone active agent group, referred to throughout the literature as endocrine disrupters will be covered briefly in this chapter.

The use of chemicals in the U.S. increased from approximately 3500 kg per person per year in 1941 to more than 10,000 kg per person per year in 1995 (Pimental P, Tort M et al. 1998) The widespread use of synthetic chemicals in agriculture began in the 1930’s with U.S. figures indicating 32 registered pesticides at the end of that decade (Environmental Protection Agency - USA; Environment Australia 2003). This figure has now risen to 16,000 pesticide products involving over 1,000 active ingredients (NIOSH; O’Malley M 2004). In Australia over the four decades from 1950-90, the value of farm output increased 250 per cent, the highest rate of growth of any Organisation for Economic Cooperation and Development (OECD) country. This was largely due to AgVets (Radcliffe JC 2002). Precise utilisation figures are not available for Australia, however, based on sales data, the Australian crop protection market has been increasing over 10% per year forming a higher proportion of input costs (Radcliffe JC 2002). It is estimated that today more than 132 million kilograms of pesticide products are used each
year in Australia (APVMA 2004; APVMA 2004), this is over 6.6 kilograms per capita (OECD Environment Directorate 2002), and more than 6,000 pesticide products are currently registered (Kookana R and Correll R 2002).

Global sales of pesticides stood at $US 31 billion in 1998. Economic pressures continue to drive reliance on AgVet chemicals, over-riding the broad public awareness of their harmful properties. Between 1990 - 1998 Germany pesticide sales increased 5 fold (European Commission 2003), and in Australia the crop protection market continues to increase 10% per annum (Radcliffe JC 2002). The worldwide market (US$31 billion in 1998) is predicted to further expand another 20% over the next five years (Committee on the Future Role of Pesticides 2000), with the United States accounting for one third of the total sales (Committee on the Future Role of Pesticides 2000). European enterprises produce 31 per cent of the world’s chemicals (US 28 per cent), and the European Union’s (EU) chemical industry is the third largest manufacturing industry with 1.7 million jobs, and provides indirect employment of a further 3 million people, with an annual turnover greater than US$600 billion (Wallström M 2004).

Figures released by the U.S. Environment Protection Authority (EPA) Toxics Release Inventory (TRI), which profiles local pollution sources, indicate that over 2.8 billion kilograms of toxic chemicals are released into the nation's environment each year, including 35 million kilograms of recognized carcinogens (Scorecard 2001), and almost one billion kilograms of neurotoxics (Environmental Defence Fund 1997), making the United States the largest single producer and user of these products in the world (Soloman G, La Dou J et al. 2004). It is not surprising then that through their enthusiastic embrace of pesticides, the impact of pesticide usage on the environment and human health became apparent relatively early in the U.S. Much of the literature presented here therefore emanates from the U.S., as comparatively little research on this issue has been conducted in Australia.

**Drivers of pesticide utilization**

The competitive nature of global markets exerts intense pressure to produce food and fibre commodities at the lowest possible cost, with maximum productivity, using best available technologies. This pressure has been intensified by increasing global human population over recent decades. It has driven the demand for more food production, and generated the trend towards larger farms and specialization via monocultures (American Association for Advancement of Science). Farming patterns using monoculture (the cultivation of large areas of a single crop) restrict genetic and species diversity, which renders plants more vulnerable to pests and disease (Epstein PR 1997). In stable naturally diverse ecosystems, larger predators fare well and keep the smaller, opportunistic species in check. But opportunists can readily
colonize overly-stressed environments, just as opportunistic infections can invade patients with weakened immune systems (UNEP 2002). From the perspective of the pests that thrive on that food, monocultures provide concentrations of an abundant food supply. The move towards monocultures has created the inevitable rapid growth in opportunistic pest populations, and hence this trend was paralleled by the rapid expansion of the crop protection market.

Since the onset of the green revolution, worldwide annual pesticide usage grew to 2.5 billion kilograms by 1999 (Radcliffe JC 2002). The American Association for Advancement of Science calculated that population growth accounted for only 14 to 18 percent of the increase in pesticide use (American Association for Advancement of Science). The underlying problem with pesticides is that they are, by design, toxic and biocidal. They are designed to kill organisms that share many biological pathways and physiological processes with non-target species in the agro-ecosystem, including humans (Dewhurst IC 2001). It is not surprising then, that whilst pesticides have been used with great success for many years to manage specific pests, they have also had significant unintentional impacts on the health of wildlife and humans.

The significance of the impact of pesticides on non-human biota cannot be overlooked. Pesticides place the ecological role of native plants, birds, fish, beneficial insects and other wildlife at risk. Bees, for example, pollinate one-third of all the food we eat, and ladybirds can eat hundreds of aphids a day, making these species important bio-controls for many crops (Canadian Public Health Association 2002). AgVets disrupt the life cycle of these natural biological controls, allowing pests to prosper, further driving the inferred need for more pesticides. Continued heavy reliance on synthetic and persistent pesticides can, by disrupting our food web, pose a serious threat to our long-term food security (Short C, Nielson P et al. 2002).

AgVet Chemicals in the Environment

Pesticides: What they are, how they work

The word ‘pesticide’ has been in common parlance for over a century (Committee on the Future Role of Pesticides 2000), and are commonly referred to by their functional class for the organisms that they are designed to control (e.g., herbicides, insecticides, or fungicides). Pesticides may also be grouped by their chemical class (e.g., organophosphate insecticides or triazine herbicides) (Helig S, Lee P et al. 2002; Alavanja MCR, Hoppin JA et al. 2004). Yet there is no biological validity in the definition of ‘pest’.
Simply put, a pest is any organism that appears in a place where it is unwelcome to humans, and historically, insects and pests have been one of the major causes of human mortality and misery. Insect vectors transmit a number of diseases, and they create havoc by consuming crops, spoiling foodstuffs, and causing damage to buildings. Insects and pests therefore compete with humans, and hence the battle between humans and pests is an ancient one dating back millennia. The craft and science of pest control throughout the ages have therefore been highly valued.

**Pesticides in the environment**

Whereas agricultural usage of pesticides is by far the most widespread, and in industrialized countries, accounts for 70% of total pesticides used (Epstein PR 1997), they are also widely applied across a variety of settings. Local governments use pesticides to maintain grassy areas near highways, parks and recreation areas, and also to limit weed growth around power transmission lines, railroad beds and road signs. Government agencies are also responsible for controlling mosquito and rodent populations, and the treatment of drinking water, all of which employ the use of pesticides.

Private usage of pesticides is also growing; 82% of U.S. households use pesticides; 50% use weed killers; and 50% use flea treatments (Schettler T, Solomon G et al. 1999). The management of golf courses, sport fields, domestic and commercial lawns also involve extensive use of pesticides (WorldWatch Institute 2004). Hence urban populations are also at risk of exposure. The issue of human exposure risk is not only one of the pervasiveness of these products, but also the application techniques. Application rates in non-agricultural areas can exceed agricultural rates manyfold, for example chemical application on golf courses is up to six-fold agricultural usage (WorldWatch Institute 2004). A Canadian study revealed that homeowners frequently, and inappropriately, use 10 times more pesticides per acre than farmers do (Canadian Public Health Association 2002). The Chemical Users Program conducted by the South Australian EPA found urban Australians are similarly applying chemicals at strengths up to ten fold the recommended concentrations (Riggs J, Taylor G et al. 2004). The AgVet regulatory authority in Australia suspects this overdosing is common, and this also highlights a need for chemical education programs for metropolitan people, hobby farmers and rural town dwellers (APVMA 2003).

Irrigation is regarded as an important mechanism affecting pesticide transport and subsequent accumulation in sediment, surface water bodies, and aquatic organisms (Wenig D and Lawrence CR 1998). Pesticides applied directly to the soil may also be transported to nearby bodies of surface water, or percolate through the lower layers and into the groundwater (Kookana R and Simpson BW 2002).
Another mechanism for dispersal occurs when pesticides volatise into the atmosphere from spray drift, to be transported on dust particles by the wind (Kurtz DA 1990). Once pesticides move into the upper atmosphere, they may be transported regionally or they can enter the global wind circulation patterns, and be deposited in remote locations. Arctic and Antarctic mammals are currently contaminated with chemicals applied in distant countries (Arctic Monitoring Assessment Programme (AMAP) 2000; Radcliffe JC 2002), and organochlorines have been found in Greenland Inuit people living in circumpolar countries (Dewailly E, Mulvad G et al. 1999).

Estimates suggest that as much as 50% of the chemicals used on lawns, gardens and crops end up in ground water or surface water (American Association for Advancement of Science; Leonard AW, Hyne RV et al. 1999). Humans and wildlife are coming into increasing contact with them, either through direct application, inhalation, spray drift or ingestion through food and water (Colburn T, Dumanoski D et al. 1997). The older organochlorine pesticides are very persistent and are still detected in the soil, sediment or biota many years since their withdrawal from sale. High persistence is demonstrated by bromacil, chlordane, Dichlorodiphenyl trichloroethane (DDT) and its metabolites, lindane, paraquat, picloram and trifluralin (Kamrin MA 1998). Alternatively, pesticides released into the environment may be degraded by the action of sunlight, water, chemicals or micro-organisms such as bacteria (Guerin TF 1999).

**Replacement by ‘safer’ AgVets due known health hazards**

Pesticides were mainly introduced to enhance crop productivity and population health by controlling insect pests and vectors. Halogenated hydrocarbons were the first generation of synthetic compounds, but their intensive use resulted in enormous environmental contaminations. DDT is the best known among the chlorinated pesticides (also called organochlorines (OCs)). These pesticides are lipophilic (attracted to fats), allowing them to accumulate in the tissues of living organisms (Mukerjee D 1998). They are not fast acting, but they are associated with chronic effects such as cancer, immune suppression (Bilrha H, Roy R et al. 2004), and disruption of hormone function (Longnecker MP, Rogan WJ et al. 1997). DDT was extensively applied for pest control from the 1930s until its ban in the U.S in 1979 (Committee on the Future Role of Pesticides 2000). The Australian regulatory authority response was much slower. Bans were not introduced in Australia until 1987 (Melville J 1989), despite the knowledge that DDT was detected in human breast milk in the 1950s (Laug EP, Kunze FM et al. 1951).

Persistence of DDT became evident when metabolites of this pesticide were found to concentrate in soil and the groundwater, and have been repeatedly detected in human populations long after eventual
withdrawal from sale (Snedeker SM 2001; Yáñez L, Ortiz D et al. 2002). Quinsey's study of breast milk in Victorian women, detected dieldrin and heptachlor epoxide in 43% and 30% of samples respectively, and PCBs were found in 79% of samples, and chlordane in 76%. The study estimated that a number of Victorian infants had daily intakes above the acceptable daily intake for total chlordane, total DDT, dieldrin, heptachlor epoxide and total PCBs (See table 2.3) (Quinsey PM, Donohue DC et al. 1995). The persistence and carcinogenicity of halogenated compounds raised serious public health concerns, and has lead to the development of carbamate and organophosphate (OP) pesticides. These have since replaced most of the chlorinated pesticides. Yet whilst many of the second-generation pesticides are not as persistent, they are acutely toxic. Developed during World War II for use as nerve gases, OPs affect the central nervous system (Midtling JE 1999), creating human health reactions ranging from depression, disorientation, to spasms, or even death (Abou-Donia MB 2003; Aygun D 2004; Kamel F and JA 2004). Phenoxy herbicides, including 2,4-D were created to eradicate the Japanese rice crop, and later used as a component of Agent Orange to defoliate South Vietnamese jungles (Stellman JM, Stellman SD et al. 2003). These cause a range of cancers (including sarcomas and lymphoma), and birth defects (O'Malley M 2004).

Initially considered to be biodegradable, OP residues are also found in certain environments (Fenske RA, Lu C et al. 2000). Due their high efficacy, carbamates and OPs are the active ingredients of most insecticides and some of the herbicides in current usage. Their use is broad, and includes crop protection, control of insects and weeds in recreational facilities, and eradication of insect vectors of animal and human diseases (Radcliffe JC 2002). However, despite their many benefits, their widespread use has also caused widespread contamination of biota and humans, raising the following concerns (Jorgenson JL 2001):

i) Most of the synthetic carbamates and organophosphates are highly neurotoxic and potent inhibitors of acetyl cholinesterase, a vital enzyme involved in neurotransmission (Leon-S FE, Pradilla G et al. 1996). Therefore, concerns have been raised regarding even the judicious commercial use of these chemicals. Chemicals residues of pesticides and their metabolites resulting from biodegradation concentrate in the food chain and cause short- and long-term human health problems (Hansen 2002; Schafer KS and Kegley SE 2002).

ii) Target insects develop a resistance to pesticides similar to drug resistance acquired in human pathogens (Lippmann M, Cohen BS et al. 2003). This in turn leads to the application
of higher doses of the pesticides to achieve the desired level of insect control, thus furthering the risk of environmental pollution, and risks of exposure (Radcliffe JC 2002).

iii) Degradation of some carbamates, such as aldicarb, yield metabolites which are as toxic as the parent compound (Louis A 1999; Bell EM, Hertz-Picciotto I et al. 2001).

**Pesticide exposure pathways**

Human exposure to pesticides can occur indirectly to entire populations, or individually via direct contact or proximity. Accidents, spills and misguided management practices relating to all chemical categories add to the general concerns of population exposure of AgVets. One notable example occurred in Belgium in January 1999, where animal feedlots were contaminated with PCBs and dioxins, including polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (Taylor DA 2001). The dioxins, probably originated from oil left at a waste recycling centre, entered the food supply when animal feed was made with recycled animal fat blended with waste oil (to provide cheap calories). Conservative estimates conclude that the incident may have doubled or tripled the PCB/dioxin body burden of some Belgians, and suggest that the Belgian incident could result in 1,540 additional cancer deaths in the total Belgian population of 10 million, and PCB exposure could add a further 6,545 deaths (Taylor DA 2001).

Personal pesticide exposure in both occupational and residential settings is influenced by both the pesticide application characteristics and personal behaviour (Alavanja MCR, Hoppin JA et al. 2004). Spills and other unintended events also contribute to an individual's pesticide exposure (Gladen BC, Sandler DP et al. 1998; Alavanja MCR, Samanic C et al. 2003). Not all individual spills result in overt poisoning episodes, but the impact of these events on total lifetime pesticide dosing, although hard to quantify, needs to be considered since they may represent the bulk of an individual's lifetime exposure to pesticides (Lee WJ, Hoppin JA et al. 2004).

Individuals may be exposed to pesticides through both direct and indirect routes. Direct exposure occurs to individuals who personally either manufacture, or apply pesticides in residential, agricultural, or occupational settings; for example exterminators; lawn, golf course, and turf maintenance workers; parks and recreation employees or cemetery and forestry personnel. Direct exposure is likely to result in the highest levels of chemical burden through dose surges (Sanborn M, Cole D et al. 2004). Whereas indirect exposures occur through breast milk, drinking water, air, dust, and food and these represent routes of cumulative long-term, generally low-level exposures (Gladen BC, Sandler DP et al. 1998;
Castorina R, Bradman A et al. 2003; Harden F, Müller J et al. 2005). Indirect exposures may occur more frequently than direct pesticide application as chronic repetitive exposure (Fenske RA 1997).

That 70% of pesticide usage in Australia occurs in agriculture, places rural populations comprising agricultural workers, their families and neighbours at a heightened risk of exposure (Radcliffe JC 2002). Pesticides are usually applied as an aerosol, via a variety of methods: aerial spraying, vehicle drawn spray units, or via hand held units. Spraying techniques can also result in unacceptable amounts of spray drift that creates an exposure risk to neighbouring farm dwellings. Spray can also drift across to play areas, vegetable gardens, clothes lines, and into domestic water supplies when rainwater tanks are connected to roofing. Rural Australians commonly source domestic water this way (APVMA 2003).

The chief route of direct occupational exposure to pesticides is through the skin, whereas inhalation poses the greatest exposure risk for domestic applicators (O'Malley M 2004). Pesticides can persist on the skin for many months after exposure, and studies have indicated that the children of exposed adults can also be affected by the residue (Gladen BC, Sandler DP et al. 1998; Curl CL, Fenske RA et al. 2002). Children are more sensitive to pesticides than adults because their brains, sex organs and immune systems are still developing (Schneider D and Freeman N 2000; Charnley G and Putzrath RM 2001; Tamburlini G, von Ehrenstein OS et al. 2002). They are in closer contact with pesticide residue when they are rolling on the ground or crawling on floors, carpet or grass (Gee D and European Environment Agency 1999). Other vulnerable groups include pregnant women and their foetuses, and chemically sensitized people (Ashford N and Miller C 1998).

**Toxic impacts of pesticides**

The basic intent and design of pesticides is to be highly toxic to selected pest species, and much less toxic to non-target species. However complete specificity is difficult to achieve, given that pests share many biochemical pathways, physiological functions, anatomical features and life histories with many non-target organisms. Herein lies the risk to humans.

Of significant concern is the lack of toxicological testing on the thousands of chemicals currently registered for use (US EPA 2003). Toxicity of a chemical refers to its capacity to cause adverse health effects, and applies to both synthetic and naturally occurring chemicals. The nature and extent of any adverse effect in humans and animals will depend on the level and length of exposure to the chemical,
and whether it is taken orally, absorbed though the skin or inhaled (Therapeutic Goods Association 2001), in addition to the genetic susceptibility of the organism or individual (Savitz DA 2003).

The physical effects of exposure to pesticides are complex, and the mechanism of their toxicity is only partially understood. It is known however, that the effects on non-target species from exposure to agricultural and veterinary chemicals include immediate short-term, which can be fatal, and a range of indirect effects, in addition to latent effects resulting from chronic low-level exposure. These can either be expressed in the intermediate or long term (Sanborn M, Cole D et al. 2004).

Toxicity of chemicals varies greatly according to their chemical properties, the species studied, and environmental factors. For example, four features determine the impact of a pesticide on aquatic environments. These are: (a) its persistence; (b) the partitioning of the pesticide between particulate and aqueous phases; (c) its toxicity to aquatic organisms; and (d) its tendency to bioaccumulate. Also, different classes of agents often show general patterns of toxicity (Radcliffe JC 2002). Organophosphorus (OP) and carbamate pesticides are usually more toxic to invertebrates than to fish. Synthetic pyrethroids are highly toxic to fish and invertebrates, but less toxic to mammals and birds, rodenticides are highly toxic to mammals, certain herbicides have low toxicity to fish and invertebrates, whereas insect growth regulators target moulting sites in target and non-target species. Applying the ‘canary in the coalmine’ thesis, such dramatic evidence of harm to other animals warns of the potential risks to human health, making chemical exposure a significant public health issue.

The toxicity of pesticides is measured in several ways. Acute toxicity is evaluated in terms of oral (ingested) or dermal (absorbed through the skin) Lethal Doses (LD), doses which are determined by the concentration of active ingredient in milligrams per kilogram of body weight, required to kill 50 per cent of test animals in a laboratory (LD50) (OECD Environment Directorate 2002). Other measures of toxicity observe the short and long term exposure creating chronic health effects, the influence of mutagens (cell damaging), teratogens (foetal damaging) and carcinogens among test animals (Hodgson E and Levi PE 1997).

There are important reservations concerning toxicity data. These are usually obtained in controlled conditions using small, purpose-bred animals. Although human data are preferable, obvious ethical problems exist in research designs using human data. There is considerable debate in the U.S. where human testing (by which human subjects drink pesticides for a small fee) has again been accepted by the U.S. EPA (Oleskey C, Fleischman A et al. 2004).
However, regardless of subject species, toxicity testing generally does not take into account factors such as differences in age, race, sex, diet, immune deficiency, genetic variability, or the effects of stress (Ashford N and Miller C 1998). Acute and chronic effect studies ignore the possible synergistic effects of chemicals interacting with the thousands of other chemicals in the environment with which organisms come into daily contact (Carpenter DO, Arcaro KF et al. 1998). Also infrequently documented are the delayed responses and impacts such as impaired immunity, respiratory, circulatory, behavioural or reproductive disorders, allergies, or general health impairment (Canadian Public Health Association 2002).

The US EPA estimates that 10,000-20,000 physician-diagnosed pesticide poisonings occur each year among the approximately 3,380,000 U.S. agricultural workers, and between 3000 and 5000 cases of accidental systemic poisoning by organophosphates alone occur annually in the US (NIOSH; Steenland K 1996). The global burden of ill-health resulting from pesticide exposure is recognized as being very high, although records are far from accurate. Variation exists between estimations of global human health effects. The World Commission on Health and the Environment claims that each year there are 300,000 cases of illness and 20,000 deaths worldwide directly attributable to acute poisonings from pesticides (UNEP 2002). In 1994, the World Health Organisation reported global figures as high as between two and five million persons were intoxicated by pesticides every year, and that 40,000 of them died (Jeyaratnam J 1990). Chronic poisonings were not included in these data (ILO 1994). Pesticides Action Network Asia and the Pacific estimate that around 200,000 people die worldwide every year from chronic and acute pesticide poisoning. Daily, 68,000 farmers and workers are poisoned by pesticides and yearly, an estimated 25 million workers around the world suffer chronic effects of long-term exposure to pesticides (Kuruganti K and Guillette E 2004), with 700,000 new cases a year according to the World Commission on Health and the Environment (Canadian Public Health Association 2002). Any of these estimates identify AgVet exposure as a significant global public health issue.

Damage to human health from environmental exposure varies depending on the properties of the contaminants, the medium duration of exposure, and the age and health status of the persons exposed, and their individual genetic make-up. Genetic variations therefore influence human susceptibility to pesticides (McLachlan JA 2001). People carrying certain genotypes, and those with less than perfect health, such as asthmatics and individuals with a chemical sensitivity, suffer the effects of pesticide exposure more severely than those without (Kipen HM and Fielder N 2002). For such people, day-to-day life can present challenges, as it is impossible to escape exposure due the widespread and persistent
use of chemicals (Loblay R 2002). The availability of genome-scale DNA sequence information has radically augmented the field of toxicology creating the new specialty of toxicogenomics, which is anticipated to further explain human response to chemical exposure, and potentially add predictive capacity (Olden K, Guthrie J et al. 2001; Potera C 2004).

**Chemicals in humans, our ‘Body Burden’**

North American and European citizens are known to have residues of hundreds of chemicals in their bodies (Schettler T 1999). In 2004, thirty-nine members of the European Parliament undertook screening to demonstrate the urgency of the problem. Of the 101 chemicals tested across five classes of compounds, 76 were detected, and every sample included at least one chemical from each class (Wagner K 2004). European Commissioner, Margot Wallström tested positive for 28 chemicals (European Commission 2003). Although chemical burden figures for Australians are unavailable, our similar lifestyle and usage patterns would suggest we are also bearing a similar chemical burden. It can be expected that figures would be even higher for those directly involved in the application of pesticides, and their exposed family and neighbours.

Worldwide concerns are now being raised about chronic effects of exposure (UNEP 2002). Many pesticides are considered ‘probable’ or ‘possible’ human carcinogens based on evidence of cancer in laboratory animals, and accumulated epidemiological evidence of cancer in humans. The ATSDR reported that 76% of the top 50 substances in the 1997 priority list of hazardous substances were capable of causing cancer, 54% produced neurotoxic effects, and 56% caused developmental effects in offspring (U.S. Department of Health and Human Services and Public Health Service 2002). The Harvard Center for Cancer Prevention suggests that 4% of the total burden of cancer in developed countries is caused specifically by environmental pollutants (Harvard Center for Cancer Prevention 1996). Whilst this remains a relatively small percentage, it nevertheless represents millions of premature deaths annually.

**Human Health Impacts of Exposure**

Age-adjusted cancer rates in the United States have risen 25% for females and 33% for males over the past 30 years (Clapp R 2000). Initial fears of chemically induced ill-health were largely centred on cancers, however emerging evidence suggests that cancers are not the only problem. Life expectancy in Australia has increased over the past century as premature morbidity from infectious diseases has
diminished, whereas the incidence of other human diseases is increasing (AIHW 2002). Certain cancers, asthma, birth defects, learning disabilities, autism, endometriosis, infertility, and others now cumulatively account for ailments affecting over one-third of Australians. Known risk factors such as aging of the population, diet, smoking and exercise patterns do not fully explain the increase in many such conditions. Increasing evidence is emerging which suggests that some of these disorders are related to exposure to environmental hazards, and exposure to agricultural chemicals has specifically been implicated in numerous studies (Gochfield M 1998; Kay D, Prüss A et al. 2000; Stewart BW and Kleihues P 2003).

Several major reports have been published in recent years documenting pesticide exposure hazards. Two such works published in April 2004, are the Pesticides Literature Review, conducted by the Ontario College of Physicians (hereafter referred to as the Sanborn Review) (Sanborn M, Cole D et al. 2004), and Health Effects of Chronic Pesticide Exposure: Cancer and Neurotoxicity by Alevanja, Hoppin & Kamel, which appeared in the Annual Review of Public Health (Alavanja MCR, Hoppin JA et al. 2004). Both these large systematic literature reviews examined chronic effects of exposure, and both concluded that pesticides pose a serious risk to the health of human populations, especially children. The reports claim that sufficient evidence now exists to demonstrate associations with solid tumours, non-Hodgkin's lymphoma, leukaemia, genotoxicity, dermatological, neurological and mental health problems, in addition to developmental anomalies, and immune system disruption. Susceptibility is mediated by genetic polymorphisms, which explains why some individuals are more or less affected by similar exposure patterns.

The following sections provide a brief summary of recent findings grouped according to specific health effects.

**Solid Cancers**

The Sanborn Review examined studies testing the relationship between pesticides exposure and 9 types of solid tumours: lung, breast, colorectal, pancreas, brain, prostate, kidney, ovarian and stomach cancers (Sanborn M, Cole D et al. 2004). Their findings concluded that sufficient evidence now exists to demonstrate significant positive associations between solid tumours and pesticide exposure. In particular, the report notes that the large, well-designed cohort studies consistently show significant positive associations, with strong evidence of dose response relationships, and that these relationships are most consistent for high exposure levels, such as those found in occupational settings.
In 1995 Blair and Zahm reviewed the literature on cancer among persons employed in agricultural settings (Blair A and Zahm SH 1995). Their review found that farmers, despite a generally favourable mortality, appear to experience elevated rates for specific cancers, including leukaemia, non-Hodgkin's lymphoma, multiple myeloma, soft-tissue sarcoma, and cancers of the skin, lip, stomach, brain, and prostate.

The US Institute of Medicine reviewed the association between occupational and environmental exposure to herbicides and specific public health problems (Longnecker MP, Rogan WJ et al. 1997). They found strong significant evidence of an association for soft tissue sarcoma, non-Hodgkin's lymphoma, Hodgkin's Disease, and Chloracne. Limited or suggestive evidence was found to link respiratory cancers, prostate cancers, multiple Myeloma, acute and subacute peripheral neuropathy, spina bifida and porphyria cutanea tarda.

The National Cancer Institute (NCI), National Institute of Environmental Health Science (NIEHS), and the U.S. EPA conducted a large study involving 55,332 farmers and nursery workers. The risk of developing prostate cancer was greater for pesticide applicators compared to the rest of the population, exposure to methyl bromide demonstrated the highest risk, others included chlorpyrifos, coumaphos, fonofos, phorate, permethrin, and butylate (Barker J, Alavanja MCR et al. 2003).

Dinse et al. examined the American cancer statistics over 2 decades, 1975-1994. This study revealed that cancers not related to smoking or screening identification were increasing markedly for men, yet only marginally for women (Dinse GE, Umbach DM et al. 1999). This trend remained consistent between racial groups. Baby boomer men had over twice the age adjusted risk of developing cancer as their grandfathers. The study concludes that gender specific occupational exposure may be a causal factor. This argument was strongly supported by the case of non-Hodgkin’s lymphoma (NHL) where the male female differential exacerbated during those years, especially in agricultural areas (Nanni O, Amadori D et al. 1996; Miligi L, Costantini AS et al. 2003). The World Health Report states that Australia has the third highest rate of cancer of the industrialized world (World Health Organization 2002). Carson reported a 12% higher incidence of cancer among rural Victorians compared to Melbourne and Geelong populations (Carson N 1997). A strong likelihood exists that exposure to these agents contributes to this elevated rate, especially among rural populations.
Non-Hodgkin’s Lymphoma (NHL)

During the 1960s and 1970s, epidemiologists in the USA noted the rise in cases of NHL were clearly clustered in agricultural areas (Sanborn M, Cole D et al. 2004), where chronic exposure to AgVets increases the risk 5-6 times (Martin K 2003). The research evidence linking specific pesticides to NHL continues to grow. In epidemiologic studies, non-Hodgkin’s lymphoma has been associated with exposure to chemicals such as phenoxyacetic acids (herbicides); carbamate and organophosphate insecticides; chlorophenols (the pesticides 2,4-D and 2,4,5-T); dioxins; amide fungicides, and to the fumigant carbon tetrachloride; organic solvents including benzene, polychlorinated biphenyls, chlordanes; and immunosuppressive drugs (Longnecker MP, Rogan WJ et al. 1997; Cocco P, Kazerouni N et al. 2001; McDuffie HH, Pahwa P et al. 2001).

The incidence of NHL continues to rise in Australia and Canada (Sanborn M, Cole D et al. 2004). The evidence linking NHL with pesticide exposure is strengthened by the recent stabilization of rates in the USA, Sweden and Denmark, where specific pesticides associated with NHL (phenoxyacetic acids and chlorophenols), were banned in 1977 and 1978 (Hardell L and Eriksson M 2003). This occurred long before their ban in Australia and Canada.

Sanborn’s review described ‘compelling evidence’ of the link between pesticide exposure and NHL. Of the 27 studies, 23 showed associations, most with statistical significance (Sanborn M, Cole D et al. 2004). This review noted that exposure misclassifications in cohort studies tended to skew the results towards the null hypothesis, and suggested the associations in those studies may have been underestimated. It is worthy to note that two of the five studies excluded by Sanborn on the grounds of poor methodology, found no significant increase in NHL. Both were funded by Dow Chemicals, manufacturer of the AgVets implicated.

Leukaemia

Leukaemia represents a vast array of hematopoietic malignancies including chronic and acute forms, which affect both children and adults. Reports have linked pesticides to leukaemia in children since the 1970s (Martin K 2003), with indications that the maternal exposure to pesticides is a key factor (Zahm SH and Ward MH 1998; Ma X, Buffler PA et al. 2002). Pest strips, made with organophosphates have also been associated with a 5.6 fold increase in childhood leukaemia (Leiss and Savitz 1995). Studies have repeatedly identified associations between agricultural exposure to pesticides and higher rates of leukaemia. (Richardson S, Zittoun R et al. 1992; Nanni O, Amadori D et al. 1996; Meinert R, Schuz J et
Beard’s Australian study found that compared with the control population, mortality from leukaemia was increased in subjects working with more modern chemicals (standardized incidence ratio = 20.90; 95% CI, 1.54-284.41 for myeloid leukaemia in the highest exposure group) (Beard J, Sladden T et al. 2003).

Details of the mechanisms underlying the association remain unclear, although exposure of leukemic cell lines (K562) to increasing doses of an organophosphate insecticide (isofenphos) has been reported to produce dose-dependent leukemic cell proliferation (Boros LG and Williams RD 2001). Cuneo’s study revealed that patients with Acute Myeloid Leukaemia (AML) who had been exposed to pesticides demonstrated the same recurring chromosomal aberration, and cytological features, which differed markedly from AML patients in the non-exposed group (Cuneo A, Fagioli F et al. 1992). Clinical findings also differed between the group with the exposed having poorer haematological profiles, they were more refractory to treatment, and accordingly, had a lower survival rate. This clinical pattern resembled leukaemias induced by an external cause such as radiation or chemotherapy, further suggesting that pesticides have a causative role in the development of leukaemia (Cuneo A, Fagioli F et al. 1992).

Sanborn’s review results indicate strong evidence of the link as demonstrated in Table 2.1 below:

<table>
<thead>
<tr>
<th>Study Type</th>
<th>Leuk</th>
<th>No. of studies</th>
<th>No. of Positive associations</th>
<th>No. with statistical significance</th>
<th>Negative associations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohort</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Case-control</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecological</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory Study</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excluded</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**Neurological and mental health impacts**

Pesticide exposure has profound effects on the nervous system (Baldi I, Lebailly P et al. 2003; Kamel F, Rowland AS et al. 2003). Neurotoxic substances are chemical compounds that, depending on the dose, produce harmful effects on brain function and interfere with the workings of the nervous system. Several types of neurologic endpoints have been examined, and demonstrated that neurological effects of chronic AgVet exposure are diverse. Many studies have reported prevalence of a range of self-reported symptoms, often based on variations of an established checklist (Goetz CG, Bolla KI et al. 1994;
Lundberg I, Hogberg M et al. 1997). Mood and affect have also been assessed using self-report as well as validated scales. Neurobehavioural test batteries, including the WHO Neurobehavioural Core Test Battery (Anger WK, Liang YX et al. 2002), the Neurobehavioural Evaluation System (Letz R, Green RC et al. 1996), and portions of other batteries, have been used to evaluate cognitive and psychomotor function. These batteries have often been supplemented with tests of sensory and motor function. Other studies have investigated abnormalities in peripheral nerve conduction directly (Pilkington A, Buchanan D et al. 2001; Kamel F and JA 2004).

Chlorpyrifos, is one of the most widely used pesticides in both Australia, (Radcliffe JC 2002) and the United States where metabolites were found in 80% of adults, and 92% of the children (Adgate JL, Barr DB et al. 2001). Chlorpyrifos belongs to a class of OPs originally developed as nerve gas for military use. The consequences of high-level exposure are well established (Alavanja MCR, Hoppin JA et al. 2004). Organophosphates inhibit the neurotransmitter acetyl cholinesterase, an enzyme necessary for the proper transmission of nerve impulses, leading to symptoms related to the autonomic nervous system (abdominal cramps, nausea, diarrhoea, salivation, tearing, pinpoint pupils, miosis) and the central nervous system (dizziness, tremor, anxiety, confusion) (Steenland K 1996; Davies R, Ahmed G et al. 2000).

Symptoms of acute exposure may be instantaneous, intermediate, occurring one to four days after exposure, or delayed. Immediate symptoms include dizziness, cramps, diarrhoea, nausea, salivation, and pupillary constrictions, which reverse in between days and weeks (Steenland K 1996). However, severe cases can lead to convulsions, coma, respiratory failure and death (Aygun D 2004). An intermediate response is characterized by muscle weakness and can be fatal if respiratory muscles are affected (Leon-S FE, Pradilla G et al. 1996). Two to five weeks after exposure, some patients develop organophosphate-induced delayed polyneuropathy (OPIDP) resulting from inhibition of a neuronal esterase leading to degeneration of large diameter axons and their myelin sheaths in distal parts of the peripheral nerves and in long spinal-cord tracts. This well-characterized syndrome produces sensory abnormalities, muscle cramps, ataxia, weakness, and in severe cases, even paralysis, primarily in the legs. These symptoms are a consequence of axonal death following OP inhibition of a neural enzyme called neuropathy target esterase and may be irreversible (Alavanja MCR, Hoppin JA et al. 2004). Cognitive deficits can be permanent (Midtling JE 1999). Aygun stresses the importance of early recognition and diagnosis of pesticide toxicity to ensure appropriate management, and argues that patient outcomes are being compromised in cases where this does not occur (Aygun D 2004).
Even in the absence of acute poisoning, chronic exposure is associated with a broad range of non-specific symptoms, including headache, dizziness, fatigue, weakness, malaise, anorexia, nausea, chest tightness, difficulty breathing, insomnia, confusion, and difficulty concentrating. Chronic exposure also results in neurobehavioural performance deficits and abnormalities in nerve function. Pesticide exposure is also associated with changes in mood and affect leading to behavioural problems and difficulties with social adjustment (Leon-S FE, Pradilla G et al. 1996). Workers exposed to OPs (Bazylewicz-Walczak B, Majczakowa W et al. 1999; Steenland K, Dick RB et al. 2000), or DDT (van Wendel D, de Joode B et al. 2001) reported higher levels of tension, anger, and depression. Keifer’s study found that exposure to spray drift from aerial spraying was associated with substantially higher rates of mental and emotional symptoms than controls (Keifer MC, Rivas F et al. 1996), and other studies reported higher levels of suicides, and death from psychiatric disorders (Davies R, Ahmed G et al. 2000; Spurgeon A 2002; Van Wijngaarden E 2003). This would suggest a need for research examining the link between the high rates of suicides among Australian rural males and AgVet exposures.

Neurotoxics affect intelligence, learning and language ability, leading to developmental delays, and problems sustaining attention, expressed as attention deficit hyperactivity disorder (Schettler T 2001). Sanborn’s pesticide review also concluded that long-term experience of farm work is associated with significant measurable deficits in cognitive and psychomotor function (Sanborn M, Cole D et al. 2004). This was confirmed in Beard’s study of Australian insecticide exposed workers (Beard J, Sladden T et al. 2003). Sheep dippers (Stephens R, Spurgeon A et al. 1995), and nursery workers (Bazylewicz-Walczak B, Majczakowa W et al. 1999) exposed to OPs, malaria-control workers who sprayed DDT (van Wendel D, de Joode B et al. 2001), vineyard workers exposed to fungicides (Baldi I, Lebailly P et al. 2003), farmers (Cole DC, Carpio F et al. 1997) and farm-workers (Gomes J, Lloyd OL et al. 1999) exposed to multiple pesticides all showed worse performance on tests of cognitive function than non-exposed groups. Significant effects can occur in 10% of those who experience low dose chronic exposure (Davies R, Ahmed G et al. 2000). It is biologically plausible therefore, that pesticides may affect academic performance of exposed rural children.

Reported rates of neurological, and psychosocial problems are rising in Australia. Among children aged 4-12 years, 15% of all Australian boys and 14.4% of girls have a number of emotional and behavioural problems children (AIHW 2002), whereas 19.3% of boys and 8.8% of girls aged 6-12 years, are reported to have attention-deficit hyperactivity disorder. The reported rate of intellectual disabilities has doubled since 1993, such that three per cent of all Australian children (5% in boys) have intellectual or other mental condition (AIHW 2002). Several studies have demonstrated a link between in-utero exposure to
organophosphates and the internationally observed rise in these conditions. It is possible that chemical exposure is affecting Australian children (Weiss B 2000; Young JG, Eskenazi B et al. 2005).

Finally, there is substantial literature demonstrating the link between pesticide exposure and specific neurologic diseases such as Alzheimer’s, amyotrophic lateral sclerosis, and Parkinson’s disease (Tuchsen F and Jensen AA 2000; Engel LS, Checkoway H et al. 2001; Baldi I, Lebailly P et al. 2003; Alavanja MCR, Hoppin JA et al. 2004). Le Couteur et al. reviewed 20 studies examining Parkinson’s, where 12 reported a positive association, with odds ratios ranging from 1.6 to 7.0 (Le Couteur DG, McLean AJ et al. 1999). Sanborn's review (Table 2.2) reported stronger findings of association, and noted remarkable consistency of findings from patho-physiological and neurological function tests, through to clinical examinations, to health care use and mortality data.

### Table 2.2 Sanborn Review findings of studies investigating pesticide association with neurological effects

<table>
<thead>
<tr>
<th>Study Type</th>
<th>No. of studies</th>
<th>No. of Positive associations</th>
<th>No. with statistical significance</th>
<th>Negative associations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviews</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Cohort</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Case-control</td>
<td>33</td>
<td>31</td>
<td>31</td>
<td>2</td>
</tr>
<tr>
<td>Cross-sectional</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

### Immune system impairment

The normal human immune response is quite heterogenous, making it difficult to discern a subtle adverse effect without a large experimental cohort. Disease associated with the immune system sometimes becomes detectable only after a long latency after more severe immuno modulation, and as a result, can be difficult to detect initially. Effects of pesticides on the immune system include a decreased cell mediated immunity and decreased antibody formation by 70% after exposure to common pesticides (National Research Council 1993; Martin K 2003; Bilrha H, Roy R et al. 2004). Maternal chlordane exposure results in defects in macrophage biochemical mechanisms associated with tumour killing in offspring. Prenatal exposure to chlordane induces long lasting and subtle effects on immune function, especially reduction in the efficacy of tumour killing macrophage mechanisms leaving the child more susceptible to cancers (Thomas PT 1995).
Thrasher's study demonstrated immunological impacts following exposure to chlorpyrifos. The study measured:

1. peripheral lymphocyte phenotypes;
2. autoantibodies (nucleic acids and nucleoproteins, parietal cell, brush border, mitochondria, smooth muscle, thyroid gland, and central nervous system/peripheral nervous system myelin);
3. mitogenesis to phytohemagglutinin and concanavalin, in workers exposed to pesticides (Thrasher JD, Heuser G et al. 2002).

Other researchers, however caution that more research is necessary to confirm these findings as farmers are exposed to a variety of substances that could operate through this mechanism, including pesticides, engine exhausts, solvents, dusts, and zoonotic microbes (Blair A and Zahm SH 1995).

Subtle widespread immunological impairments resulting from chronic exposure to the mixture of environmental chemicals have been attributed to the rise in allergenicity witnessed in many countries (Brown KS 1998; Salam MT, Yu-Fen Li et al. 2004). is now reported by 16% of Australian children (AIHW 2002), and these figures are significantly higher in rural areas (Carson N 1997). This rising trend is also reported in the U.S. and elsewhere (Harris SB, Glazier R et al. 1998; Landrigen PJ, Schechter CB et al. 2002). A growing body of evidence is suggesting that environmental exposures, including pesticides, are implicated (Tamburlini G, von Ehrenstein OS et al. 2002).

Also increasing globally is a range of newly emerging symptom clusters, without clear underlying medical explanations (World Health Organization 1998; Kipen HM and Fielder N 2002). Patients and practitioners have organized these into syndromes such as Chronic Fatigue Syndrome (CFS), Multiple Chemical Sensitivity (MCS), and sick building syndrome. All these syndromes are defined solely on the basis of an agreed set of symptoms. Some of the above-described conditions overlap strongly with explained conditions such as asthma, and a state of comprised immune systems is suspected (Aaron LA and Buchwald D 2001).

Long latency periods, and inexact histories of exposure to a mixture of chemical agents complicates attempts to draw precise causal links, hence the relationship of such symptoms and syndromes to environmental exposure is often sharply debated, as is the distinction between the various syndromes (Engel LS, Checkoway H et al. 2001). Sufferers vehemently argue their symptoms are real. The early literature suggested the symptoms were largely psychosomatic (Black, Okiishi et al. 2001), and Stevens reported in 2000 that 70% of Australian GPs believed depression was the primary cause (Steven ID, McGrath B et al. 2000). However some discernable pathophysiological parameters have recently been
identified in these patients (Bell IR, Patarca R et al. 1998; Scroop G, Buckley J et al. 1998; Burnet R, Barnden AL et al. 2001).

**Dermatological impacts**

As the primary route of exposure to pesticides occurs via the skin, contact dermatitis is one of the most commonly reported conditions (Spiewak R 2001). Contact dermatitis can be either an irritation or allergic reaction, acute or sub-acute. Paraquat is reported to be a strong irritant, but in contrast to all other pesticides, it does not cause contact allergic reactions. Many other factors also contribute to dermatological conditions for those exposed to pesticides, such as use of solvents, arsenic, cleansers, temperature extremes, and physical abrasion (Blair A and Zahm SH 1995; Ceneno JA, Mullick FG et al. 1999; Riley, McKone et al. 2004). Hence, although dermatological conditions are a commonly reported feature among pesticide users, differentiating the attributable factor related solely to pesticide exposure has proven difficult.

**Effects on children’s health**

Exposure risks for children are especially hazardous (Gee D and European Environment Agency 1999). Children share the same routes of exposure to toxic agents as do adults. However children differ from adults not only in size, but also their immune response, lung function, metabolic rate, surface area to body weight ratio, and distinct patterns of activity and behaviour when compared with adults (Zahm SH and Ward MH 1998). A broad range of potential exposure pathways to pesticides poses risks to children living in agricultural communities (Landrigen PJ, Schechter CB et al. 2002; Belson M, Kieszak S et al. 2003). Fenske’s study of cumulative dietary pesticide intake in children living on farms found that acceptable chronic dietary doses were exceeded in by 56% of the children compared to 44% of non-farm dwellers (Fenske RA, Simcox NJ et al. 2000). Other sources include inhalation of ambient air, ingestion of contaminated household dust, dust in the car, parental occupational “take-home” exposures, where chemicals are transported from the work place to home on a workers clothing or person, and playing in or eating produce directly from treated fields (Curl CL, Fenske RA et al. 2002; Flower KB, Hoppin JA et al. 2004). Farm children also assist their family members in farming activities, and fossick amongst farm yards and sheds where over the years chemical agents have been stored, and spills are likely to have occurred.

Therefore children represent a sensitive sub-population in terms of exposures to pesticides. Of particular concern are OP pesticides because of their acute toxicity and widespread use both use both residentially
and agriculturally (UNEP, UNICEF et al. 2002). Farm workers’ children have shown higher levels of pesticides in their urine than the adults (Curl CL, Fenske RA et al. 2002). Infants appear to be particularly susceptible to the effects of pesticides because they have incompletely developed acetylcholinesterase systems and their immature livers cannot detoxify these compounds (Abou-Donia MB 2003).

**Developmental abnormalities**

Children are also at risk in utero through maternal exposure. In 2003, Castorina and colleagues reported that up to 35% of pregnant women in a farming region of California had levels of urinary organophosphate metabolites that exceeded the US EPA margin of exposure for total OPs (Castorina R, Bradman A et al. 2003). New evidence suggests that critical effects on reproductive, brain and immune system development of the embryo can be caused by single, low doses of synthetic chemicals, challenging the current methodology for determining long-term effects (Ashford N and Miller C 1998), as certain critical times of cell differentiation, and rapid organ development leave the foetus highly vulnerable (Bell EM, Hertz-Picciotto I et al. 2001; Chapin RE, Robbins WA et al. 2004). Epidemiological studies may show an increase in the frequency of a congenital abnormality as exposures rise, but a decrease in frequency at even higher doses. This is because severe problems cause foetal death in utero, and hence abnormalities will not be exhibited (Bailer and Bailer 2001). Additionally, miscarriages may go unnoticed.

Neonatal conditions and congenital abnormalities together account for 27% of the total disease burden in Australian Children, and these figures are notably higher in non-capital cities (AIHW 2002). The total rate of childhood disability increased from 69.9 per 1000 in 1993 to 75.4 per 1000 in 1998. (The report notes that some of this increase may be due to different reporting requirements and changes to survey questions.) Similar trends have been observed elsewhere, and opinion is broadening that maternal exposure to chemicals may be a contributing factor to this rise (Faustman EM, Sibernagel SM et al. 2000; de Rosa C 2003).

Almost all organs have demonstrated pathological changes resulting from exposure to AgVet chemicals, including the thyroid (Schroeder SR 2000; Thrasher JD, Heuser G et al. 2002). Thyroid hormone is essential for many biological functions, including many developmental processes and normal brain development. That thyroid function can be altered by a very large number of chemicals routinely found in the environment ranging from natural to manufactured compounds therefore raises serious concerns
(Abelsohn A, Gibson BL et al. 2002). Recent clinical evidence strongly suggests that brain development is much more sensitive to thyroid hormone excess or deficit than previously believed, making pesticide exposure especially hazardous at critical times of foetal development (Zoeller RT, Dowling ALS et al. 2002).

**Endocrine Disrupting Chemicals (EDCs): Human Health Impacts of Exposure**

The term "endocrine disrupting chemicals" (EDCs) is commonly used to describe environmental agents that interrupt functioning of the endocrine system (National Research Council 2000). The endocrine system releases hormones, which act as physiological messengers, and rigid feedback loops monitor timing of their release. Molecules with high informational content can induce long-term changes in a communication system if the information is disseminated at inappropriate times (Welshons W, Thayer KA et al. 2003). The physiological effect will be related to the number and types of programming mistakes induced (IPCS). Hormones that alter the information processing, by imprinting a response pathway, or imparting memory functions in a cell, can be expected to have long-term effects on developing organisms (Choi SM, Yoo SD et al. 2004). The intent of EDCs is to disrupt the reproductive capacity of insect pests, hence such chemicals stand a good chance of affecting cell differentiation in unintended species and in unintended ways. McLachlan observed signals developed for one communication system can be functionally misinterpreted by another system (McLachlan JA 2001), resulting in a spectrum of errors in the fundamental instruction system of organism development and function.

Environmental chemicals known to do this, act on receptors derived from the steroid/ thyroid/ retinoid gene family, and many function as estrogen, antiestrogen, and antiandrogen (McLachlan JA 2001). This finely tuned communication system relies on hormones having great sensitivity and specificity to maintain the complex information flow required for normal health (Kelce WR, Stone CR et al. 1995). The underlying mechanism is that chemicals in the environment that mimic or block endogenous hormones upset this fine balance by fooling the body into accepting new instructions that distort the normal development of the organism. A growing number of pesticides have been recognized recently as androgen antagonists (Wong MD, Anderson R et al. 2001). A significant feature about EDCs is that the estrogenic activity of chemicals cannot be deduced from their molecular structure; therefore it is difficult to predict whether pesticides currently used are estrogenic. A second feature making these agents hazardous, is that they are capable of producing profound effects at extremely low concentrations (Soloman GM and Krstevkska-Konstantinova M 2001; Bulayeva NN and Watson CS 2004). Very small doses therefore can have profound effects at critical times of embryonic cell differentiation.
Concern escalated in 1996 amongst the public and the scientific community worldwide about the possible harmful consequences of exposure to chemicals following the release of *Our Stolen Future: Are We Threatening Our Fertility, Intelligence and Survival?* by Theo Colborn et al. (Colburn T, Dumanoski D et al. 1997). Colburn reported findings from scientific studies on wildlife populations that revealed that exposure to EDCs had resulted in feminisation, masculinization, infertility and birth defects in species of fish, birds, reptiles and some mammals. These effects are also evident in many Australian species (Kookana R, Ying G et al. 2002).

Evidence also links harmful human health effects from EDC exposure, including decreased sperm quality and testicular abnormalities (Carlsen E, GiwercmanA et al. 1992; Veeramachaneni DNR, Palmer JS et al. 2001), increased incidence of breast and testicular cancers (Dyer O 2003), a range of reproductive effects (European Commission 2003), immune dysfunction (WHO International Programme On Chemical Safety 2002), plus significant neurobehavioural and developmental disorders (Bell EM, Hertz-Picciotto I et al. 2001).

Environmental oestrogens are chemicals in the environment which mimic the female sex hormone, oestrogen (estradiol). Oestrogenic chemicals occur normally in nature, in plants and therefore our diet. (ASTDR 1995) Others are synthetic. These are mostly found in plastics or insecticides such as PCB’s DDT, Dioxins, and furans (Soloman G, La Dou J et al. 2004). Exogenous oestrogen acts as a hormonal carcinogenetic agent, by functioning as signals in the tumorigenic process, as a secondary stimulus or promoter. Treatment of various species, including humans, with exogenous oestrogen is associated with tumour development in different organs (Degen GH and Metzler M 1997).

The pesticide dieldrin was restricted from use in Australia in 1987, and toxaphene remains in usage, both are oestrogenic (Melville J 1989). These compounds are highly lipophilic and bioaccumulate through ecosystems; they are still found in wildlife, coincident with signs of reproductive impairment (Soto AM, Chung KL et al. 1995). Toxaphene accumulates in soil, and bioaccumulates in fat where it persists.

Endosulfan produces testicular atrophy, and lowers gonadotrophin and testosterone plasma levels (Soto AM, Chung KL et al. 1995). Endosulfan has been used in Australia for 35 years, commonly on cotton, but also in the Goulburn Valley on stone fruits (APVMA 2003). The APVMA Chemical review on Endosulfan reported that aerial transport losses from spray drift, with 10% of the total application
carrying a distance of 200-400 m downwind from the target, and over 70% of applied Endosulfan is eventually transferred to the atmosphere, mainly to volatilisation in the 7 days after application. It is possible that the reportedly high incidence of male genitourinary problems observed in the Goulburn Valley region could be related to Endosulfan.

**Hormone growth promotants (HGPs): Human Health Impacts of Exposure**

HGPs are used to increase the growth, by maximizing feed conversion efficiency and carcass leanness in cattle, and are typically administered via subcutaneous implants in the ears. Although hormonal implants are widely used in beef-exporting countries such as the USA, Canada, New Zealand and Australia, they have been officially banned in Europe since 1988 on the basis of health safety concerns. The European ban has fuelled ongoing protest from the USA and Canada, which has reinforced the polarisation in scientific and regulatory opinion regarding the safety of HGPs (Graham JD and Hsia S 2002). The EU had adopted a precautionary approach and had considered social, economic and political factors as part of its risk assessment. It concluded that in the absence of data to support an alternative view, 17β-oestradiol was a “complete” carcinogen and that progesterone, testosterone, zeranol, melengestrol acetate and trenbolone acetate should all be viewed as having potentially endocrine-disrupting, developmental, immunological, neurobiological, immunotoxic, genotoxic and carcinogenic effects (Therapeutic Goods Association 2001).

A limited number of HGPs have been approved for use in Australia since the mid 1970s. Ear implants containing 17β-oestradiol, progesterone, testosterone, trenbolone acetate or zeranol, or various combinations thereof, are registered for use in all states and territories. In Australia, they are only registered for use in cattle and not in sheep, pigs or poultry, as per the U.S. (Chemical Review and International Harmonisation Section Office of Chemical Safety 2003).

In children, exposure may affect the thyroid and the immune system and alter physical and mental development (Birnbaum LS 1999). The potential threat to human health makes endocrine disrupters both a medical and a social concern (Soto AM, Chung KL et al. 1995). Krimsky, warns “From the standpoint of human pathology, the environmental endocrine hypothesis could turn out to be the most significant environmental health hypothesis since the discovery of chemical mutagenesis” (Krimsky S 2000).
Arsenic: Human Health Impacts of Exposure

The summary above provides a brief review of the most significant health effects of AgVet chemical exposure, but one other agent cannot be overlooked. The widespread usage of sheep dips in Australia has left a legacy of an estimated 100,000 contaminated sites on past and current sheep proprieties (Langley AJ 2002; Cribb J 2004). Acute exposure to arsenic irritates the eyes, the skin and the respiratory tract. Arsenic may cause effects on the gastrointestinal tract, cardiovascular system, central nervous system, and kidneys, resulting in severe gastroenteritis, loss of fluid and electrolytes, cardiac disorders, shock, convulsions and kidney impairment (ATSDR 2004). The effects may be delayed (ILO 1994). Chronic exposure to arsenic is associated with increased risks of cancer (particularly of the skin, lung, and genitourinary tract), skin pathology (sensitization, hyperkeratosis, pigmentation changes, Bowen disease, squamous cell carcinoma, and basal cell carcinomas), organomegaly, cirrhosis, vascular changes (including hypertension) and neurotoxicity (ILO 1994; Ceneno JA, Mullick FG et al. 1999). In Australia, arsenic contamination also arises from timber treatment practices, and natural geological sources (Leder K, Sinclair MI et al. 2002).

Australian environmental contamination studies

Several Australian studies have demonstrated chemical contamination of the environment, although few studies have been conducted in Australia to specifically explore contamination of agricultural regions by pesticides, and these are presented in table 2.3 below. Victorian areas include the orchard districts near Shepparton, and the tobacco growing area near Myrtleford, the Ovens and King Rives. Pesticide contamination of groundwater bores was demonstrated in both areas, and DDT and metabolites were detectable in the Ovens and King Rivers (McKenzie Smith F 1990; Bauld J, Evans WR et al. 1993; Griffiths RA, Beumont PJ et al. 1996; Wenig D and Lawrence CR 1998).

During the 1960s and 1970s, up to 40000ha of river flats in the Ovens River- King River region were under cultivation to tobacco, and organochlorines were used intensively as pesticides. DDT and dieldrin were prohibited from use on tobacco crops in Victoria in 1987. The McKenzie-Smith study, analysed water and sediment samples from five sites on the two rivers in 1993 (McKenzie Smith F, Tiller D et al. 1994). The samples demonstrated that DDD, DDE, DDT and dieldrin residues remain widespread, most likely transported from surrounding land and upstream sources. Increased concentrations of DDT, DDE and dieldrin residues were found in sediments in the quiescent areas of the rivers. Swimmers are most likely to enter these quiet parts of the rivers. Changes in flow during a storm event had a marked effect.
on distribution of residues where DDT was present in largest amounts, probably due to its association with non-filterable organic matter.

A literature search of Australian studies examining chemical contamination of humans (n=3) and environments (n=26), is summarized (chronologically) in Table 2.3 below.
Table 2.3 AgVet contamination studies in Australia

<table>
<thead>
<tr>
<th>#</th>
<th>Author / Year</th>
<th>Country</th>
<th>Method</th>
<th>Data Source</th>
<th>Focus / Aim</th>
<th>Study Factor/s</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>(Harden F, Müller J et al. 2005)</td>
<td>Australia, 12 sites, 150 samples (pooled), plus 24 samples pooled</td>
<td>Analysis of human breast milk</td>
<td>Breast milk collected for other studies (National Dioxin Program, and historical blood from 1993)</td>
<td>Organochlorine Pesticides (OCPs) and Polybrominated Diphenyl Ethers (PBDEs)</td>
<td>The highest concentrations of OCPs were found in the samples from Sydney, Melbourne and rural NSW samples. An elevated concentration of HCB was detected in the sample from rural Queensland. No significant differences in the concentrations of OCPs over the ten-year period 1993-2003. Australian levels of PBDE compounds detected in breast milk are higher than those levels observed in Europe and Japan but lower than those observed in North America and Canada.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>(Beard JR 2002)</td>
<td>Aust - Rural NSW</td>
<td>Retrospective occupational cohort</td>
<td>Compare morbidity &amp; mortality of rural occupational pesticide applicators, with rural outdoor workers, and Australian population</td>
<td>Health tracking</td>
<td>Occupational use of Insecticides</td>
<td>DDT exposed subjects had higher rates of pancreatic cancer. More asthma, diabetes, and leukaemia were seen in subjects working with more modern chemicals. There was also an increase in self reported chronic illness and asthma, and lower neuropsychological functioning scores among surviving exposed subjects when compared to controls.</td>
</tr>
<tr>
<td>3.</td>
<td>(Quinsey PM, Donohue DC et al. 1995)</td>
<td>Aust - Victoria</td>
<td>selected ion gas chromatograph-mass spectrometer monitoring of lipophilic fraction of the breast milk</td>
<td>Breast milk, Victorian rural and urban mothers</td>
<td>Determine infant daily intake</td>
<td>organochlorine (OC) contamination</td>
<td>Widespread contamination of milk with dichlorodiphenyltrichloroethane (p,p'-DDT) and its metabolite dichlorodiphenyldichloroethene, hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs), oxychlordane and hexachlorocyclohexane, with p,p'-DDT and HCB being found in nearly all samples. Dieldrin and heptachlor epoxide were detected in 43 and 30% of samples respectively. PCBs were detected in 79% of samples and chlordane in 76%. A number of infants had daily intakes above the acceptable daily intake for total chlordane, total DDT, dieldrin, heptachlor epoxide and total PCBs.</td>
</tr>
<tr>
<td>#</td>
<td>Author / Year</td>
<td>Country</td>
<td>Method</td>
<td>Data Source</td>
<td>Focus / Aim</td>
<td>Study Factor/s</td>
<td>Finding</td>
</tr>
<tr>
<td>----</td>
<td>---------------</td>
<td>---------</td>
<td>--------</td>
<td>-------------</td>
<td>-------------</td>
<td>----------------</td>
<td>---------</td>
</tr>
<tr>
<td>4.</td>
<td>(Wenig D and Lawrence CR 1998)</td>
<td>Aus – Vic Shepparton irrigation area</td>
<td>Ground water monitoring</td>
<td>Groundwater – bore water</td>
<td>Investigate contamination</td>
<td>Pesticides</td>
<td>OCPs- DDT &amp; Dieldrin, Ops- chlorpyriphos, s-triazine, simazine &amp; amitrole found under horticultural areas, more than under grazing areas.</td>
</tr>
<tr>
<td>5.</td>
<td>(Sinclair, Knight et al. 1997)</td>
<td>Aus – Vic Myrtleford &amp; Bacchus Marsh</td>
<td>Ground water monitoring</td>
<td>Groundwater table - – 6 bores each,</td>
<td>Contamination levels</td>
<td>Nutrients &amp; pesticides</td>
<td>No detectable contamination at Bacchus Marsh. Myrtleford groundwater contaminated with DDT &amp; DDD in 2 bores, &amp; dieldrin &amp; DDE at another bore</td>
</tr>
<tr>
<td>7.</td>
<td>McDougall KW, 1994</td>
<td>Aus – NSW north coast ag regions</td>
<td>Field study</td>
<td>Water collected in rainwater tanks</td>
<td>Persistence of ag sprays in drinking water</td>
<td>Dieldrin, aldrin, lindane, chlorpyriphos, &amp; prothiofos</td>
<td>Dieldrin &amp; lindane stable for 36 wk test period,, Aldrin has half life of 4-5 weeks, Chlorpyriphos has half life of 12-18 wks Prothiofos has half-life of 11-14 weeks. Recommend activated carbon filter or safe disposal of water</td>
</tr>
<tr>
<td>8.</td>
<td>(McKenzie Smith F, Tiller D et al. 1994)</td>
<td>Aus – NE Vic Ovens &amp; King Rivers</td>
<td>Field study</td>
<td>River water</td>
<td>Impact &amp; fate of residues</td>
<td>OC biocide residues</td>
<td>OC residues exhibit predictable behaviour, redistribution may have substantial impact on fauna &amp; flora exposed.</td>
</tr>
<tr>
<td>9.</td>
<td>Ang C, 1989</td>
<td>Aus - NSW Nth Coast</td>
<td>Survey - comparison</td>
<td>Public &amp; Private Drinking water 659 supplies</td>
<td>Measure pesticide &amp; herbicide residues</td>
<td>Dieldrin</td>
<td>23% contaminated, 4.6% were high. Most were from private water tanks</td>
</tr>
<tr>
<td>10.</td>
<td>Fabris G, 1999</td>
<td>Aus – Vic Southern rivers &amp; Lakes</td>
<td>Field studies</td>
<td>Eels (Anguilla Australia)</td>
<td>Determine status of contaminants in wild eels</td>
<td>Mercury, OCs, Organophosphate, DDT &amp; Dieldrin</td>
<td>No OPs or simazine found. Traces DDT, mercury &amp; dieldrin detected. High concentrations of mercury in Barwon R &amp; Lake Wellington</td>
</tr>
<tr>
<td>11.</td>
<td>Roach AC, 1998</td>
<td>Aus – NSW Sydney</td>
<td>Field studies</td>
<td>Edible tissues of fish 8 species from 5 locations</td>
<td>Levels of contaminants</td>
<td>Selected chlorinated hydrocarbons</td>
<td>At some locations, mean levels of PCBs &amp; Organochlorine Pesticides (Chlordane, dieldrin, heptachlor) were greater than MRLs in 5 species.</td>
</tr>
<tr>
<td>12.</td>
<td>Scannes, 1997</td>
<td>Aus - Sydney</td>
<td>Field experiments</td>
<td>Sydney rock oysters</td>
<td>Rates of uptake &amp; depuration of chemicals</td>
<td>Chlordane, dieldrin, eptachlor, epoxide, PCBs, DDT, DDD, DDE</td>
<td>Detectable concentration of all organochlorines were present after 3 days in contaminated location</td>
</tr>
<tr>
<td>#</td>
<td>Author / Year</td>
<td>Country</td>
<td>Method</td>
<td>Data Source</td>
<td>Focus / Aim</td>
<td>Study Factor/s</td>
<td>Finding</td>
</tr>
<tr>
<td>---</td>
<td>---------------</td>
<td>---------</td>
<td>--------</td>
<td>-------------</td>
<td>-------------</td>
<td>----------------</td>
<td>---------</td>
</tr>
<tr>
<td>13.</td>
<td>Moore S, Lewin K et al. 1996</td>
<td>Aus – NE Vic</td>
<td>Field study</td>
<td>36 fish @ 7 sites</td>
<td>OC residues &amp; sublethal toxicity on midge larvae &amp; fish</td>
<td>DDT, &amp; metabolites detected, low incidence of morphological abnormalities</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Andrijanic S, 1991</td>
<td>Aus - Sydney</td>
<td>Filed study</td>
<td>Ocean Fish – red morwong</td>
<td>Residues &amp; bioaccumulation</td>
<td>Chlordane, HCB, DDT * &amp; metabolites, PCBs, dieldrin</td>
<td>Chemical residues in fish suggest point source pollution at Malabar &amp; Kurnell outfalls</td>
</tr>
<tr>
<td>15.</td>
<td>Mann RA, 1990</td>
<td>Aus – Sydney</td>
<td>Bioaccumulation studies</td>
<td>Several fish species</td>
<td>Industrial compound residues in fish</td>
<td>OCs, Benzene hexachloride, heptachlor epoxide</td>
<td>Concentrations found in fish muscle exceeded NHMRC guidelines, dieldrin, heptachlor &amp; aldrin found in some fish</td>
</tr>
<tr>
<td>17.</td>
<td>McDougall KW, 1994</td>
<td>Aus – NSW Nth Coast</td>
<td>Residue tests, fish &amp; bird residues</td>
<td>Soil samples, fish &amp; birds</td>
<td>Extent of contamination</td>
<td>Organochlorine pesticides</td>
<td>Concludes that current levels of contamination &amp; banning of further use of OCs for agriculture will leave minimal environmental impact</td>
</tr>
</tbody>
</table>

**Pollution of environment**

<table>
<thead>
<tr>
<th>#</th>
<th>Author / Year</th>
<th>Country</th>
<th>Method</th>
<th>Data Source</th>
<th>Focus / Aim</th>
<th>Study Factor/s</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.</td>
<td>(Dingle P, Williams D et al. 1999)</td>
<td>Aus – WA</td>
<td>Field study</td>
<td>Residential houses n = 22</td>
<td>Measure indoor air quality post termite control</td>
<td>Pesticides</td>
<td>Detectable level in 19 (86%) houses of heptachlor, dieldrin, chlordane, aldrin &amp; chlorpyrifos. Highest levels were in bedrooms. Strong correlations between time of application &amp; measurements for heptachlor - &amp; chlordane, but not for aldrin &amp; dieldrin.</td>
</tr>
<tr>
<td>19.</td>
<td>Mele PM, 1999</td>
<td>Aus – NE Vic</td>
<td>Field study</td>
<td>Soil samples</td>
<td>Abundance &amp; distribution</td>
<td>Earthworms</td>
<td>Low abundance and species poverty. Soils under pasture supported 3.2 times more earthworms than areas under cropping.</td>
</tr>
<tr>
<td>#</td>
<td>Author / Year</td>
<td>Country</td>
<td>Method</td>
<td>Data Source</td>
<td>Focus / Aim</td>
<td>Study Factor/s</td>
<td>Finding</td>
</tr>
<tr>
<td>----</td>
<td>---------------</td>
<td>---------</td>
<td>--------</td>
<td>-------------</td>
<td>-------------</td>
<td>----------------</td>
<td>---------</td>
</tr>
<tr>
<td>20.</td>
<td>Good J, 1995</td>
<td>Aus – Vic</td>
<td>Water sampling survey</td>
<td>18 sites</td>
<td>Measure ambient pollutant concentrations</td>
<td>common organic pollutants</td>
<td>Hydrocarbons most widespread, PAH found throughout the bay, dieldrin, cyanide &amp; sulphide. Increased concentration as after heavy rain event of petroleum’s, PAHs &amp; OC insecticides.</td>
</tr>
<tr>
<td>21.</td>
<td>McKenzie Smith F, 1994</td>
<td>Aus – NE Vic</td>
<td>Environmental sampling – 5 sites, 2 rivers</td>
<td>Water &amp; sediment samples</td>
<td>Measure residue contamination</td>
<td>DDD, DDE, DDT, dieldrin</td>
<td>Residues of all are widespread, and fairly even. More DDD in quiescent part of rivers, &amp; 70% of the dieldrin residues in unsettled sediment fraction. Marked changes post storm event, with more DDT deposition.</td>
</tr>
<tr>
<td>22.</td>
<td>Ghadiri H, 1993</td>
<td>Aus - SA</td>
<td>Field &amp; controlled environment experiments</td>
<td>Soil samples - Comparison of soils c 10% water content &amp; wetter soils</td>
<td>Persistence &amp; degradation in soil of aged or newly added OC pesticides</td>
<td>Degradation of all aged OCs was slower in drier soil. Degradation of endosulphan much slower than commonly thought. Endosulphan slows degradation of other agents indicating possible toxic effect on micro-organisms responsible. Degradation of dieldrin &amp; aldrin significantly slower in submerged soils.</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>McCormick MJ, 1993</td>
<td>Aus – Vic</td>
<td>Toxicant survey</td>
<td>Werribee Treatment Complex - soils &amp; sludges samples</td>
<td>Measure levels * trends</td>
<td>Range of toxicant classes</td>
<td>Heavy metals were above guidelines. Dieldrin, DDT &amp; trichlorobenzene also at elevated levels. Dioxins &amp; furans, PAHs, Phthalate esters, OCs, PCBs &amp; Chlorinated aromatic hydrocarbons are still entering but trend is declining.</td>
</tr>
<tr>
<td>24.</td>
<td>Bowman Bishaw, 1992</td>
<td>Aus – WA</td>
<td>Environmental survey</td>
<td>Treated wastewater Beenyup ocean outlet, sediment &amp; mussel sampling</td>
<td>Establish levels of pollutants</td>
<td>Metals, pesticides &amp; Organo halogens</td>
<td>Organo halogen concentrations were low, Metals, &amp; Chlorinated pesticide levels of dieldrin &amp; lindane were elevated.</td>
</tr>
<tr>
<td>25.</td>
<td>Pettigrove VJ, 1990</td>
<td>Aus - NE Vic</td>
<td>Field study</td>
<td>Chironomid taxa (larvae)</td>
<td>Compare levels between tobacco regions and control</td>
<td>Frequency &amp; severity structural abnormalities</td>
<td>Populations near tobacco plantations displayed higher frequencies &amp; more severe structural abnormalities.</td>
</tr>
<tr>
<td>26.</td>
<td>Davis J, 1990</td>
<td>Aus – inner urban Perth</td>
<td>Pesticide sampling program</td>
<td>Herdsman Lake – freshwater wetland</td>
<td>Measure surface water (recreational) concentrations</td>
<td>Chlordane, dieldrin, heptachlor</td>
<td>Levels OCs in mosquito fish, swamphens, grassbirds &amp; other wetland biota exceed guidelines. Large amounts of pesticides are washed into the lake after rains.</td>
</tr>
<tr>
<td>#</td>
<td>Author / Year</td>
<td>Country</td>
<td>Method</td>
<td>Data Source</td>
<td>Focus / Aim</td>
<td>Study Factor/s</td>
<td>Finding</td>
</tr>
<tr>
<td>----</td>
<td>---------------</td>
<td>-----------------</td>
<td>-----------------------------</td>
<td>-----------------------</td>
<td>-----------------</td>
<td>----------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>27</td>
<td>Byrne D, 2002</td>
<td>Aus</td>
<td>NRA (APVMA) Fact sheet</td>
<td>Registration status</td>
<td>Withdrawal</td>
<td>Endosulphan</td>
<td>Current registration suspended all products containing endosulphan. Guidelines available to assess residues in cattle fed endosulphan treated materials</td>
</tr>
<tr>
<td>28</td>
<td>Leonard AW, 2001</td>
<td>Aus – NSW Cotton growing regions</td>
<td>Field studies</td>
<td>River water &amp; sediments</td>
<td>Analysis</td>
<td>Biota &amp; endosulphan concentrations,</td>
<td>Pulse exposures of endosulphan in water following storm run off may be more acutely toxic to riverine biota than in contaminated bottom sediment</td>
</tr>
<tr>
<td>29</td>
<td>Enoma AO, 2001</td>
<td>Malaysia</td>
<td>Laboratory studies</td>
<td>Sandy loam &amp; clay soils</td>
<td>Degradation pattern &amp; fate</td>
<td>Endosulphan</td>
<td>Degradation is mainly due to soil micro-organisms. Endosulphan degraded slowly. 3 Degradation products formed including endosulphan sulphate.</td>
</tr>
</tbody>
</table>
Exposure events in Australia

Few Australian studies have examined the impact of AgVet exposure on human health. One study identified a group exposed to herbicides, and sharply criticised the health sector response. In 2001, Andrew Harper, an occupational and public health physician, was contracted by the Western Australian Minister for Agriculture, Forestry and Fisheries, to conduct an independent investigation of a long standing issue in the Kimberley Region in north west, Western Australia. Harper’s report, The Kimberley Chemical Review, was released in June 2002. The former Agriculture Protection Board commenced a weed control program in the Kimberley Region in 1975, and community health concerns emerged soon afterwards. This ten-year long program employing Kimberley local Aboriginal workers to spray herbicides, was managed from Perth, some 1,400 kilometres away. The herbicides used were 2,4 Dichlorophenoxyacetic acid (2,4-D) and 2,4,5- Trichlorophenoxyacetic acid (2,4,5-T), which were first produced in the 1940’s, and subsequently used widely across Australia. Recognition that the impurity 2,3,7,8 Tetrochlorodibenzo-p-dioxin (2,3,7,8-TCDD) contaminated 2,4,5-T occurred in the 1960’s, but at that time the levels involved were considered to pose no danger to human health (Harper AC 2002).

The higher cost and lower effectiveness of alternative chemicals contributed to the continued reliance of 2,4-D, and 2,4,5-T, and the sale and use of 2,4-D continues today. Specifics of the Kimberley case relied on government advice that “no harmful effects could be expected if used according to label directions”. Amid increasing reports of birth defects, and skin disorders, general ill-health and unexpected deaths, which were presumed to be linked to exposure to 2,4,5-T, government agencies and the National Health and Medical Research Council (NH&MRC) repeatedly advised that it did not represent a significant threat to human health. In 1979, the Victorian Vermin and Noxious Weeds Destruction Board advised that with normal care, a human being could not be exposed to levels of 2,4,5_T or dioxin, which would cause any serious health problems. The document also recommended that applicators wear boilersuits or similar clothing to minimise exposures and avoid inhaling the spray during “normal agricultural use” (Parsons WT 1979).

Harpers’ investigation revealed that safety procedures were not followed. Over 88% of sprayers reported receiving no chemical safety training, personal protection gear was either not supplied or not encouraged, partly due to the hot climatic conditions, and the guidelines specifying adherence to label instructions were futile, when illegal importation of unlabelled drums after the end of the Vietnam War was widespread, and decanting into smaller (also unlabelled) drums was common practice. The dioxin content of those drums was analysed at a strength of 26mg/kg compared to the NH&MRC’s maximum
‘safe’ recommendation of 0.01mg/kg. Some workers knew the chemicals were dangerous, others were
told that it ‘was so safe, you could drink it’. Leakage and spills were common, workers were constantly
soaked with the chemicals, and inhaled the fumes, and the chemicals were stored where workers slept,
resulting in extremely high exposure levels. Workers reported that employers and health providers
routinely disregarded their health complaints.

The illnesses among weed sprayers demonstrated recurrent non-specific symptoms similar to those
being increasingly reported by people in other occupations exposed to a various types of synthetic
chemicals. This Kimberley Chemical Review concluded the chronic symptoms were clinically significant
in causing significant illness and disability, and for this reason warranted medical management. The
exposed group reported high levels frustration with medical treatment in relation to lack of attention to,
and management of their chemical induced ill-health (Harper AC 2002). Quotes from disgruntled
Kimberley residents included:

- ‘It (visiting the doctor) was a waste of time’
- ‘The doctor didn’t ask or enquire about my exposures’
- ‘The doctors tended not to take my daughters health complaints seriously’
- ‘They couldn’t do anything, I only got Panadol’
- ‘Doctors don’t know what the problems is’
- ‘The doctor said there was nothing wrong with me’

Harper argued the observed dissatisfaction with medical treatment is a common problem when disability
and sickness is met with lack of understanding, support and explanation, which, furthermore, can result
in aggravated symptoms through the added distress of being ignored. The review identified widespread
gaps in the chemical management system within Australia, from the institutional level, chain of
command, through to medical management, and community education throughout the 1975-1985 weed
eradication program.

A second study reporting a lack of medical expertise to identify chemical exposure injury was conducted
by the Royal Australian Airforce as a Senate inquiry. The study reported there is a risk in circumstances
of inadequacies in clinical knowledge, medical practitioners will downplay the significance of the
symptoms (RAAF 20001).

Other studies identifying chemical contamination of Australian populations include Quinsey’s
examination of organochlorine (OC) contamination in the milk of mothers resident in Victoria, which
monitored OC elimination by the nursing mother and estimated the infant’s daily intake of OCs from
breast milk. Widespread contamination of milk with dichlorodiphenyltrichloroethane (p,p'-DDT) and its metabolite dichlorodiphenylchloroethene, hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs), oxychlordane and hexachlorocyclohexane was found, with p,p'-DDT and HCB occurring in nearly all samples (Quinsey PM, Donohue DC et al. 1995). Dieldrin and heptachlor epoxide were detected in 43% and 30% of samples respectively, and PCBs were detected in 79% of samples and chlordane in 76%. A number of infants had daily intakes above the acceptable daily intake for total chlordane, total DDT, dieldrin, heptachlor epoxide and total PCBs.

A Monash University media release recently reported the findings of a doctoral study demonstrating a link between OC exposure and breast cancer in the Ovens Valley, the study attributed the heightened risk to exposure from the tobacco plantations (Khanjani N 2005). (At time of writing, these findings were yet to be published.) Researchers at Monash University commenced a study exploring health status of agricultural workers who have applied organochlorines in the Goulburn Valley regions in late 2004, and anticipate releasing their findings in late 2005.

Beard explored health impacts of human exposure to pesticides by following the health outcomes of approximately 4000 outdoor workers in NSW over a period of up to sixty-one years (Beard JR 2002). Beard’s study identified that agricultural workers exposed to cattle dips showed significant poorer health status, compared to a cohort of outdoor workers across a range of conditions (Beard J, Sladden T et al. 2003). These include pancreatic cancer in some DDT exposed subjects, and asthma, diabetes, and leukaemia in subjects working with more modern chemicals. There was also an increase in self reported chronic illness and asthma, and lower neuropsychological functioning scores among surviving exposed subjects when compared to controls. Diabetes was also reported more commonly by subjects reporting occupational use of herbicides (Beard JR 2002). Australian studies exploring human exposure to agricultural chemicals are summarized in Table 2.4 below.

The Health Risk Perception in Australia study conducted for the enHealth Council, investigated community perception of risks, and people’s confidence in various sources of information, and their opinions as to where responsibility for protecting the public from health risks lies, and how well these responsibilities have been met. This study by Starr et al. revealed that 71% of the Australian population believes their existing environmental health risks are moderate or greater (Starr G, Langley A et al. 2000), substantial concern about exposure to chemicals with over 81% of respondents indicating a conscious effort to avoid them in their daily life. Pollution issues all frequently rated as high risks, with chemical pollution overall being regarded as the greatest risk. Chemicals such as pesticides and
insecticides were considered high risk by about half of the Starr study respondents. The study found concerns were heightened by risks that are:

- Involuntary or imposed on the community
- Man made rather than natural
- Inescapable
- Controlled by parties outside the community
- Have little or no benefit to the community
- Unfairly distributed
- Related to a distrusted source
- Exotic or unfamiliar
- Affect children or pregnant women
- Affect identifiable rather than anonymous people
- The cause of insidious and irreversible damage
- The cause of dreaded health effects such as cancer
- Poorly understood by science
- Subject to contradictory statements from responsible sources
- Related to situations where the risk makers are not the risk takers (Starr G, Langley A et al. 2000)

**Prior recognition of health risk**

Chemicals management attracted considerable focus at the United Nations Conference on Environment and Development in Rio De Janiro 1992. This was recognised in Chapter 19 of Agenda 21, which laid out a series of objectives designed to help countries work together to improve and strengthen their management of chemicals to contribute to improved human and environmental health. To encourage countries to develop a national profile, and a guideline document was disseminated by UNITAR (United Nations Institute for Training and Development)(UNITAR 1996). Australia complied.

The Commonwealth Department of Environment and Heritage published in 1998 a National Profile of Chemicals Management Infrastructure in Australia (Environment Australia 1998). The report noted significant weaknesses which added to exposure risks. Individual states had differing training requirements for AgVet users, and that farmer knowledge was insufficient, which resulted in inappropriate use of chemicals. Existing labels were an unsatisfactory substitute for MSDS (Material Safety Date Sheets), and there was insufficient knowledge available about potential health impacts of pesticides when mixed with other chemicals. It also reported that the medical profession was not educated about the health risks of AgVet exposure, and that there was a lack of notification
requirements, so that documentation of cases not collated. The document made the following specific recommendations with regard to occupational health in agriculture:

a)  re-education of users
b)  re-education of medical profession
c)  research on mixing of chemicals
d)  extension of industry training programs
e)  reduction of use of chemicals.

This section was classified as having a low ability for government control to rectify the problem. This may be the reason behind lack of implementation (Environment Australia 1998).

The stated objective of this document is to serve as a tool to assist the process of effective chemicals management in Australia. The National Profiles are to serve as a reference point from which to measure progress in legal, institutional, administrative and technical infrastructure, and to assist in the identification of infrastructure related strengths, weaknesses, and gaps, as well as priority needs for national action and external technical assistance (UNITAR 1996). The ultimate objective is that such a step would assist to minimize harm to human health and the environment. However, involvement of the health sector in development of Australia’s National Profile appears scant. The consultation process included industry, trade unions, farmers groups and environment groups. The authors did not seek public health input.

**Discussion**

Exposure to AgVets can be damaging to human health, causing a range of disorders, which can be severely debilitating, or even fatal. The studies reviewed here flag the need for strategies to reduce environmental contamination, and minimize exposure to harmful agents. Chemicals available for use in Australia must be relatively safe, and AgVet users must adopt safe chemical handling techniques. Public health infrastructure can work to ensure available agents are safe to use, and monitor health impacts. Chemical exposure is an environmental health issue, and the health problems described in the above sections indicate that a role exists for primary health care providers to provide health education and health promotion, screening, and to identify and manage health problems as they arise. This implies
active involvement of the health care sector is required in environmental health issue, as significant
evidence now exists to demonstrate harmful health impacts of exposure to individual chemicals.

Exacerbating the problem further is the issue of exposure to multiple chemicals. Unlike laboratory
animals, people are rarely exposed to a single hazardous chemical, as unlike the environments of 50
years ago, chemicals are now ubiquitous. It has been suggested that this continual chemical exposure is
contributing to a general diminution of immune function, which is expressed as rising rates in asthma,
chemical sensitivities, and the incidence of certain cancers (Soto AM, Chung KL et al. 1995; Thomas PT
1995; Thrasher JD, Heuser G et al. 2002).

Over recent years attention has been drawn to the effect of chemical mixtures, in the U.S., Europe and
Japan (Feron VJ, Cassee FR et al. 1998). Most information documenting adverse human health effects
from environmental and occupational contaminants derives from studies focused on exposure to
individual chemicals, and there is little information available on how two or more contaminants affect
humans (Carpenter DO, Arcaro KF et al. 1998). Additionally, much of this information emanates from
animal systems, with limited investigations of isolated human cells in culture. Two or more compounds
may show additive, antagonistic, or synergistic interactions or may act on totally different systems and
thus not interact (Hansen H, De Rosa CT et al. 1998). For example pyrethrin is a commonly used
domestic pesticide, which is known to cause asthma, it is intentionally mixed with compounds to increase
its toxicity to insects 100 fold (Midtling JE 1999). Furthermore, a single chemical may have multiple
effects and affect more than one organ system (Feron VJ, Cassee FR et al. 1998).

A person's history of previous exposures, and resultant physiological impacts, may influence health
response to subsequent exposures. Effects may vary with age, and metabolites may have totally
different actions from the parent compound (Carpenter DO, Arcaro KF et al. 1998). Information on the
total impact on human health from exposure to AgVets, in concert with exposure to other domestic and
industrial chemicals is therefore extremely limited. From this it can be safely assumed that the
information currently available substantially underestimates the real impact of exposure to these agents
(Bucher JR and Lucier G 1998).

The question emerging from this literature review asks why the health professions have been slow to
incorporate chemicals exposure into the health training and practice. Butler and McMichael
recently explored the methodological problems associated with establishing causality with sufficient
rigour to convince those operating from the biomedical paradigm (Butler CD and McMichael AJ 2005).
They argue that limitations inherent in epidemiological methodology render epidemiology a blunt instrument for detecting a causal effect from low dose pesticide exposure and ill-health. The criticism is based on four main limitations. These are:

(a) the difficulty of investigating the causation of diseases such as cancer and neurological conditions with development times as long as several decades;
(b) the difficulty of measuring the cumulative dose of pesticide exposure;
(c) the significance of interactions between different pesticides; and
(d) the scarcity of adequate control groups.

Here, the fourth limitation is the most restrictive, because exposure to multiple pesticides is now almost ubiquitous – within developed and developing countries, making it extremely difficult to find comparable populations with little or no pesticide exposure. In effect Butler and McMichael argue that rigorously establishing causation has been too hard, and therefore largely ignored.

**Conclusion**

The evidence linking exposure to AgVets to human health problems is now firmly established. Implementation of the recommendations made in the *National Profile of Chemical Management in Australia* appears fundamental to minimize the risk of harm associated with chemical usage in the agricultural sector. Assessment of Australia’s progress towards these strategies occurs during this study.

In addition to the evidence provided through international research, several studies now indicate that Australia is not free of these problems. Australian studies have found environmental and human contamination arising from hazardous exposure to AgVets, and two studies (Kimberley and the RAAF), described situations of reported inadequate medical practitioner responses to chemical injury. These studies found that medical practitioners did not recognize symptoms of chemical injury and thereby dismissed patients’ symptoms. As health provider education and their practices are common across the nation, the potential exists then, for rural communities working and living amongst areas of high AgVet usage to suffer health consequences, which may not be adequately identified by their attending physicians.
CHAPTER 3
ENVIRONMENTAL HEALTH SYSTEMS

Introduction

The question of how well Australia addresses problems through its primary health care system and chemical management framework, necessitates comparisons with other countries to serve as a frame of reference from which to compare what is currently recognised as feasible. Strategies adopted in Europe and the U.S. demonstrate differing approaches taken by these similarly industrialised countries. This chapter therefore compares how Australia’s response compares to their progress towards developing a comprehensive system to identify, minimise and manage human health effects from exposure to AgVet chemicals.

The first sections outline the initial development of environmental health systems in Europe and the U.S., and review Australia’s early attempts to address situations where it became evident that environmental conditions were impacting negatively upon population health. These driving forces mirrored situations experienced elsewhere, yet emerged much later in Australia’s fledgling society in the late 1800’s. This is followed by a summary of the rising global awareness throughout the last third of the twentieth century, of emerging environmental health problems emanating from intensification of industrial and agricultural activities. These have generated a new set of health hazards, and reinstated the need for appropriate government attention to expand environmental health system management.

The next sections explore the key elements of the recent developments in environmental health management systems introduced in Europe and the U.S. Emphasis is on their responses to human exposures to chemicals, chemical regulatory frameworks, government strategies to encourage a reduction in reliance on chemicals, and systems introduced to conduct risk assessments, and human health surveillance. Discrepancies between these advancements and Australia’s existing systems are then highlighted.

The final part of this chapter then explores the recognition of a need for environmental health skills and expertise among the primary health care workforce, and how other nations have moved to address this need.
Evolution of Environmental Health

Hunter-gatherer societies, using only renewable naturally occurring resources, moved often, in a rotational pattern as resources depleted, and returned later after the seasons had replenished stocks. Wastes generated were relatively minimal, easily dispersed and biodegradable. As townships developed, concentrating large numbers of people into settlements, issues of reliable resource supply and waste removal, rose to the fore and demanded satisfactory resolution (McMichael AJ 1993). Failure to respond resulted in the spread of disease and malnutrition. Successful societies learnt these lessons thousands of years ago. In A.D. 80, the Roman Senate passed a law to protect water stored during the dry periods so it could be released for street and sewer cleaning. After the dark ages however, few further government interventions were reported until 1285, when King Edward of England responded to a petition from members of the London nobility, distressed by the offensive coal smoke arising from the burning of soft coal (Paustenbach DJ 2002).

The Public Health Act, enacted in 1848, effectively enshrined the notion of state responsibility for human health (McMichael AJ 1993), especially for vulnerable populations. During this first public health revolution, public health practice and legislation focussed largely upon engineering environmental improvements to sanitary conditions, and improving living and working environments (Yassi A, Kjellstrom T et al. 2001). The birth of public health was therefore, in effect, sparked by the evolution of environmental health (Fairbanks J and Weise WH 1998; Yassi A, Kjellstrom T et al. 2001), when it became evident that exposure to unhealthy living and working environmental hazards resulted in human diseases. The activity of protecting the health of the public from harmful physical environments via legislation and enforcement (and other means) is termed ‘health protection’, and still remains a core role of environmental health today. With improvements in hygiene and living standards in the developed world, living environments became less of a health threat. Core public health practice focus then diverged from health protection, towards the Ottawa health promotion principles, and the social, behavioural and educational factors influencing health (WHO Regional Office for Europe 1986).

In some aspects, the evolution of environmental health protection in Australia mirrors the international experience, transposed to a new land, where the timing of rising population densities and industrialisation were greatly delayed. Australia had the benefit of introducing strategies relatively early in its development history. The first Public Health Act in Australia was passed only six years later than England, in December 1854 (Smith J 1996). Original concerns about hazardous environments similarly arose from highly unsanitary conditions created in Melbourne and the rapidly expanding gold fields when
a sudden influx of migrants during a twenty-month period outstripped the capacity of existing infrastructure (Cumpston JHL 1989; NEHF 1998).

Most public health efforts throughout the late 1800s and into the early part of the 1900s, in Australia, as elsewhere, were primarily concerned with the control of infectious diseases through environmental health interventions focussed on ensuring safe and healthy environments. These were achieved through legislation, which were modelled on the early English laws, and regulations imposing restrictions on the activities of individuals and organisations (Reynolds C 2004). Australia’s advantages of ‘late development’, low population densities with smaller industrial base, and general adherence to regulations have resulted in considerable success in these efforts when compared to other countries. Australia currently enjoys a reputation of being ‘clean and green’, and has not experienced environmental disasters of the scale experienced elsewhere to prompt community outrage and subsequent development of rigorous chemical inventories, or community right-to-know acts.

From the 1950s through to the 1980s, a series of industrial pollution disasters alerted the world to the seriousness of chemical pollution and overuse of natural resources. Many industrialised countries were directly affected by environmental catastrophes: the Great London Smog of 1952; Minamata (Japan, 1956); pollution of the Great Lakes¹ (1972) and Love Canal (New York, 1978); Seveso (Italy, 1976); Bhopal (India, 1984), and Chernobyl (Ukraine, 1986) (Clapp R 2000; Weir E 2002). The environment re-emerged from these events as a health determinant capable of seriously damaging human health, and so could no longer be viewed as a permanently renewable resource. Carson’s 1962 book ‘Silent Spring’, intensified public concern about pesticide exposure and virtually launched the first wave of environmentalism in the United States (Smith C 2003). Widespread media coverage of events through the 1970’s and 1980’s elicited community outrage, and political response in the form of funded research, and several environmental laws aiming to curtail environmental damage and to protect human health (Rodricks JV 1997; Gore A 2000). (These will be explored later.) And thus, in recent decades environmental matters have reconnected to the public health agenda. Table 3.1 below, outlines the pathway towards current international chemical management agreements to protect human health and the environment.

---

¹ In 1963 it was known that herring gulls in the Great Lakes region were failing to reproduce, this was later understood to be a function of dichlorodiphenyltrichloroethane (DDT) exposure. In 1972, upon the culmination of evidence from multiple studies, the Great Lakes Water Quality Agreement was signed; the agreement identified over 350 hazardous polluting substances and called for the virtual elimination of the discharge of any or all persistent toxic substances.
**Table 3.1 Pathway to International Conventions relating to Chemicals**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1968</td>
<td>Sweden proposed that the United Nations (UN) convene an international conference to address issues arising from the interrelation between human activities and the global environment</td>
<td>Sweden proposed that the United Nations (UN) convene an international conference to address issues arising from the interrelation between human activities and the global environment.</td>
</tr>
<tr>
<td>1972 Stockholm</td>
<td>First UN Conference on the Human Environment</td>
<td>Establishment of the United Nations Environment Program (UNEP) to embrace all activities undertaken within the UN system related to the environment.</td>
</tr>
<tr>
<td>1983</td>
<td>The United Nations created a World Commission on Environment and Development (WCED)</td>
<td>Urged that all human activities should follow a path of sustainable development, defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”</td>
</tr>
<tr>
<td>1987</td>
<td>WCED (Brundtland) report entitled “Our Common Future”</td>
<td>The Basel Convention Imposes strict controls over the transboundary movement of hazardous wastes (poisonous, infectious, corrosive, explosive or ecotoxic), to prevent the dumping from OECD countries to non-OECD countries.</td>
</tr>
<tr>
<td>1987</td>
<td>The Basel Convention</td>
<td>WHO commissioned a report entitled “Our planet, our health” to be endorsed at the Earth Summit - Rio Conference.</td>
</tr>
<tr>
<td>1989</td>
<td>Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade</td>
<td>International treaty to give importing countries the power (information and capacity) to make informed decisions as to which chemicals they will receive, and which they can exclude because they cannot be managed safely.</td>
</tr>
<tr>
<td>1998</td>
<td>Stockholm Convention on Persistent Organic Pollutants, UNEP</td>
<td>International treaty to protect human health and the environment from persistent organic pollutants (POPs) including measures by implementing Governments to eliminate or reduce the release of POPs into the environment.</td>
</tr>
<tr>
<td>2000</td>
<td>World Summit on Sustainable Development (WSSD)</td>
<td>Johannesburg Plan of Implementation (JPOI) called for increased efforts to ratify international instruments; by 2020 use and production of chemicals to minimise adverse health and environment effects; develop a strategic approach to international chemicals management; by 2005, of a SAICM based on the IFCS Bahia Declaration and Priorities for Action Beyond 2000; new globally harmonised system for the classification and labelling of chemicals (GHS), by 2008 <a href="http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal">http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal</a></td>
</tr>
<tr>
<td>2001</td>
<td>First Preparatory Committee for Strategic Approach To International Chemicals Management (SAICM)</td>
<td>120 countries, 14 UN bodies, four IGOs, 24 NGOs agree to pursue JPOI, and global programme of action with targets and timetables; an overarching chemicals policy strategy.</td>
</tr>
</tbody>
</table>
Health problems resulting from exposure to chemicals remained among the topics causing international concern. The International Programme on Chemical Safety (IPCS) was established in 1980 as a joint program of three cooperating organisations: International Labour Organisation (ILO); UNEP; and the World Health Organisation (WHO), with WHO as the Executing Agency (International Programme on Chemical Safety 2002). The IPCS brief is to establish the scientific basis for safe use of chemicals, and to strengthen national capabilities and capacities for chemical safety.

Once released, chemicals move around the environment. Some react with light or with other chemicals, and some are naturally degraded. But others persist for many years in an active state (Guerin TF 1999). Living organisms can take them up, and low-level pollutants are ‘bio-magnified’ as they move up food chains, sometimes in predator species, including humans, reaching over 100,000 fold the concentrations seen in lower life forms (Cullen MC and Connell DW 1992).

Evidence of chemical toxicity was rapidly amassing, making the first priority activity of the IPCS the development of a global treaty to reduce the utilisation and impact of the most hazardous agents on the global market. The Basel Convention (1989) imposes strict controls over the transboundary movement of hazardous wastes that are poisonous, infectious, corrosive, explosive or ecotoxic. It was introduced to prevent the dumping of chemicals from OECD countries to non-OECD countries. The Rotterdam Convention (1998) arose out of concern about the large volumes of chemicals being traded, especially in countries without the infrastructure to monitor the import and use of 22 pesticides, and five industrial chemicals of greatest concern. This convention obliges parties to notify the secretariat of regulatory actions regarding these banned or severely restricted chemicals (UNEP 2002). In June 1996, the Intergovernmental Forum on Chemical Safety (IFCS) concluded that sufficient evidence was available to demonstrate a need for binding international action to reduce the risks to human health arising from the release of the most persistently hazardous chemicals (UNEP 2002).

Twelve of the world’s most toxic chemicals were designated by the UN for initial attention, and have been dubbed “the dirty dozen” (Johansen BE 2003). These agents are Persistent Organic Pollutants (POPs): aldrin, chlordane, DDT, dieldrin, dioxins, endrin, furans, hexachlorobenzene, heptachlor, mirex, polychlorinated biphenyls (PCBs) and toxaphene (UNEP 2002). POPs are highly stable compounds that can last for decades before breaking down. They circulate globally through a process known as the

---

2 One in three of all recognised occupational diseases in Europe are related to exposure to chemicals substances. Dimas S (Member of the European Commission responsible for Environment) (2005). State of play on REACH, SPEECH/05/197 Date: 04/04/2005. Brussels, European Commission, Annual Meeting of Chairpersons of the CDU and CSU Groups in the German Bundestag, Laender Parliament and the EPP-ED Group of the EP.
"grasshopper effect", such that POPs released in one part of the world can, through a repeated process of evaporation and deposition, be transported through the atmosphere to regions far away from the original source (Lippmann M, Cohen BS et al. 2003). Global agreement on the reduction and eventual elimination of these substances, banning their production and trade, has been a long-term goal.

The 2001 Stockholm Convention on POPs came into force on Monday, May 17 2004, marking the start of an international effort to rid the world of PCBs, dioxins and furans, and nine highly dangerous pesticides. Australia, as a signatory, is currently developing its National Implementation Plan. With the recent addition of the Stockholm Convention, these three international chemical conventions combine to provide the international framework covering the key elements of ‘cradle to the grave' management of chemicals.

Of specific relevance to this study is that nine of these twelve POPs are pesticides, and a tenth is formed as a decomposition by-product from pesticides (UNEP 2004). Pesticides are therefore rated among the most hazardous agents in our total chemical repertoire, and on this basis, have been recognised internationally as a serious health issue attracting attention from international health sectors. These agents have been used extensively in Australia, and Mirex is still in use. The U.S. and Europe banned other POPs over 15 years earlier than Australia, which has increased the vulnerability of Australian rural communities to serious health risks (Melville J 1989; Committee on the Future Role of Pesticides 2000).

The “Dirty Dozen" chemicals subject to Stockholm Treaty were classified as the 12 worst, or most persistent pollutants, other agents equally damaging to human health, are currently being added to the Stockholm’s second list for action (UNEP 2002). In the interests of harmonisation, and to reduce the cost of individual countries replicating information, the IPCS developed the INCHEM database, which offers quick and freely available electronic access to thousands of searchable full-text documents on chemical risks, health impacts, and the sound management of chemicals, helping countries fulfil their commitments under UN’s Agenda 21, Chapter 19 (WHO International Programme On Chemical Safety 2002). This also supports the Rotterdam Convention’s aims to facilitate the exchange of scientific, technical, economic and legal information concerning the chemicals, including toxicological, ecotoxicological and safety information, and the provision of publicly available information on domestic regulatory actions relevant to the objectives of the Convention (Lloyd-Smith M 2002).

For decades these toxic chemicals have killed and sickened people and animals by causing cancer and damaging the nervous, reproductive and immune systems. They have also caused uncounted birth
defects (UNEP 2002). From inception to enforcement, the Stockholm treaty’s slow evolution demonstrates the complexities, and long lead times required to enlist international cooperation on issues of undeniable health importance. Long lead times to engage regulatory action to reduce chemical exposure by withdrawing toxic substances from sale, has two effects; a) continued utilisation (and hence extending human exposures) long after sufficient evidence of harm has been established, and b) continuing exposure occurs post withdrawal from sale, either through the agent’s persistency in the environment, or through lingering biological effects, or both. Evidence of dioxin toxicity first appeared the 1950’s (Committee on the Future Role of Pesticides 2000), but was not banned in Australia until 1987 (Melville J 1989), therefore the continued use of these agents will continue to impact upon the health of Australians farmers, their families and communities.

The environmental and public health movements had struggled for years to find ways to protect human health and the environment from hazardous chemical exposure when establishing clear evidence of causation was hampered by the inability to conduct randomised controlled trials, regarded as the gold standard for providing valid evidence. Chemically induced harm was seen as shrouded by scientific uncertainty (Ashford N and Miller C 1998). Potentially dangerous activities and the products of those activities were argued as being ‘innocent until scientific evidence was available to prove them guilty’ (Johansen BE 2003). Meanwhile, the burden of proof fell on the public. The 1992 Rio Declaration sought to alleviate this impasse by recommending nations adopt the precautionary principal:

“In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”


It is now estimated that around 25-33% of the burden of disease in industrialised countries can be attributed to environmental factors (Hallstrom N 2000). The magnitude of the risks posed by chemicals is clearly apparent to the European community, where 89% reported being worried about the impact of environmental contaminants on their health (European Commission 2003). Many European countries, and the United States have signed and ratified the Rio Declaration, by doing so, they are bound to use the precautionary principle. Application of the principle is far more advanced in Europe and on the international level than it is in the United States (Rosenstock L 2003; Tickner J, Raffensberger C et al. 2003). The Australian government has not ratified the Declaration, so is not bound to incorporate the precautionary principle into policy.
Key Elements of Environmental Health Management

Systems

The definition of environmental health given below, was adopted at the World Health Organization meeting in Sofia in 1993.

“Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychological factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially have an adverse effect on the health of present and future generations.”

(Cromar N 2004).

This definition relates environmental health to its impact on human health. The second part of this definition refers to environmental health practices: assessing; correcting; controlling and preventing, is of primary concern to this study. In the U.S. and parts of Europe, these activities are undertaken within the health care system. In Australia however, these activities largely occur outside the health system, where an assortment of local, state and federal government departments manage environmental health according to a health ‘protection’ paradigm. Accordingly, the budgetary, program, and activity focus is directed towards the physical environment and limiting the release of harmful factors. ‘Assessing, controlling and preventing’ is limited to aspects of the physical environment, rather than applying these to the humans at risk of hazardous exposure. Scant attention is given to assessment of the environmental impact on human health. Consequently, the Australian health sector maintains minimal involvement in environmental health. Although some statewide variation exists, this approach is nationwide.

Chemical management systems include direct regulation of use, codes of practice, industry responsibility schemes, community information, risk reduction strategies, disposal infrastructure and environmental health monitoring. They are designed to reduce the risks associated with exposure to chemicals, and to ensure that chemical use is sustainable for human health and the environment (EPHC National Chemicals Taskforce 2003). Whereas structures vary between across jurisdictions, several key elements are common, including legislative frameworks, collaborations or nationally coordinated action plans, risk assessments, and surveillance systems. The following sections describe the key elements of environmental health management systems, and show how the U.S. and Europe have recognised that health risks result from the separation of environmental issues from health issues and from the health workforce. Strategies are successfully reconnecting health care workforce with environmental health.
The framework model adopted by Europe is one of multinational cooperation. Over recent decades, parts of Europe have experienced rapid economic growth, whereas in other parts, economic development came to a standstill, are in transition, or have deteriorated (UNEP 2002). Widespread economic recession characterised by rising unemployment, wars, civil unrest and ethnic conflicts have given rise to areas of intense environmental destruction (Clancy T 2004). Illegal imports, and the use of unauthorised chemicals, compounded by poor knowledge and lack of operator training in some countries have also resulted in a wide range of immediate and direct anthropogenic environmental threats to human health (Hansen 2002; International Institute for Sustainable Development (IISD) 2004)\(^3\). Other problems have arisen from a series of industrial accidents (many emanating from industrial negligence), such as the contamination of the Rhine. This exemplifies the precarious situation in Europe, characterised by high population densities, aging infrastructure, and close proximity of multiple countries, and hence shared physical resources and environments (Watterson A 2000).

Cognisant of sharing their environmental neighbourhood, European wide collaborative agencies have evolved to lead the environmental health process. Within the EU, a declaration given by heads of state and governments in Paris in October 1972 gave the impetus for the adoption of environmental legislation. Soon afterwards, the first Community Action Program on the environment was adopted in 1973; many more have followed (WHO Regional Office for Europe 1994). In response to growing concern about the state of the environment and health, WHO’s First European Conference on Health and the Environment was held in December 1989 at Frankfurt, Germany. This brought together senior representatives from 29 European Member States, as well as from the then Commission of the European Communities (now the European Commission – EC), to work collaboratively. The Conference unanimously approved the European Charter on Environment and Health (WHO Regional Office for Europe 1990), to function as a joint development of public health and environmental policies. The Charter underlined the shared responsibilities of individuals, public authorities and economic sectors for protecting the environment; and outlined principles for public policy (WHO Regional Office for Europe 1994).

Much of European policy is therefore linked globally, having a coordinated European focus, with examples such as “Concern for Europe’s Tomorrow”, a project entrusted to the WHO European Centre for Environment and Health. The model still allows for individual nations to manage local issues, such as

\(^3\) Recognition of the difficulties facing countries with limited chemical infrastructure to address this issue prompted the Rotterdam Convention, and provided the impetus to introduce the IPCS INCHEM database.
National Environment and Health Action Plans to address local needs and health policy making (European Region WHO 2004).

The United States and Australia also operate within the global network; yet functionally operate their environmental health management systems as distinct nations. In 1950 the United States had less than five major pieces of federal legislation dealing with manufacture, use, transport, sale and dispersal of hazardous materials. Spurred by the widespread community concern emanating from the unfolding series of local pollution disasters, and advocacy by the environmental movement, this figure had by 2000, risen to over 45, with the steepest rise occurring between 1970 and 1980 (Gore A 2000). The twin releases of cyanide gas into the environment, one in Bhopal (India), and the other in Institute (West Virginia), powerfully demonstrated the need for enhanced preparedness, and planning locally for chemical accidents. They also highlighted the need for environmental health expertise within the public health workforce (Soloman G, La Dou J et al. 2004).

Australia’s three levels of government all play a role in environmental health management. The Australian Constitution restricted Federal environmental powers to international treaties, the development of national policy, and controls on chemicals in the market place (enHealth Council 1999). Accordingly, environmental health comprises a mere 0.23% of the federal health expenditure (AIHW 2004). State governments enforce State Acts, such as Health and Food Acts (Stoneham M, Dodds J et al. 2004). Some State Governments have recently directed local governments to develop Municipal Public Health Plans to better respond to local environmental issues, provide greater accountability to their communities, and encourage a more participatory approach (enHealth Council 2002). Environmental health management at the local community level in Australia largely falls to Local Governments which provide health protection, infrastructure and policy to address local environmental health issues. They are responsible for waste management, urban management, roads and cemeteries, and licensing and monitoring of food premises (Smith J 1996). This is ‘health protection’.

A legacy of this arrangement is the fragmented nature of environmental health management. The 1999 National Environmental Health Strategy (NEHS) aimed to coalesce the disparate environmental health activities across the country. The Strategy was published as a collaborative effort between all health departments from all state and territories; the Australian Institute of Environmental Health; the Australian Local Government Association; and the Commonwealth Department of Health and Aged Care in 1999. Also involved in this process was a considerable body of expertise from universities, public and private sector agencies, and expert individuals. The Strategy launched the National Environmental Health
Council (enHealth) as a subset of the National Public Health Partnership (NPHP), to be the peak advisory group providing national leadership and to focus national cooperation on all environmental health issues (enHealth Council 2003). As an advisory body, enHealth is not funded to perform or manage environmental health activities, such as surveillance.

Environmental health practice is defined by the NEHS as:

"... about creating and maintaining environments that promote good public health. It covers the assessment, correction, control and prevention of environmental factors that adversely affect health, as well as the enhancement of those aspects of the environment that improve human health."

(enHealth Council 1999)

This ‘de-humanized’ definition removes mention of “… those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychological factors in the environment” which appears in the WHO definition given earlier. This act demonstrates an operational paradigm of environmental control, and articulates the paradigm from which Australia approaches environmental health, the focus of which is still dominated by environmental protection.

Environmental protection is important. Accumulation of the by-products of anthropogenic activity creates hazardous environments and leads to poor health outcomes (Woodward A and McMichael A 2004). This is true whether the waste material generated is biological or chemical in composition. For industrialised nations, the traditional concerns of classic environmental health have largely been addressed via complex and effective systems of infrastructure and legislation, and this remains the case in Australia. Whilst the traditional attention to sanitation and clean water remain vital, overwhelming evidence accumulated over of the past decades suggests the scope and nature of emerging environmental hazards is enormous, and the anthropogenic component is increasing rapidly (UNEP 2002). Human exposure to chemicals is one such issue which has prompted rigorous coordinated strategic responses in Europe and the U.S. The following sections further describe developments over recent decades in Europe and the U.S, where engagement of the health sector has reframed environmental health to include monitoring human health, and human health outcomes. With a definition of environmental health which is limited to the physical environment, Australia has yet to embrace this expansion in approach.

The National Environment Protection and Heritage Council (EPHC) established the National Chemicals Taskforce, to investigate chemical management frameworks in Australia and to scope the issues associated with, and the need for, a national approach to ecologically sustainable chemicals management (EPHC National Chemicals Taskforce 2003). The EPHC reports to the federal Environment Minister, and has therefore conducted its investigation of chemical management within the context of
impacts on the physical environment. Little focus has been given to the direct impacts of chemicals on human health, and input from the health sector throughout the consultation process has remained scant. The ramifications of this separation of environmental management frameworks from health portfolios have a flow on effect throughout strategic responses and policy development in Australia that contrasts starkly with other countries. Human health considerations are assumed to benefit vicariously, however the following sections demonstrate that issues of human health are continually overlooked, leaving a gap which heightens the vulnerability of Australian populations to undetected exposure hazards.

**Regulation of AgVets: Policy and Institutional Frameworks**

Regulation of chemicals registered for sale and use in most countries requires examination of the efficacy of the product, and toxicological evidence of off-target harm to humans and the environment, plus a risk assessment using the local likely usage patterns, and local environmental characteristics (APVMA 2004). This level of stringency of health safety criteria was introduced after many products were already registered for use. A backlog now exists for all regulatory authorities, where thousands of products are available for sale which have received little or no toxicological testing. The Rotterdam Convention introduced moves to attempt to reduce the need for duplication of the basic scientific research required by each country through extending the sharing of information and research. The OECD commenced a coordinated effort to screen chemicals marketed in Europe. It was found that nearly 3 out of 4 (71%) of the sampled high-priority chemicals did not meet the minimum data requirements for health hazard screening set by the OECD chemicals program (Grandjean P 2004).

In 2001, the European Commission adopted a White Paper setting out its strategy for a future Community Policy for Chemicals. The White Paper proposed that the process for reviewing new and existing substances should move toward the UN directive to harmonise chemical programs (Commission of the European Communities 2003), and be regulated under the same procedures within a single system. It also recommended a system for toxicological testing of new substances, and that this should be extended to existing substances (Wallström M 2004). Under this revised system REACH, registration of substances involves manufacturers submitting a technical dossier of toxicological information about the chemical, including a testing package, replacing the previous system whereby government authorities conducted the tests. The proposed REACH system requires the all existing substances classified as CMRs (carcinogens, mutagens and toxic to reproduction), and supplied in quantities greater than 1 tonne per year, will have to be registered in a central database within the first 3 years (Commission of the European Communities 2003).
Introduction of these broad strategies, primarily focused on protecting human health, has met with resistance. Global pesticide manufacturing is a multi-billion dollar industry dominated by a few large corporations who sell their products on the international market. Manufacturing nations therefore have a vested interest in the regulation of these agents in other places. U.S. authorities have protested against the European Commission draft principles for obtaining toxicological information on those chemicals about which little is known, as it would require that manufacturers exporting to Europe must abide the new proposals (Becker E and Lee JB 2003). This impasse builds on the long standing trade debates between the U.S. and European countries, where attempts to ban imports of American beef treated with growth hormones, and genetically modified foods, has prompted legal action from chemical manufacturers Monsanto, Syngenta and others (Rowland 2002; European Court of Justice 2003).

Globalisation of world food markets has also exerted major influence on agricultural industries and associated AgVet usage across a variety of spheres. Several rounds of General Agreement on Tariffs and Trade (GATT) talks have lead to a reduction in some tariffs, with the goal of phasing out subsidisation and protection of agricultural industries. Establishment of free trade blocs has increased competitive pressures and provided further incentives for agricultural producers to reduce costs and increase yields, therefore fuelling the demand for more effective and efficient pest control. Additionally, pesticide residue limits vary between different trading partners, and although serving to drive the efforts towards harmonisation of standards, these are viewed by exporting nations as a tool for imposing trade barriers (Committee on the Future Role of Pesticides 2000).

In 2002, the European Parliament Committee on the Environment, Public Health and Consumer Policy made a raft of recommendations to introduce a thematic strategy on the sustainable use of pesticides across Europe, as a component of the REACH program aiming to restrict the reliance on chemicals (Committee on the Environment Public Health and Consumer Policy 2004). The Committee urged the European Union to aggressively define clear goals including a quantitative target of 50% reduction in pesticide use (Commission of the European Communities 2003). This process is still ongoing, yet testifies the European recognition that these agents pose a serious threat to human health and the environment. This move is also seen as a threat to countries exporting agricultural commodities who strive to maintain, or expand their market share, and exert pressure where able, to achieve this (Becker E and Lee JB 2003). The American Farm Bureau Federation acts as a powerful multi-billion-dollar lobby group, which reportedly carries enormous congressional influence (Monks V, Ferris RM et al. 2000).
Europe and the U.S. therefore differ in many aspects of their approach to chemicals, stemming from their diverging views on the role of free markets versus government intervention, their varying approaches to balancing agricultural economics against human health and safety in relation to AgVet exposure, and their commitment to the precautionary principle. Major policy disagreements were evident among the 130 nations attending the UN International Biosafety Conference in Montreal, in 2000, largely centred around the adoption of the precautionary principal, described as the basis ‘for banning the import and export of products in the absence of scientific evidence that such products pose health or environmental risks’ (Pollack A 2000). These differences have escalate to threatened contests within the World Trade Organisation (Becker E and Lee JB 2003).

The precautionary principle is now a part of the treaty that forms the legal basis for the European Union. U.S. legislation, in various ways, also reflects precautionary approaches, although in a diluted or compromised form (Rosenstock L 2003; Grandjean P 2004). The Australian government has not formally adopted the precautionary principle in relation to chemical management framework. Based on its adoption of the precautionary principle, the EU has taken the lead in attempting to restrict imports, and reduce reliance on pesticides. In contrast, actions to lessen AgVet utilisation in the Americas and Australia (both major agricultural exporters), have been limited.

The U.S. EPA, acts as the regulatory authority for chemicals in America, it also manages regulation and compliance (Committee on the Future Role of Pesticides 2000; Kaiser J 2002; USA EPA 2005). The EPA was created in 1970 to pull environmental and health protection activities from across the government into one administrative unit (Booker S 2004). All pesticides used in the U.S. must be registered (licensed) by the EPA. AgVets are regulated under two statutes, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the Federal Food, Drug, and Cosmetic Act (FFDCA), and the primary focus of these is to provide federal control of pesticide distribution, sale, and use. EPA was given authority under FIFRA not only to regulate, and register AgVets, and establish tolerances for pesticide residues on food and feeds, but also to study the consequences of pesticide usage, and to require users (farmers, utility companies, and others) to register when purchasing pesticides (Lynch S and Kuchler F 1993). The registration process aims to ensure that pesticides will be properly labelled and that if in accordance with specifications, will not cause unreasonable harm to the environment or people. The law also requires users to take exams for certification as applicators of pesticides (USA EPA 2005).
The role of the U.S. EPA is more expansive than the Australian EPA and the APVMA. In addition to developing and enforcing regulations that implement environmental laws enacted by Congress, the U.S. EPA carries broader responsibilities for researching and setting national standards for a variety of environmental programs, it also provides public education programs, and offers direct financial support through grants to state environmental programs. The EPA is intricately involved in supporting, and maintaining human health, occupational health and safety and issues relating to chemical exposure (USA EPA 2005). For these activities, it collaborates with the Centers for Disease Control and Prevention (CDC), recognised as the lead federal agency for protecting the health and safety of the American people (CDC 2001). As an agency of the Federal Department of Health and Human Services (DHHS) operating nationally and throughout the international arena, CDC's mandate includes environmental health. These agencies work together to provide the policy framework for chemicals in the U.S. to protect human health.

Development of the chemical management framework in Australia has been influenced by international commitments and developments such as UN-sponsored chemical safety programs and treaties, global trade relationships, as well as national legislative review programs including the National Competition Policy (EPHC National Chemicals Taskforce 2003). In Australia, the different categories of chemical used are covered by four major Commonwealth schemes of registration and assessment. These are:

- National Industrial Chemical Notification and Assessment Scheme (NICNAS), which governs industrial chemicals; including dyes, solvents, plastics, photographic materials as well as some chemicals used in the home, such as paints, cleaning agents and cosmetics,
- The Therapeutic Goods Administration (TGA), for medicines and medicinal products,
- Food Standards Australia and New Zealand (FSANZ), for food additives and contaminants,
- The Australian Pesticides and Veterinary Medicine Authority – (APVMA) (formerly the National Registration Authority, for agricultural and veterinary chemicals) It regulates all chemicals designed for sale and use in the agricultural and veterinary sectors, that is all AgVet chemicals, plus insect repellents for use on humans, and household and garden products for pest and weed control.

Some other chemical controls result from the listing of particular chemicals under international conventions. Examples of these are the Chemical Weapons Convention and the Montreal Protocol on Substances that Deplete the Ozone Layer.

Table 3.2 below depicts the chemical management framework operational in Australia. It also shows the complex interrelationships between portfolios, national regulatory and assessment bodies work across national management systems through shared responsibilities between the assessment and implementation phases. The APVMA is the only lead agency that does not report to the health minister.
Placement of the APVMA within the portfolio responsible for primary industries has been criticised as it establishes a relationship whereby the regulator reports to the minister whose responsibility is to maximize farm output. Under such an arrangement, the commercial needs of primary industries take precedence over human health. Critics fear that pressure can be applied to expedite licenses to allow products on the market, indeed, the APVMA Annual Report lists as its number one key performance indicator, the speed of licensing of new products (APVMA 2004). There have been calls from both community and industry stakeholders for a national approach to ecologically sustainable chemical management via the development of a “national chemicals policy”. This move is unlikely in the near future as the EPHC National Chemicals Taskforce review concluded that ‘this would not achieve improved human health and environmental outcomes’ (EPHC National Chemicals Taskforce 2003).

**Table 3.2 Australia’s Chemical Management Framework**

<table>
<thead>
<tr>
<th>Chemical Category</th>
<th>Industry</th>
<th>Therapeutic</th>
<th>AgVets</th>
<th>Food &amp; Contaminants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supporting legislative role</strong></td>
<td>Industrial Chemicals Notification &amp; Assessment Act 1989</td>
<td>ASSESS &amp; REGISTER</td>
<td>ASSESS &amp; REGISTER</td>
<td></td>
</tr>
<tr>
<td><strong>Risk Assessment Inputs</strong></td>
<td>NICNAS – Public health, toxicology</td>
<td>TGA – Public health</td>
<td>APVMA – Efficacy TGA - ADI</td>
<td>FSANZ - Av Daily Intake (ADI) TGA – Public health APVMA Chemical residues (MRLs)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NICNAS - Public health, toxicology</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dept Env &amp; Heritage Environment</td>
<td></td>
</tr>
<tr>
<td><strong>National Management Framework</strong></td>
<td>NOHSC model (workplace) Dangerous Goods (transport)</td>
<td>NDPSC/SUSDP (medicines, poisons) ACC (Cosmetics)</td>
<td>National AgVet Code (Labels &amp; supply)</td>
<td>National food Standards (Residues)</td>
</tr>
<tr>
<td><strong>State/Territory Lead &amp; Support Agencies</strong></td>
<td>HEALTH via WORK SAFETY Environment, Planning, Transport, HEALTH</td>
<td>AGRICULTURE, Work safety, Environment, Health</td>
<td>HEALTH Agriculture</td>
<td></td>
</tr>
</tbody>
</table>


Compared to many countries, Australia currently enjoys a relatively robust system for regulating AgVets, however over 60 agencies are currently involved in this process. This fragmented framework introduces complexities within the overarching management system, engenders responsibility boundary confusion (EPHC National Chemicals Taskforce 2003). It also creates the potential for untracked gaps where the systems are not in strict alignment, and leaves Australians vulnerable to major catastrophic events (Allen Consulting Group 2002).
The APVMA is the statutory body responsible for the assessment and registration (marketing authorisation) of pesticides and veterinary medicines, up to and including the point of retail sale. Funded on a cost recovery basis from registration revenues, the APVMA therefore regards chemical manufacturing industry as key stakeholders. The 2003-2004 Annual Report lists Product Registration as the APVMA’s Principal Goal 1, which aims to ‘gain stakeholder confidence that independent product assessment protects public health, environment and trade’. This goal receives 86% of the expenditure budget (APVMA 2004). However, performance criteria for this goal reveals that efficiency of registration approval takes priority, as the first four items report the number of applications finalised within timeframe, the next two refer to labelling changes, two refer to productivity gains, and streamlining minor use registrations, and the final two performance measures note staffing issues, such as a peer review program, and service agreements with other agencies providing technical advice. None of the criteria relate to human health.

The remaining fourteen per cent of the budget is allocated towards Principal Goal 2, Quality Assurance and Compliance. This covers the chemical review program assessing currently registered chemicals associated with known health concerns, monitoring residue limits in food, investigations and recalls, and adverse event reporting programs, in addition to managing the manufacturers’ licensing scheme. This focus on meeting agricultural and the chemical industry needs may reflect the reporting framework; the APVMA reports to Federal Minister of Fisheries, Forestry and Agriculture. This contrasts with the U.S. regulation of pesticides, which moved out of the Department of Agriculture to the newly created EPA in 1970, and has promoting human health, and avoiding exposure risks as its primary focus (Williams LK and Langley RI 2001; USA EPA 2005).

In Australia, the states and territories control the use of AgVet chemicals beyond the point of sale. Characterised by a lack of consistency, the portfolios charged with compliance monitoring include State Departments of Agriculture, Environment Protection Agencies, or Departments of Health. In Victoria, the function of setting the standards and promoting good farm chemical practices lies with the Chemical Standards Branch (CSB) of the Victorian Department of Primary Industries. The CSB has responsibility for identifying and managing risks to food safety, trade, public health, the environment and animal welfare, in relation to AgVet use (Department of Primary Industries 2005). The CSB does not make publicly available the number of compliance breach reports received, nor a summary of actions taken in response to notifications; it has therefore not adopted a community-right-to-know approach.
In some states, more than one agency is involved in this process (Allen Consulting Group 2002). The EPHC Taskforce identified a lack of consistency in which the portfolios charged with compliance monitoring (i.e. Agriculture, Environment or Health) exercise control of chemical application in individual states / territories, and further added that these controlling jurisdictions do not consistently ensure that chemicals are used within these parameters (enHealth Council 2002; EPHC National Chemicals Taskforce 2003). Any system is as weak as its weakest link. Setting stringent guidelines for AgVet application does little to protect public safety when no effective system exists to monitor, encourage, or enforce adherence to these.

Compliance monitoring of chemical handling in Australia varies according to characteristics of the industries involved. In the industrial workplace, compliance monitoring is relatively simple, as specific operators use industrial chemicals, routinely or periodically, within the confines of a designated area. Occupational health and safety officers, foreman and others are usually on site, and are charged with the task of ensuring constant surveillance. A rigorous system also applies throughout the pathway of therapeutic goods, as prescriptions and dispensing of pharmaceuticals are both carefully regulated.

In contrast, compliance monitoring of the handling and application of chemical agents within the agricultural sector is complicated by the fact that farmers apply AgVets across their farms (including the back paddocks not visible from public roads), at any time between sunrise and sunset – or beyond, and often on weekends. Application frequently depends on the vagaries of the weather, so the decision to proceed is often made at relatively short notice. These factors contribute to making effective formal surveillance is difficult to achieve. Notifications of non-compliance must occur via a voluntary reporting mechanism by the applicator or witnesses. For this to occur, those wishing to submit a report must understand the process, and can identify the appropriate channels. Radcliffe argues that this is thwarted by the fragmented and inconsistent infrastructure operating across Australia (Radcliffe JC 2002). Compliance monitoring for AgVets is therefore weak, and consumer confidence has been undermined (EPHC National Chemicals Taskforce 2003).

Two recent independent reports examined efficacy of the AgVet management infrastructure in Australia. The first of these, “Pesticide Use in Australia” (2001), known as the Radcliffe Report, found that ‘assessment of pesticides by the APVMA appears to be a vigorous process that uses internationally accepted principles of risk assessment’ (Radcliffe JC 2002). However the report also identified several significant structural shortcomings, including:
Lack of adequate and user friendly information, available in several languages, on appropriate use of pesticides for a wide array of products;

- Lack of robust summary versions of Material Safety Data Sheets (MSDS);
- Lack of harmonisation of control of use across states and territories, based on food residue data, and adverse environmental, health, occupational health and safety incidents or claims;
- Lack of a single standard from Minimum Residue Limits (MRL) for food and livestock feeds, where pesticide residues on domestically consumed foods are less stringent than for export markets;
- Absence of detailed and publicly available information on usage of pesticides, either nationally or by regions, which is needed for public confidence and performance measurement purposes⁴;
- Lack of a national approach to user accreditation and training, a critical element in managing the risks associated with AgVet chemical use; and
- A lack of consistency in implementing national assessment and registration decisions, rendering it difficult to determine if risk assessment strategies are effective.

These major shortcomings prevent a streamlined management system from manufacturer through to the user, and allow for undetected misuse of chemicals, thwart communities’ attempts to identify the location, and application of AgVets, and limit efforts to establish robust surveillance systems. The result is increased risk of exposure hazards, and lack of consumer confidence.

When compared to other countries where chemical management systems are closely linked to the health sector, in Australia, ‘responsibility for ensuring safety of human health lies with manufacturers and industrial users of chemicals to avoid the potential adverse impacts of their activities’ (EPHC National Chemicals Taskforce 2003). Industry carries responsibility to ensure OH&S standards are met, to provide safe industrial workplaces, and training where appropriate. Agsafe provides training and accreditation of premises and staff involved in the transport, handling, storage and selling of farm chemicals (Environment Australia 1998). But no agency is responsible, beyond the point of sale, for the safe application of AgVets, or for ensuring a safe workplace. Individual farmers are responsible for the end of the line chemical management, to protect the safety of themselves, their families, employees and neighbours near and far.

---

Risk assessment

Although there are different uses of the term ‘risk assessment’, the standard steps for conducting risk assessments involve; a) hazard identification, b) dose-response assessment, c) exposure assessment, and d) risk characterisation (Lippmann M, Cohen BS et al. 2003). Then follows risk management (Yassi A, Kjellstrom T et al. 2001). The risk can be expressed in a variety of ways, depending on the context in which it is considered; for example average annual risk per individual, average lifetime risk per individual, average number of individuals affected annually in a given population, or average loss of life expectancy.

Environmental health risk assessment in Australia means the process of estimating the potential impact of a chemical, biological, or physical agent on a specified human population system under a specific set of conditions, and for a certain time frame (Langley A 2004). Potential gaps exist in the assessment of risks associated with AgVet exposure. The APVMA conducts risk assessments prior to registration of new chemicals, by examining the toxicological profile and the likely human health effect if applied according to the label instructions. However, risk is not evaluated when compliance is poor, as is commonly reported in agricultural settings (Franklin RC, Brown P et al. 2001; Perry MJ 2003), thereby exacerbating the risk of harm. Additionally, many chemicals are in current usage about which little toxicological data are known, and community and environmental groups are alarmed that the UN is pushing for the onus of testing toxicological effects to rest with the manufacturer (Stanton A 2003; Wallström M 2004).

Watterson argues that many Eastern European nations have reduced spending on public health infrastructure, such that risk assessment monitoring is variable (Watterson A 2000). REACH proposes that for substances supplied in quantities over 10 tonnes, registration packages submitted to the REACH program will also require the submission of a Chemical Safety Report (CSR). The CSR details a Chemical Safety Assessment (CSA). This is a risk assessment in which the registrant takes into account the risk management measures implemented by the manufacturer, or recommended to (not necessarily complied with) downstream users and is not, therefore, the classic model of risk assessment as understood by persons involved in chemical management today (Commission of the European Communities 2003).

Monitoring provides exposure information for assessment of risk from environmental chemicals. This can either be direct, such as personal exposure monitors, or indirect via measurement of contaminants in air,
food, soil and water (Moore M and Shaw G 2004). Limitations associated with the application of risk assessments to environmental decisions have attracted criticism of the process, such as that they:

- Do not incorporate disproportionate risk burdens, or sensitivities;
- Do not account for cumulative or multiple exposures;
- Can lead to regulatory delays - “paralysis by analysis;”
- Focus on quantitative, provide little information on qualitative aspect – such as fear, and anxiety;
- Have been primarily used to justify certain amounts of pollution, rather than focus on pollution elimination. (DiBartolomeis MJ 2004).

The European Environment and Health Strategy also identified the need for changes to health policies emanating from the Community Action Program on pollution-related diseases. These were to improve information on pollution related diseases, and to enhance knowledge and understanding of the assessment and management of exposure related disease. Integral to this process were the development of environmental health indicators and health impact assessments (European Commission 2003). This process is currently being introduced in Europe.

In the U.S., the CDC releases National Reports on Human Exposure to Environmental Chemicals, including metals, organophosphates, pesticides and phthalates (National Center for Environmental Health 2003). The National Toxicology Program (NTP) was established in 1978 in response to concerns among scientists and Congress about the effect of chemicals on human health (National Toxicology Program 2005). The NTP publishes an annual listing of chemical carcinogens registered for use in the U.S. Other DHHS agencies also identify and deal with environmental chemical hazards, including the National Institute for Occupational Safety and Health (NIOSH), and the ATSDR. Management of environmental health therefore resides within the health portfolio, providing public information on chemicals, their toxicity, and location in the environment.

The ATSDR, created by Superfund Legislation in 1980, is charged with the mission to prevent or mitigate human health effects and diminished quality of life resulting from hazardous substance exposure in the environment (Williams LK and Langley RI 2001). The ATSDR conducts environmental health assessments, health investigations, toxicological profiles, manages an exposure and disease registry, and emergency responses. Several other initiatives have been introduced to tackle the problem of risk assessment of exposure to chemicals. The National Institute of Health Roadmap is establishing a
database on genotype and toxicity, to form the basis for research into human assessments of risk of harmful reaction to chemical exposure (Olden K 2004).

The biotechnology revolution has now opened new opportunities for addressing current inadequacies in decision-making regarding environmental health. Kenneth Olden, Director of the NIEHS, argued the need for three strategic investments to be made:

- To develop high-throughput technologies that could accelerate toxicity testing and generate a mechanistic understanding of toxicity;
- To incorporate individual susceptibility into risk assessments; and
- To establish a rational basis for testing and regulatory decision making (Olden K, Guthrie J et al. 2001).

Excluding isolated studies, Australian assessment of risks to environmental exposures occurs at the physical environment level, and not at the individual level (Moore M and Shaw G 2004). The AIHW and the National Environmental Health Forum (NEHF) have acknowledged that Australians were suffering severe chronic illness as a result of exposure to toxic substances (AIHW 2002). EnHealth published national guidelines for assessing human health risks from environmental hazards in June 2002 (enHealth Council 1999). This document, *Environmental Health Risk Assessment*, lists a series of 13 key principles on how risk assessments should be performed; yet the document does not explain how human exposure will be recognised. It limits its attention to the health of the environment, not assessing environmental risks on human health. This document fails to suggest any strategies to ensure that the identification process occurs in a timely or efficient manner, nor does it recommend a mechanism for linking diagnoses from health care providers to a system of monitoring. This process seems to be assumed.

**Health Surveillance**

Beyond risk assessment is the measuring and tracking of human health impacts of exposure. Public health surveillance is the ongoing systematic collection, analysis, and interpretation of health data essential to planning, implementation, and evaluation of public health practice, closely associated with timely dissemination of these data to those who need to know (Osorio AM and Reynolds P 2004). These data only become meaningful when they are applied to prevention and control. Therefore, to gain functional capacity, public health surveillance must be linked directly with public health programs (Last JM 1998), and in the case of AgVets, regulation of chemical usage. In many circumstances, where
timing is crucial, the linkage must be prompt. Researchers maintain that exposure data represent the weak or missing link in their efforts to characterise human health hazards due to chemical exposures (de Rosa C 2003).

In 1993 (10 years after the United States), the All Wales Environmental Health Surveillance Project became the first population-based surveillance system monitoring acute chemical incidents described in Europe (Bowen HJ, Palmer SR et al. 2000). The report indicated that on average 2.6 chemical incidents involving community exposures occurred each week in Wales, with a population of 2.9 million. Most of the 402 incidents identified during the initial phase of the project were not associated with sites governed by the Control of Industrial Major Accident Hazard Regulations, but with smaller shires and commercial premises. This fact highlighted the need for broad based surveillance that is not restricted to large organisations. The report also noted the need for public health doctors to have a central role on planning for, and managing chemical incidents.

On 23 September 2002, the European Parliament and the Council adopted a decision establishing a programme of community action in the field of public health (2003-2008). This action aimed to develop methods and strategies to prepare member states, and the community as a whole, for potential threats of biological or chemical agents. The Council stated that priority would be given to:

- Collaboration on laboratory diagnostics for biological agents; and
- Exploring the feasibility of setting up a surveillance system for syndromes caused by exposure to chemicals recorded by poison centres, and for detection of chemicals (The Commission of the European Communities 2004).

The 2004 Fourth Ministerial Conference of the European Region WHO noted development of surveillance had been slow since first proposed and reaffirmed their call for an Environment and Health Information System. At this conference, the EC launched their Environment and Health Action Plan 2004-2010 aiming to reduce diseases caused by a polluted environment. The Plan involves establishing a harmonised European Integrated Environment and Health Monitoring and Response System, with human biomonitoring at European level. This includes monitoring of blood, urine or hair samples to measure exposure to environmental pollutants (European Commission 2003). The Commission stated that such a system would allow a better understanding of the environment and health linkages, and long-term health effects, and will be used as a tool for the development of further environmental health policy. Such a system will allow priorities to be set on the basis of evidence, and better communication with the public will be facilitated through enhancement of public information access. (European Region WHO
2004). The EC stressed the importance of awareness raising on exposure risks among the citizenry, and additional training of professionals in environment and health issues.

The US has a long history of surveillance. The CDC first looked at blood and urine samples of the general population in 1976, and also checked for environmental chemicals, including lead and a handful of pesticides. The National Report on Human Exposure to Environmental Chemicals program, an ongoing $6.5 million survey now measures 145 chemicals (up from 27 in 2001), in 2500 people across the United States every 2 years (Stokstad E 2004). Biomonitoring’s strong suit is that it directly measures the amount of a chemical in bodily fluids or tissues. Those exposure data are much more relevant for risk assessments than are extrapolations from chemical concentrations in soil, air, or water (Meister RK 2004).

The initial chemical exposure surveillance programs responded to the significant environmental degradation problems experienced across the U.S, and were therefore location specific. California introduced a Pesticide Illness Surveillance Program (PISP) in 1971. This regional system required physicians to report suspected pesticide illnesses via telephone to the local health officer within 24 hours of examining the patient. This program continues to collect data from three sources:

- The receiving health officer;
- The diagnosing physician’s First Report of Occupational Illness and Injury; and
- The California Poison Control System, whereby poison control staff complete a case report when physicians call for assistance with a pesticide case (Osorio AM and Reynolds P 2004).

The County Agricultural Commissioner is then responsible for the investigation of all pesticide exposure incidents within their jurisdiction, with analytical support provided by state-based laboratories.

Structural weaknesses persist despite the relatively long history of the Californian PISP. These result in significant under-reporting, especially in cases of chronic exposure (Osorio AM and Reynolds P 2004). Structural deficiencies include continued lack of physician recognition of Acute Pesticide Intoxications (APIs). Subtle and early manifestations of API may not cause an individual to seek medical care. Some residents do not have medical insurance so do not seek healthcare until severe symptoms develop. Some workers lack relevant residency documents and do not feel empowered to seek healthcare. The migratory nature of the U.S. agricultural workforce results in some cases returning to their native country for care (Maizlish N, Rudolph L et al. 1995). In 1988, a system called Sentinel Event Notification System for Occupational Risks (SENSOR) was added to improve reporting of occupational exposures. (Maizlish N, Rudolph L et al. 1995).
Another example of how a regionally based surveillance system evolved occurred following alerts to the presence of high concentrations of toxic substances in the Great Lakes (GL) basin. These substances posed significant health concerns (de Rosa C 2003). Contaminants included organochlorines (e.g. PCBs, dioxins, furans, dieldrin, etc.), heavy metals such as methylmercury, and alkylated lead, and polycyclic aromatic hydrocarbons (e.g., benzo(a)pyrene). In 1990 the U.S. Congress amended the Great Lakes Critical Programs Act to create the Great Lakes Human Health Effects Research Program (GLHHERP). This program monitors exposure to contaminants via consumption of GL fish, and investigates the potential for short- and long-term adverse health effects (Hicks HE and De Rosa CT 2002).

De Rosa argued that surveillance capacity must include the ability to identify and monitor “hot spots” in the human population with respect to elevated exposure to toxic substances, as well as potential clusters of environmentally related diseases (de Rosa C 2003). This program also demonstrated the power and effectiveness of tracking chemical exposures and translating scientific information into public health service on a local level (McGeehin MA, Qualters JR et al. 2004). Current surveillance examples include the Cape Cod breast cancer study, run by the Silent Spring Institute, which uses GIS (Geographical Information Systems) technology to map exposure to past DDT spraying (Brody JG, Aschengrau A et al. 2004). These efforts also empower communities by providing to them the means to make informed decisions on personally relevant environmental public health issues, such as where to choose to live and work.

Despite these alerts, the 2000 Pew Environmental Health Commission report America’s Environmental Health Gap found surveillance capacity in the U.S. remained fragmented, and highly compromised (Environmental Health Tracking Project Team 2000). The report’s central recommendation was that CDC and the ATSDR establish a tracking capacity for chronic diseases and environmental exposures with integrated links to associated environmental hazard data.

The Environmental Public Health Tracking Program (EPHT) feeds into the U.S. National Disease Monitoring Tracking Network, and includes a biomonitoring network to build on the existing population-based National Health and Nutrition Examination Survey. It also increases the number of chemicals found in the human body that are already monitored by the CDC (McGeehin MA, Qualters JR et al. 2004). The CDC is currently establishing Centres of Excellence of Health Tracking, according to the requirements given in Table 3.3 below. The intent was to develop capacity to detect adverse health
events associated with environmental exposures, to significantly expand and enhance the ability to prioritize research initiatives, and support the implementation of effective disease prevention strategies predicated on research findings (Physicians for Social Responsibility 2000). The intent is also to enforce routine surveillance, capable of detecting hot spots, and establish a foundation system capable of handling emergency responses (Marmagas SW, King LR et al. 2003).

Table 3.3 Required Elements for Establishing a Health Tracking Network

<table>
<thead>
<tr>
<th>ELEMENTS OF HEALTH TRACKING NETWORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>National and state tracking of chronic diseases and environmental exposures</td>
</tr>
<tr>
<td>Nationwide environmental health rapid response service</td>
</tr>
<tr>
<td>National environmental health report</td>
</tr>
<tr>
<td>At least five biomonitoring labs; five environmental health centres; an environmental health scholarship program</td>
</tr>
</tbody>
</table>

SOURCE: NATIONAL HEALTH TRACKING ACT OF 2002 (CDC 2004)

National or state based monitoring systems depend on compilation of accurate data on chemical usage to enable linkage to human health effects. The United States is therefore relatively well advanced in its attempts to monitor health effects resulting from environmental chemical exposures. For Australia however, this basic information is lacking.

Health Surveillance Systems in Australia

Comparing environmental health surveillance systems operational in the US, highlights the slow progress towards establishing similar systems within Australia, despite specific recommendations to do so by the National Environmental Health Strategy (NEHS) in 1999. Australia does not currently have a nationally agreed framework for considering the linkage relationship between the environment and health via a defined set of environmental health indicators (enHealth Council 2002). EnHealth was charged with their development (NEHS Imp Plan 2000), but these have yet to be established.

Instead, enHealth has argued that environmental health surveillance had been strengthened with the routine reporting of morbidity and mortality data on cancers, respiratory diseases, and other health data provided by the AIHW. However environment related illnesses are not restricted to cancer, gastroenteritis outbreaks and asthma (Sanborn M, Cole D et al. 2004). Secondly, this complex and detailed system of health intelligence existing for other categories (such as national datasets for
notifiable diseases, and registries of birth disorders and cancers) is unsuitable for monitoring environmental health, as the AIHW documentation does not attempt to link health outcomes with potential causative roles such as environmental chemical exposures.

A national administrative data collection exists for a range of conditions based on diagnostic categories for admitted cases according to the international system ICD-10, and also for cases presenting to hospital emergency departments. However, these ICD codes are designed to monitor hospital workloads, and do not have the capability to link causation, and therefore cannot act as a surveillance system. Hospital episodic datasets therefore do not capture exposure patterns in a manner which allows effective monitoring of environmentally induced diseases, and few other datasets focus on environmental health (NOHSC 2002).

Data available in Australia relating to occupational injury and disease are also incomplete and fragmented (Driscoll CT, Driscoll KM et al. 2003) because they are collected for different purposes by different organisations using different definitions (NOHSC 2002). There is no single data source or groups of data collections that effectively capture all the influences and outcomes that characterize occupational health and safety environment (NOHSC 1997). This makes existing data on occupational diseases in Australia unreliable and insufficient to usefully inform policy formulation (Labour Ministers’ Council 1998).

The primary source of information on occupational injury and disease for Australia is the National Data Set of Compensation-based Statistics (NDS). Published NOHSC occupational health data accumulated by the NDS, was derived from successful claims for workers’ compensation requiring five or more days off work. This effectively skewed the data towards acute conditions and significant injury, whilst ignoring many disease processes, especially chronic diseases, and poisoning data were very limited (NOHSC 2002). The data excluded the self-employed, such as cases occurring on farms, which are largely family operated, and who under-report incidences (Franklin RC, Brown P et al. 2001). NOHSC acknowledged the poor reporting of farming data in this dataset (NOHSC 1998). Therefore monitoring of occupational health risks deriving from AgVet exposure fell outside the main NOHSC brief, but fell to no other organisation. The NEHS was designed not to duplicate occupational health (NEHF 1998), therefore workplace exposures are not addressed in detail in the Strategy, so exposure to AgVets, slips between the two major policy frameworks in Australia.
The Victorian Workcover Authority also reports workers’ claims for compensation, listing disorders per organ system. The data includes an item called “other injuries and poisonings”, whereby separation of poisonings by AgVets is not differentiated, and therefore the data are not publicly available (Victorian Workcover Authority 2002).

Other occupational health data sets exclusively report data derived from emergency departments which carry many of the same biases towards significant injury (AIHW 2004). Primary health care service delivery data, whilst improving, provide little data on diagnoses relating to environmental health. As could reasonably be expected, the General Practitioner BEACH study (Bettering the Evaluation and Care of Health), highlighted the distortions in these data sets of work related ill-health by producing data from GP practices with significantly lower rates of traumatic health complaints. However, the BEACH data also under reports certain work related disorders (Driscoll CT, Driscoll KM et al. 2003). Illness as a consequence of chemical exposures is one such under-reported condition, and therefore monitoring of this health issue in Australia is currently severely limited.

In 1987 the NOHSC identified the six occupational health and safety priorities in Australia as occupational back pain, management of chemicals used at work, occupational noise-induced hearing loss, occupational skin disorders, occupational cancer and mechanical equipment injury (Phoon WO 1998). Management of chemicals at work, however, has been largely restricted to the industrial setting (Radcliffe JC 2002). In 1994, the NOHSC endorsed the National Model Regulations for the Control of Hazardous substances, established requirements for workplaces in which employees were exposed to hazardous agents, to ensure regular surveillance, including health screening, biomonitoring, providing health advice and maintaining employee health records (NOHSC 1998). These model regulations did not extend to individual farms, hence compliance with safety regulations in these settings was self–monitored, and health monitoring does not exist.

The link between the NOHSC and AgVets was limited to assisting the APVMA by examining the occupational health and safety implications for workers in order to identify the potential health risks associated with the registration of new products, and to contributing to the chemical review process of existing agents (NOHSC 2004). The NOHSC investigated requirements to establish an effective surveillance system in Australia, comparing respective benefits and challenges offered by exposure registers, disease registers, compulsory notifications systems, sentinel event systems, and surveys (NOHSC 2002). The report noted that the United States, European Union, and United Kingdom have achieved significant improvements in their surveillance of occupations diseases, which have included a
Sentinel Event Notification System for Occupational Risk in the US, occupational disease systems monitoring conditions of the musculoskeletal system, skin, stress and mental illness in the UK, and carcinogen exposure surveillance data base (CAREX) in the EU.

The NOHSC report recommended a first step for Australia, was to identify and prioritise activities relating to disease hazard exposure monitoring, monitoring of disease incidence and prevalence, and establish indicators of occupational disease control measures (NOHSC 2002). The current status of establishing this surveillance system is unknown, given the Howard Government's decision to replace the NOHSC with the Australian Safety and Compensation Council (ASCC). The ASCC would not have the legislated powers and responsibilities of the NOHSC, and is designed to function purely as an advisory body to the Workplace Relations Ministers Council (Moylan P 2004). Workplace safety surveillance systems, and environmental health monitoring in Australia is therefore remain extremely limited, and their future is uncertain.

Australia therefore collates little environmental health intelligence for the purposes of health planning or management of chemically induced harm. The exception to this situation is mesothelioma. Australia has the highest incidence of asbestos induced malignant mesothelioma in the world (Phoon WO 1998). This rare cancer is remarkable in having few known causes (Gottschall EB 1999), making the exposure link with asbestos easily identifiable, and hence has attracted health sector, political and legal attention. Other hazardous agents have not received equivalent reaction in Australia, as attributing such direct causal relationships is more complicated.

Rosenstock states that in the "post 9/11" world, America is acutely aware of the emerging threats of terrorism, bio-terrorism and weapons of mass destruction (Rosenstock L 2003). Rosenstock adds that attention to, and visibility of environmental health and public health are paramount to being prepared. Increasingly, individuals, communities, and decision makers appreciate that public health, and environmental health being fundamental to it, is no longer just a concern for others but for themselves (Rosenstock L 2003). The United States now recognizes the potential of investments made in public health infrastructure, such as building laboratory and surveillance capacity to monitor yet unrealised terrorist threats, to provide the capacity to do the traditional day-to-day work of public health that for decades has gone neglected (Lichtveld MY, Cioffi JP et al. 2001; Lichtveld M, Hodge JG et al. 2002). Beyond terrorism, there is greater appreciation than ever in the U.S. that environmental factors are highly influential in relation to individual and population health (McCurdy LE, Roberts J et al. 2004). Evidence of this appreciation in Australia appears to be lacking.
In contrast to the U.S., Australia has not embarked upon a systematic national surveillance of human exposure to environmental chemicals. The five environment-related human health issues for which national data exists are skin cancer, food-borne illnesses, air pollution and low-level lead exposure of children, and the vector-borne diseases. These vector-borne diseases include Ross River virus disease, Murray Valley encephalitis, Japanese encephalitis, dengue fever, Barmah Forest virus disease, and legionellosis (Australian Institute of Health and Welfare 2002). Monitoring occurs for microbial agents and anthropogenic chemicals in water, toxic blue-green algae, food contamination, contaminated sites, incineration facilities, and waste water re-use (Moore M and Shaw G 2004). Some isolated studies have investigated national human exposures. For example in May 2004, the Commonwealth Department of Environment and Heritage (DEH) published findings from the National Dioxins Program (NDP), which measured dioxins in soil, aquatic environments, fauna, food, human serum levels, and breast milk in a sample of 173 women from 12 locations across Australia (National Dioxins Program 2004).

The NDP report noted that dioxin levels had halved since 1993, and that levels are low by international standards, having levels at 6th highest from 18 studies. The study reported that no hot spots were identified, however Harden reported that these breast milk samples were pooled by broad region (Harden F, Müller J et al. 2005). In contrast, non-government studies have however identified hot spots by analysing small area data. In January 2005, Monash University disseminated a press release of research examining organochlorine levels in 800 samples of breast milk across Victoria (Khanjani N 2005). Highest levels occurred in the Ovens Valley (exposed to extensive DDT spraying on Tobacco until 1987), and some organochlorines, including Atrazine and Triazine, that are still used today. This study also noted that this shire showed the highest rates of breast cancer in Victoria, which serves to highlight the importance for surveillance systems to be capable of detecting local area clusters, in addition to broad national surveillance.

In 1997, contamination of the oyster beds in Wallis Lake (NSW) was a watershed event in environmental health management in Australia. Human waste was the culprit, causing significant human illness (444 cases), and a lack of consumer confidence. This resulted in $10 million in economic losses to the shellfish industry (Goudy R, Bakewell E et al. 1995; NEHF 1998). At the time, however, the NEHF was focussed on hazard identification, risk assessment, and risk management. It differentiated environmental health from public health by stating that the health sector has the primary responsibility for managing health (NEHF 1998). In 1998 the NEHF, under the auspices of the NPHP, examined environmental health.
health infrastructure across Australia. The partnership recognised that such compartmentalisation diminished Australia’s ability to predict and control environmental threats to human health (NEHF 1998).

The National Environmental Health Strategy (NEHS) 1999 identified the need for an effective environmental health information system to be established to meet the needs of environmental health practitioners, environment managers, health professionals, policy makers, researchers and the general community (enHealth Council 1999). The information nominated by the Strategy for such a system included:

- Scientific research on environmental hazards and potential human exposure to them;
- Epidemiological research on the links between exposures and health outcomes;
- Ongoing surveillance of environmental hazards and health outcomes;
- Information about the processes and practices undertaken by environmental health managers;
- Evaluation reports of environmental health interventions.

These surveillance systems have yet to be established. Australia does not currently have a nationally agreed framework for considering the linkage relationship between the environment and health via a defined set of environmental health indicators. EnHealth has been charged with their development (EnHealth Council 2000). EnHealth has argued that environmental health surveillance had been strengthened with the routine reporting of morbidity and mortality data cancers, respiratory diseases, and other health data provided by the AIHW (enHealth Council 2002). However environment related illnesses are not restricted to cancer, gastroenteritis outbreaks and asthma (Sanborn M, Cole D et al. 2004). Furthermore, the AIHW documentation does not attempt to link health outcomes with potential causative roles such as environmental chemical exposures. However they do stress the need exists for this data (AIHW 2002).

The Developing National Environmental Health Indicator Discussion Paper explains that indicators will be based on information about actual emissions or concentrations, and (if available) actual exposure data in humans (eg. Biomarkers) (enHealth Council 2002). This suggests that future environmental health policy directions will continue to place greater emphasis on environmental parameters, rather than health outcomes associated with environmental interaction, such as occurs in the US, and is planned for Europe. Limited reunification of environmental health with the health sector can be expected to arise from Australia’s policy direction.
The list of indicators planned does not include exposure to agricultural chemicals. This confirms that Australia has yet to adopt the view taken by Europe and the U.S. that AgVets pose a serious health threat, which can be monitored by nationally tracking chemical exposures, with the capacity to drill down to small localities.

**Environmental Health Workforce**

Across the world, health practitioners, academics, and private enterprise undertake the practice of environmental health. This is in addition to roles taken by government departments and agencies. Diverse environmental health infrastructures exist to address local concerns and reflect national understandings of the role, functions, and scope of ‘environmental health’.

In most countries in Europe, environmental health workers fall into one of three categories: medical doctors, environmental engineers, and environmental/public health scientists or technicians. Education of these professionals in environmental health is highly variable, and environmental health education is often absent from curricula for medical doctors. In some western European countries, environmental health officers are educated to degree level, and trained in broad aspects of the environment and health in terms of technical knowledge, social policy, management and personal skills. In Eastern Europe, long-term reliance on central direction has made it difficult for local managers of environmental health services to develop new and independent strategies (WHO Regional Office for Europe 1994).

The first Environmental Health Action Plan for Europe, published in 1994 (WHO Regional Office for Europe 1994), recognised that the concept of environmental management for the promotion of health was relatively new. The Plan recommended the introduction of appropriate educational courses, either in the form of specialised degrees or supplementary professional education. The document stressed that all doctors should be able to draw the appropriate links between the occurrence of diseases and exposure to environmental factors, and recommended further development of environmental health as a medical speciality, in parallel with occupational or public health. The Action Plan lists specific objectives and actions to achieve this goal:

- To provide education and training at all levels so as to create cadres and teams of environmental health professionals who will be responsible for implementing and managing specific programmes to improve environmental health;
• Introduce courses in colleges, universities and other institutions, at various levels to educate and train environmental health and other relevant specialised personnel;
• Develop environmental health as a speciality, perhaps in association with existing related specialities of occupational or public health, with a suitable programme of continuing professional education;
• Increase coverage of environmental health in curricula for professional training in a wide range of subjects such as medicine, veterinary science, engineering, the law, economics, architecture, town planning, food and occupational hygiene;
• Provide continuing professional education as an essential part of the career of environmental health professionals, to help make them aware of new developments so that they can adapt to new situations; and that
• Use of exchange fellowships and institutional links should be considered.

European member states noted in the 2004 Budapest Declaration that during the intervening ten years progress towards this had also been slow and expressed their concern of the high burden of disease, that resulted from chemical exposure within the occupational health environment (European Region WHO 2004).

This separation of environmental and health portfolios was also entrenched in the USA. For historical reasons, clinical toxicology/poisons information and regulatory toxicology/risk assessment existed in parallel worlds, having developed as separate disciplines, although they the shared common objectives to protect human health. The US Congress passed the Occupational Safety and Health Act of 1970 to assure “every working man and women in the United States (had) safe and healthful working conditions” (La Dou J 2004). From this act, emerged the Occupational Health and Safety Administration (OSHA) and the NIOSH, and saw a steady rise in speciality trained occupational and environmental physicians in communities, academic centres and in public health and related agencies. The Institute of Medicine (IOM) ascribes the significant under-reporting of exposure induced illness to the continued critical lack of environmental expertise in the primary health care workforce, arguing insufficient front line primary care practitioners are able to diagnose (McCurdy LE, Roberts J et al. 2004). The IOM therefore recommended that “all primary care physicians be able to identify possible occupationally and environmentally induced conditions, and make referrals for follow-up” (La Dou J 2004).

The need to incorporate an environmental awareness into clinical practice has been long recognised by clinicians. The founder of the National Medical Advisory Service in the USA, wrote in 1983 of the rise in
their patients asking if their ill health was caused by exposure to environmental chemicals, and advised
doctors to educate themselves about environmental health impacts (Gotts RE 1992). Calls to increase
environmental health expertise within the public health workforce therefore came from many sectors.

In 1994, the ATSDR in the USA, took the first step in developing an Environmental Health Nursing
Initiative (EHNI) (ATSDR 2001). This project, now national across the United States, was designed to
increase the competencies of public health nurses by ensuring that course curricula include
environmental health topics, and that educational opportunities were available to practicing nurse
professionals. This initiative is now sustainable and has proven to be a motivating force behind
environmental public health action nationwide. The American Nurses Association published in 2001, a
series of web based environmental health Independent Study Modules, accompanied by practical
solutions to avoid risks, perform environmental health assessments and treatment guidelines, plus links
to further information (Sattler B, Afzal BM et al. 2001). These were linked to Continuing Education
Points.

Because of the broad spectrum of potentially exposed populations, environmental and occupational
health issues permeate all aspects of nursing practice, research and health care delivery (Viscusi K
1994). The IOM argues the rationale to include environmental health training in to the nursing curricula
was ‘obvious’ as occupational health nurses are at the forefront on the areas of occupational and
environmental health (IOM 1995). In 1998 US had 13,000 registered environmental and occupational
health nurses (Rogers B and AR. 1998). The ATSDR continues to collaborate with the EHNI, and the
American Association of Occupational Health Nurses, and The Association of Occupational and
Environmental Clinics (AOEC) (ATSDR (b)).

The AOEC, founded in 1987, is a network of 65 clinics and approximately 300 individual health
professionals committed to improving the practice of occupational and environmental medicine through
information sharing and collaborative research. Occupational and Environmental health physicians and
nurse practitioners staff the clinics to provide site-specific health promotion, which includes
environmental health interventions to enhance local communities’ access to environmental health
services where exposure to hazardous substances are occurring or are likely to occur. Their specific
activities, including community needs assessment, environmental health education, clinical evaluations,
and clinical specialty referrals, are designed to help clarify exposure status and evaluate any associated
health concerns, improve access to environmental health services, and strengthen the local public health
system to follow up on environmental health concerns (ATSDR (b)).
Health education is another function of these clinics. Environmental health education activities provide training to health care providers who work within affected communities and to communities affected by hazardous substances in the environment. This training is implemented in conjunction with local health care providers and with community advice and guidance. One method in environmental health education is distance-based learning using satellite facilities broadcast to participants statewide. The ATSDR website provides a searchable list of clinics, contact details, and major areas of activity on their website. Several clinics list pesticide exposure as a speciality service provided, and offer counselling, treatment and biomonitoring (ATSDR (a)).

Across the U.S., accredited environmental programs are now designed to provide Environmental Health Officer (EHO) graduates with a combined foundation in environmental health science and public health in the context of developing the critical thinking skills necessary for problem solving. Currently, there are only 24 undergraduate programs and three graduate programs accredited by the National Environmental Health Science and Protection Accreditation Council accounting for 1,500 of the EHO workforce. These 27 programs alone cannot meet the increasing demands which have been exacerbated by the bio-terrorism events (APHA 2003).

With minimal engagement of the health sector, the Australian environmental health workforce is instead comprised almost exclusively of EHOs. However, the primary health care workforce also has a valid role to play in environmental health. A definition of the theory and practice of environmental health was given earlier, “... assessing, correcting, controlling and preventing those factors in the environment that can potentially have an adverse effect on the health of present and future generations.” (Cromar N 2004).

The definition has relevance to human health where ‘assessing’ involves taking environmental health histories, biomonitoring, and physical health assessments to ascertain the level of impact on individuals or groups. ‘Correcting’ can be applied to human behaviour modification to reduce exposures. ‘Controlling’ relates to the advisory input from health professionals and toxicologists to the decision-making process, and regulatory systems authorising safety guidelines. ‘Prevention’ extends also into the realm of behaviour modification, health promotion and industry practice.

EnHealth documentation identifies that improvements in environmental health practice should be couched in terms of best practice, and improvements in health impact assessment, legislation and service delivery (enHealth Council 1999). Enhancing the capacity of the environmental health workforce was one of the key features identified within the NEHS, and to this end, the Strategy recommended an increase in an environmental health knowledge base to support decision-making.
The NEHS adds that qualified health professionals are the mainstay of identification of variances from good health. However the NEHS restricted its listing of professions who have a role in environmental health to environmental health workers, epidemiologists, toxicologists, researchers, academics, policy officers, urban planners, engineers, administrators, allied health professionals, and ‘other professional and managers’. No mention was made of the primary health care workforce, doctors and nurses, recognised internationally as critical in diagnosing environmental related disorders, and providing the clinical information required for surveillance.

Further reading of the Strategy reveals that recommendations to strengthen workforce capacity are limited to enhancing training for environmental health officers and workers, plus raising the profile of environmental health in the allied health curricula. Again, the recommendation does not extend to injecting environmental health training into the curricular of medical practitioners or nurses, who are not customarily defined as allied health professionals.

A subsequent document, the NEHS Implementation Plan, developed actions plans for seven key areas to improve environmental health system in Australia (EnHealth Council 2000). One of these related to workforce, but yet again, focussed exclusively on environmental health officers. The need to broaden awareness of environmental health issues amongst other environment and health practitioners was identified. However the document also failed to identify strategies to generate sufficient momentum to increase an environmental health focus within the primary health care sector. The action statement to achieve this broadening of awareness of environmental health issues was ‘contributing to a paper defining the core concepts and principles underlying environmental health, and promoting this at professional conferences and associations across a broad range of disciplines’. The efficacy of such a strategy to potentially achieve any real change remains questionable.

The lead vehicle nominated for this action was Public Health Education and Research Program (PHERP) through the Education and Workforce Development Section of the Department of Health & Aged Care. PHERP was established in 1987 by the Australian Government to strengthen national capacity to educate and train Australia’s public health workforce. Clear demonstration that chemical exposure has not featured in the mindset of public health in Australia exists in the NPHP 2000 publication “A Planning Framework for Public Health Practice”. This document lists public health action areas in the field of environmental health as: water quality; air quality; food safety and quality; contaminated land; health aspects of waste management; vector borne disease; and hazards in the built
environment (NPHP 2000). The bulk of these activities are routinely managed by environmental health officers operating through local governments (NPHP 2000), with little active support from the health sector.

A list of national priorities guiding PHERP activities included environmental health, and a project was initiated at Curtin and Griffith Universities to establish a master’s degree in environmental health. However, this program was not designed to encapsulate the primary health care workforce, instead, course graduates are expected to move into the mainstream EHO workforce (Department of Health & Ageing 2004). Qualifications required by EHOs were, until recently, controlled by legislation directly linked to the British system of training health inspectors. Accordingly, diagnosis of clinical conditions is not a function of the EHO role, and lies outside their scope of practice. A small stream of calls to increase environmental health capacity of the Australian primary health care workforce have met little response (Shearman D 2002). This is largely a function of funding mechanisms, and the prevailing mindset of what constitutes environmental health practice within Australia, where enHealth and the NPHP limit their view of the practice of environmental health to be solely the realm of EHOs. The human-chemical interface does not appear to be on the NPHP or enHealth radar.

The marginalisation of the environmental health workforce can be seen in the way in which (in one jurisdiction) is placed in the organisational structure. Examination of the organisational structure of Department of Human Services (DHS) reveals that it views environmental health as tangential to the health portfolio. Accordingly environmental health carries a low profile. The Social and Environmental Health Branch5 (the Branch) of the DHS is a sub-section of the Public Health Group, which is part of Rural and Regional Health & Aged Care Services. Accessing the Branch on-line involves five ‘clicks’ from the DHS home page to track through the various levels of business units (Department of Human Services 2005). Having no guidance along this pathway limits accessibility by the public.

The Branch budget is limited, and no state program funding is allocated towards the health sector to perform specific environmental health activities. In Victoria, total state government expenditure on Environmental Health was $3.2 million in 2000–01 (AIHW 2004). This was 1.8% of total expenditure on core public health activities, which in itself comprises only 2% of the State health budget and is significantly less than other states6. This contrasts with the United States, where environmental health

---

5 The word “Social” is a recent inclusion to the title of the Social and Environmental Health Branch (since 2004).
services account for approximately one-half of the expenditures and personnel practicing public health (Boatright D, Brandt M et al. 1999). The Branch activities focus on the physical environment, and do not include human chemicals exposure monitoring or surveillance. The final point demonstrating the separation of ‘environment’ from ‘health’ can be seen from the DHS website list of the health care workforce, where the category of environmental health is not included.

**Conclusion**

For several decades the problems of chemicals in the environment: their proliferation; minimal toxicological assessment on the thousands chemicals in current usage; and amassing evidence of the harm these agents are contributing to human health and the environment, have attracted increasing international concern. Subsequently, a series of UN lead multilateral conventions emerged to protect human health and the environment from the dangers posed by chemicals. AgVets comprise 10 of the Stockholm POP Treaty ‘Dirty Dozen’. These agents are biocidals designed specifically to interfere with biological pathways, and it is the seriousness of their exposure risk that has placed them at the core of the UN Chemical Conventions.

The current situation in Australia involves rigorous systems of chemical regulation, and strong compliance monitoring for industrial and therapeutic agents, yet the weakest compliance monitoring exists for AgVets, the most dangerous chemicals on the market. Information regarding the quantity and location of AgVet application, and breaches of guidelines is lacking. This leaves Australians vulnerable to exposure risks.

Europe is pursuing reduction in environmental contaminants, such as pesticides and endocrine disrupters in the environment, and is developing strategies to increase environmental expertise within the public health workforce to identify exposure related illnesses. Investments in surveillance and monitoring, including biological population assessments are also underway. The United States takes a different approach. The U.S. thus far has demonstrated little political will towards reducing reliance on pesticides, but has become the world leader in the development of exposure assessment and biomonitoring systems, and has long recognised the need for environmental expertise within its health workforce.
Other industrialised countries have therefore recognised the need to formally connect health portfolios with environmental protection and chemicals management frameworks. From this has evolved the European and U.S. efforts to establishing surveillance systems to monitor exposure related health effects. That environment and chemicals management frameworks remain divorced from health portfolios has meant that Australia has yet to respond to environmentally induced human health risks by way of health infrastructure. Australia also fails to recognise the need to involve the primary health care workforce in environmental health practice. This present infrastructure in Australia therefore continues to polarise environmental health, whereby management of the environment to protect human health is divorced from the health sector, and occupational health largely ignores chemical harm. Hence the health sector is not engaged in chemical exposure issues, without which diagnoses of chemical induced harm cannot be made. Without clinical diagnoses, surveillance is not possible, and without surveillance, appropriate health planning cannot occur. In the absence of information, it is presumed that no problem exists. However absence of data does not equate with absence of problem.
CHAPTER 4
RURALITY and PRIMARY HEALTH CARE in AUSTRALIA

Introduction

In Australia, health services are expected to be ‘appropriate’. This means that services offered must be tailored to meet the specific needs that are pertinent to the community (The Australian Health Ministers Conference 1994). Many national health policies have inevitably been influenced by the needs of metropolitan services and populations (Simmons D and Hsu-Hage B 2002). Whereas some health needs are universal, others are regionally or culturally specific, and the rise in rural health awareness over recent years has highlighted the different way life is experienced in rural areas compared to metropolitan living (Wilkinson D and Blue I 2002). Therefore a study examining the health needs of rural people must be fully contextualized to include the specific features of ‘rurality’ that serve as distinctly rural health determinants.

The first sections of this chapter therefore explore the defining features that contribute to making ‘rurality’ an important health determinant in Australia. For agriculturalists, connection with the land is paramount. Factors defining rural experience include the major environmental challenges facing this ancient and distinct landscape, the agricultural-environmental interface. Major features therefore include the climate, geophysical landscape, and environmental degradation, and rural economics, which are largely a factor of commodity prices. Further psychosocial features of life in the country also impact, such as the socio-political environment, and the stoicism, resilience and independence characteristic of rural Australians. These features combine to mould the rural mindset, motivate behaviours, and act as powerful drivers of physical and mental health, and therefore well-being, and hence serve as rural specific health determinants. This chapter therefore explores factors that have the ability to determine whether rural communities flourish or wither.

The second part of this chapter turns to examine the health of rural Victorians, drawing comparisons with their urban counterparts, and factors determining rural workplace safety. Training and expertise of the existing rural primary health care workforce are then examined to determine Australia’s preparedness to deal with environmental exposures to AgVet chemicals, an issue which may serve to explain a significant proportion of the health disparity observed between urban and rural populations.
Natural environment and human health link

In evolutionary terms, both social and biological, our physical fitness has been largely dependent upon our nutritional status (Aplin G, Beggs P et al. 1999). By ensuring the availability of nutritional food sources, agriculture became the foundation for success of civilizations, and agricultural success was in turn, determined principally by local environmental conditions. A healthy natural environment (that is a fertile soil, an abundant reliable water supply, temperate climate and the presence of ‘appropriate’ indigenous plants and animals amenable to domestication so as to ensure a stable food supply), were the preconditions for the initial development of agriculture (Diamond J 1998). Lands with barren soils, harsh climates, poor water quality, or unsuitable native flora and flora for domestication or human consumption, were unable to sustain large settlements. Conversely, conducive environments allowed populations to flourish. Diamond argues that environmental resources helped determine why some societies were successful in the establishment, and ongoing survival of civilizations, whereas others failed, and explains why agriculture did not develop (historically) in Australia (Diamond J 1998).

The relationship between human health and the surrounding environment is one of dependency, and over exploitation spells eventual decline. Salient lessons exist for Australia in terms of over exploitation through the numerous historical examples of anthropogenic environmental catastrophes that have wreaked devastating effects, and at times, obliterated civilisations. Mesopotamia, located in today’s Iraq, forms part of the fertile crescent. Despite having a low rainfall, it developed a thriving civilization of 1.5 million people based on irrigation delivering a regular food source (Pidwirny M 2001). Mesopotamia’s eventual decline is now thought to be a function of salinity (McMichael AJ 1993). Numerous other civilizations have collapsed as a direct result of environmental pressures occurring naturally, or through human intervention such as resource depletion, salination following deforestation, and soil erosion (McMichael AJ 1993). Chemical contamination of environments and people has no historical precedent, but the indications of harm are already apparent (Australian State of Environment Committee 2001; Australian Bureau of Statistics 2002; Sanborn M, Cole D et al. 2004).

The Australian environment: an agricultural challenge

Australia is a physically isolated, resource rich country with a large landmass, with a small and increasingly multicultural population giving it one of the world’s lowest population densities (Crabb P 1997; O’Connor M 1998). Most of the continent is suited more to nomadic lifestyles than agriculture
(Flannery T 1997; Diamond J 1998), as much of the native vegetation is tough, unpalatable and
unsuitable to domestication, with harsh environmental conditions, and a climate characterized by
frequent droughts and floods. Unlike Europe and America, Australia lacks the deep fertile soils formed by
the weathering action of glaciers (Crabb P 1997; Williams J and Saunders D 2005). Hence during the
40,000 to 60,000 years of human habitation, virtually no agriculture was employed, and population
growth remained slow, compared to other continents of this size (Flannery T 1997).

The Australian continent therefore shares little similarity with the rest of the world. Australia is the driest
inhabited continent on Earth, and its geological history has created a unique, ancient continent that by its
flatness has accumulated enormous amounts of salts in the soils, regolith, lakes and groundwater
(O'Connor M 1998). Unlike other lands, most Australian rivers and groundwater systems flow inland.
There is little fall, so flow is relatively sluggish which limits their capacity to remove salt from the
continent. Salinity and deteriorating water quality are now seriously affecting the sustainability of
Australia’s agricultural production, the conservation of biological diversity and the viability of our rural
infrastructure and regional populations. At least five percent of cultivated land (2.5 million hectares) is
now affected by dryland salinity, some estimates predict this will rise as high as 22 percent by 2050

Early European explorers, such as Hartog and Darwin, described the landscape as hostile (Hughes R
1987). Agriculture was never going to be easy on this old, dry continent, and at best success would be
short lived, and cyclical. Yet despite these harsh conditions, agricultural management practices imposed
on this continent were originally developed to suit a much different place – a wet and fertile landscape
(Wentworth Group of Concerned Scientists 2002). With European settlement came the direct
importation of European agricultural practices. Unfortunately, most of these are ill-suited and are
degrading the environment at a rate estimated by the Australian government at $1 billion per year
(Beynon N 1997).

From the early beginnings, it was evident that intense intervention would be needed to produce yields
sufficient to enable a secure livelihood. The hardships facing Australian farmers, past and present, are
well known, and the success of our Agricultural industries testifies to the perseverance that evolved over
several generations, which in part explains the resilience and stoicism inherent in the rural Australian
character. This plays a critical role in determining current farming practice, and also influences health
behaviour patterns. Chemical hazard exposures are a function of these two factors.
Agriculture revolves around seasons, hence climatic variations impact acutely on production, so global warming paints a grim picture for the future of Australian agriculture as the International Panel on Climate Change warns much of southern and western Australia may be facing a permanent drought situation (Pittock B 2003). The major concern for agriculturalists is that global warming models predict increased frequency and severity of extreme weather events (IPCC 2002). Rainfall that is excessive, altered in timing such as a late “winter break”, which marks the beginning of spring rains, heavy rains in summer, or alternatively, low in volume, as in drought situations, all have a devastating effect on agricultural production (Working Group I (IPCC) 2001). Pressures facing farmers in the future can be expected therefore to intensify rather than ease or remain stable.

Agriculturalists in Australia face a constant battle with the variable climatic patterns which characterize this continent (Botterill LC and Fisher M 2003). Recent droughts demonstrate the resulting economic pressures facing farmers. The 2002-2003 drought, regarded by many as the worst on record (National Farmers Federation 2002), came as an acute drought after a period of chronic low rainfall, which for many districts represented 8 years of successive drought (National Climate Centre 2004). The Federal Minister for Agriculture, Fisheries & Forestry reported the net value of farm production was estimated to fall by around 80 percent (Truss W Minister For Agriculture Fisheries and Forestry 2003), meaning that many farmers would again experience a negative income. Much of the country is again in drought in May 2005.

Cognisant of this perennial battle against the seasonal variations, and in an effort to maintain financial viability in competitive global markets, Australian farmers have enthusiastically embraced new technologies to improve their agricultural output, as testified by the rapid rise in reliance of AgVet chemicals. Resultant productivity gains have been impressive, showing an annual net increase of 2% in net farm production from 1975 to 1996, rising from $1.3 billion to $4.6 billion (Radcliffe JC 2002). However, despite increases in yield, actual agricultural profits are notoriously variable (Larson A 2002). Australia’s farming and grazing industry in 1998-99 had a farm gate gross value of $28 billion, however input costs were $24.1 billion, leaving a net value of agriculture at $3.9 billion (National Land and Water Resources Audit Report 2002).

Agricultural production feeds and generates the fibre to clothe the population, and currently comprises 20% of Australia’s exports. Half of this comes from irrigated agriculture, which covers less than one percent of the land area (Cullen P 2002). Once the agricultural sector was recognized for its significance to the survival and prosperity of the growing nation (Gray I and Lawrence G 2001). However, by any
measure, the agricultural sector’s influence on the total Australian economy has declined. More than a century ago Australia’s survival depended on providing a continuous source of food and fibre to feed and clothe its growing population, and to form a sound financial basis for the economy (Larson A 2002). Then, almost half the Australian population lived on rural properties or in small towns (less than 3,000 people), and in 1911 nearly one third of Australia’s white population were employed in agricultural and pastoral industries, which contributed to about half the GDP (AIHW 1996).

By 1953-54, fishing, forestry and agriculture contributed 84% of Australia’s export market, and had reduced to only 20% of the GDP (Radcliffe JC 2002). Australian farmers were reported to be 51% more productive than their United States counterparts, 155% more productive than their British farmers, and 220% cent more productive than German primary producers on a per capita basis (Cribb J 1991). But economic problems from the mid 1970’s have taken their toll, as shown in Fig 3.1 below, which depicts profit erosion due the escalating costs of production against minimal increases in prices received for raw commodities. National and global inflation, rising interest rates, fuel price rises (diesel increased from 4c/L in 1970 to over $1 in 2002), inability to compete with international subsidized imports, and the slump in global commodity prices have eroded profits (Conacher A and Conacher J 1995; Ray DE, de la Torre Ugarte D et al. 2003).

![Fig 4.1 Prices received / paid by Australian farmers 1965-95](image)

**Fig 4.1 Prices received / paid by Australian farmers 1965-95**

*Source: ABARE Commodity Statistical Bulletin 2004*

By 1990, farmers’ terms of trade were at their lowest point since the Great Depression, and as farm debt increased, farmers have been forced off the land. The number of farms decreased from 205,000 in the early 1950’s to around 165,000 by the late 1980’s, and this was accompanied by a loss of 100,000 from
the rural workforce (Penn J and Fischer BS 2004). The situation persists as farmers continue to leave, driven either by financial imperatives or retirement (Barr N 2004). The pressure to maximize returns from their farms necessitates that farmers engage whatever strategies promise greater yields, hence the rising reliance on AgVets witnessed over the recent decades. Continued demand for these chemicals can therefore be expected (EPHC National Chemicals Taskforce 2003).

Australia has not followed international policies of subsidizing farmers. Rather the National Competition Policy has seen an increasing shift away from government supported ‘agrarian socialism’, as it is no longer viewed as politically acceptable to support individual landowners (Botterill LC 2003). The Australian government's direct financial support for agriculture has fallen from 0.8 per cent of GDP in 1986-87 to 0.3 per cent in 2001. Comparative European Union figures for 2001 show support at 1.7 per cent, and the U.S. support was 0.9 per cent in 2001 (Penn J and Fischer BS 2004).

Today, fewer than five per cent of Australians (430,000 people) are employed directly in primary industries production, which now produces less than three per cent of Australia's GDP (Barr N 2004). In contrast, the United States views rural America as an integral part of a total food and fibre industry, although agriculture accounts for less than 1 per cent of the U.S. GDP. This is not seen as an issue because it recognizes that agriculture underwrites 16 per cent of GDP, and contributes directly and indirectly to 17 per cent of total employment (Rees B 2003). In Australia, agriculture directly and indirectly employs 20 per cent of the total workforce (Beynon N 1997).

The Australian Bureau of Agricultural and Resource Economics (ABARE) attributes the contracting Australian agricultural workforce to the adoption of industrial techniques of vertical integrated production, but mostly to falling commodity prices which have reduced economic returns, limiting the financial viability of small holdings (Penn J and Fischer BS 2004). The WorldWatch Institute suggests that in order to generate the equivalent purchasing power, farms need to be roughly four times as large today as in 1950, or must supplement income with off farm employment (Halweil B 2000).

Despite the contracting workforce, agriculture remains the dominant industry, covering over 61% of the landmass, and providing employment for over 30% of 66% of small non-coastal towns (National Farmers Federation 2002). Currently ninety-five percent of farms establishments in Australia remain family owned, yet a mere 20 percent of farms are responsible for 80% of total production (Gray I and Lawrence G 2001). This means that 80% of farms are producing only 20%, barely a subsistence, which explains why additional ‘off–farm’ income is a necessity for financial survival. Social and health impacts are
especially visible in the smaller, more remote communities where off-farm work is not readily available, forcing farming families to move to metropolitan areas in search of work (Gray I and Lawrence G 2001). The decline in agricultural population also reduces demand for goods and services from the remaining rural businesses servicing them, and thus infrastructure further contracts (Stehlik D 2003).

Service closure, withdrawal of government services, downsizing of railways and telecommunications, all continued throughout the 1990's across regional Australia which created a domino effect (Larson A 2002; O'Meagher B 2003), and has undermined the liveability of rural areas (State of the Environment Council 1996). This accelerated as the ‘critical mass’ formulations come into effect, which has been particularly apparent for health services. The situation has now evolved into a social justice issue, as Chris Sidoti, as Human Rights Commissioner, argued that through this relentless infrastructure decline, rural people are being denied their basic rights to the best attainable standard of physical and mental health (Sidoti C 2000).

**Health of rural farmers**

A traditional yet erroneous view of Australian agriculture, has been one of an industry where fit and healthy people living and working on farms enjoy the wide open spaces, fresh air, good health and are reasonably free from external interference (Lavelle P 2003). Recent research confirms the beneficial health aspects of accessing green spaces (Townsend M, Maller C et al. 2003), and enjoying a sense of self-determinism (Lawlor DA, Davey Smith G et al. 2005), which are indeed both regarded by farmers as the most positive features of agricultural life. However, rather than enjoying greater health, a paradox exists, whereby rural Australians, and farmers in particular, experience significantly worse health than their metropolitan counterparts across a range of indicators, and the gap is widening (AIHW 2003).

Male farmers face about a 40 percent increase in age standardised death rates compared to the male population of Australia, with standardized mortality ratios are 62 per cent higher for circulatory disease, and 20 per cent for neoplasms (Reeve I, Frost L et al. 2001). Two Victorian Burden of Disease studies confirmed that, overall, rural Victorians are more likely to suffer from a broad range of adverse health conditions and likely to die earlier (Glover J, Harris K et al. 1999). Only part of this differential can be explained by higher rates of lifestyle risks such as high fat diets, smoking and alcohol consumption differentials (Vos T and Begg S 1999).
Campbell made the observation in 1992 that ‘the rural sector is ageing, declining, stressed and going broke’ (Campbell R 1992). Economic depravation and social pressures increase levels of violence, stress, and ill-health. Rural people suffer markedly higher levels of substance abuse, psychiatric disorders, stress–related and chronic illness than urban dwellers, and rural suicides have increased dramatically from the 1980's (Fuller J, Edwards J et al. 2002). Chapter two demonstrated that pesticide exposure can induce psychological symptoms, which can reduce resilience to such social impacts. Effects of economic downturn on communities can create a sense of increased isolation, deprivation and worthlessness. It can also reduce social interaction with neighbours, reduce schooling and after school sporting or hobby activities, social and employment opportunities for farm children, and exacerbate problems associated with vast distances to be covered (Human Rights & Equal Opportunity Commission 1998; Wilkinson D and Blue I 2002). Reduced opportunities to obtain post secondary qualifications limits employment options in declining rural towns where businesses are also closing. Kellehear noted in 1992 that a third of rural towns are in decline (Kellehear A 2001), with many servicing populations less than 2500 looking like ghost towns (Conacher A and Conacher J 1995).

The rural financial decline observed over recent decades links directly with health status. Poor financial returns have pressured farmers to cut corners, and delay maintenance and repairs, thereby forcing them to work with aging and marginally performing equipment. The ability to employ part time assistance is usually no longer an option for most farmers. Children from farms are well aware of the financial disincentives, and the long hours of difficult physical labour in harsh conditions (Human Rights & Equal Opportunity Commission 1998). Alternatives for less arduous employment, with greater remuneration, have meant that fewer children are electing to continue to farm. The result has been a gradual aging of the rural workforce (Barr N 2004). As farming families decrease in the size, the availability of additional ‘pairs of hands’ is diminished. In the absence of farm help, the farmer, physically tired, especially after working long hours, is forced to take risks, and attempt to do two-person jobs solo, in an effort “to get the job done” (Franklin RC, Brown P et al. 2001).

**Workplace safety in agricultural Australia**

That farms are family owned and operated is highly significant. Workplaces are not only varied, but in business terms, are usually small. The Occupational Health and Safety Act 1985 applies to all employers including those who work in the farming industry (Victorian WorkCover Authority 2004). Workplaces receiving close occupational health and safety scrutiny via accreditation and monitoring are the larger operations, where multiple employees are involved. Therefore, the majority of family operated
agricultural workplace environments are largely unregulated. Financial imperatives to stretch resources, work long hours, in dangerous conditions, alone, with antiquated equipment, unaided and with little regard for personal safety sets the scene for almost certain health risks and injury, both chronic and acute (Franklin RC and Davies DL 2003). Labels on chemical products are sometimes not read carefully, protective gear is left in the Ute, over-reaching is necessary, and carrying heavy loads all combine and lead to a potential snowballing of risks which can easily progress towards accidents and chronic misuse of agriculture equipment and chemicals (Sandall J, Cooksey R et al. 1999).

Environmental factors, are reported to account for some of the health differential noted between SES groupings (Evans GW and Kantrowitz E 2002). The Evans study found the strongest predictor of the gradient was poor living and working conditions, with the latter defined as heavy lifting or tasks with repetitive strain plus daily contact with toxins, fumes, dust, explosives, vibration, and the like. This study also found seasonal agricultural workers to have the greatest body burden of persistent chlorinated hydrocarbons, and an almost perfect linear gradient between SES and pesticide body burdens, using DDE, a major metabolite of DDT, indicative of lifelong exposure. Many of those organochlorines were withdrawn from sale in Australia in 1987 (Melville J 1989), yet their hazardous effects linger. The chemicals remain active for 30 years, and they are lipophilic, remaining sequestered in fatty tissue for many years (Dewailly E, Mulvad G et al. 1999).

The Australian agricultural environment presents the potential for occupational exposure to a large number of hazardous agents – physical, biological, and chemical. Exposures vary depending on type of crops and livestock produced, and the level of industrialisation of the particular sector. Substantial mechanical risks derive from rural machinery, which can be massive, or old and temperamental. Routine maintenance and repair of fences, buildings, yards and equipment involves the use of powered tools, and activities such as welding, present further exposure hazards to welding fumes, electrical hazards, solvents and physical injury from tools (Franklin RC 2002). Agricultural workers, by the very nature of working the land, must endure extremes of weather conditions, often on a daily basis. Additional environmental stressors include humidity, noise, ergonomic stresses, mechanical hazards, organic and inorganic dusts, in addition to agricultural chemicals (Franklin RC and Davies DL 2003).

Working with livestock is dangerous, especially in confined spaces such as yards, and the ergonomics of lifting and manipulating stock and equipment, can lead to injuries. Livestock work also presents other hazards. Environmental agents measured in poultry, swine, and dairy buildings include a complex mixture of irritant gases, micro-organisms, and organic dusts. Dusts are biologically active and contain
plant material, animal-derived particles (skin, hair, droppings, urine), bacteria and fungi, microbial toxins (endotoxin, glucans, mycotoxins), mites and other arthropods and insects, feed additives and pesticides (Kirkhorn SR and Garry VF 2000). Diseases associated with livestock proximity include anthrax, brucellosis, leptospirosis, dermatophytoses, Q fever, and bovine spongiform encephaloliths (Porta M 2002; Cohen R and Estacio PL 2004).

Irritant gases include ammonia, hydrogen sulphide, methane, nitrogen oxides and other gases produced by the microbial action in manure and feed. Air sampling studies have been found exceeding current occupation health standards up to a thousand fold. Ammonia produced from microbial degradation of urea and uric acid is a highly reactive alkaline irritant gas (Kirkhorn SR and Garry VF 2000). Working in confined spaces, in feed silos for example, poses great risks for inhalation of acutely toxic levels of fumigants mixed with the grain for the purpose of destroying vermin, and preventing the growth of moulds and fungal diseases (Soloman G, La Dou J et al. 2004).

Production of crops also presents an array of health risks. Direct health implications that link agriculture, plant pathology, and public health include emerging and re-emerging plant diseases, Mycotoxigenic fungi, agricultural biotechnology, allergens, food safety in addition to chemical exposure (Scholthof KBG 2003). Occupational exposures depend on the type of crop (grains, fruit, vegetables), and the size of the operation (Franklin RC, Brown P et al. 2001). On smaller farms, typical of the Hume region, workers are usually involved in the whole production cycle including soil preparation, planting, pruning, harvest, storage, equipment maintenance, and transport. Preparation of the soil involves tilling the fields, discing, ploughing, and other activities requiring physical labour and the use of heavy machines (Conacher A and Conacher J 1995). Harvest involves manual labour, often in precarious positions up ladders, and the use of sharp implements, in addition to heavy machinery.

In addition to the frequent use of machinery during the planting and growing of crops, workers mix, and apply fertilisers, insecticides, herbicides, fungicides, and other agricultural chemicals regularly throughout the year (Yassi A, Kjellstrom T et al. 2001). Hot weather, and the need for dexterity, act as disincentives for agricultural workers to wear protective clothing and gloves. Exposure to chemicals and organic dusts is high (Cohen R and Estacio PL 2004).

Little place exists in the culture of the bush for sentimentality, ultimately you are ‘on your own’, but unequipped with the tools for self-care (Wainer J 2004). Pain is incidental, often unacknowledged, and only significant impairment of function attracts sympathetic attention. Risk-taking is often perceived as
necessary to complete the activities demanded. It is also regarded in some sectors, as a requirement for social acceptance, where going to lengths to adhere to precautions, can be associated with signs of weakness (Human Rights & Equal Opportunity Commission 1998). A subculture exists whereby weakness among men is ridiculed, and serves as a disincentive for many to ask for help, such that acknowledging feelings and honouring fear are suppressed by bravado and alcohol (Fuller J, Edwards J et al. 2002; Wainer J 2004).

Agriculture is ranked the second most dangerous industry in Australia, following mining (Franklin RC, Brown P et al. 2001). Every three days a person is fatally injured on an Australian farm, and although farms account for only 5% of Victoria's workforce, almost half the deaths in the first three months of 2004 in Victorian workplaces occurred on farms (Victoria WorkCover Authority 2004). In addition to the high number of fatalities occurring within agriculture, it is estimated that between 200 and 600 injuries per 1,000 farms require attention at rural hospitals each year (Farmsafe Australia 2003), and every day an average of ten people make a workers compensation claim for an injury sustained in while working in the agricultural industry (Franklin RC 2002).

Contemporary occupational health and safety legislation in all states and territories requires employers / managers to implement a risk management approach to health and safety hazards in the workplace (NOHSC 2002; Farmsafe Australia 2003). Yet in most jurisdictions the agricultural sector attracts workers compensation premium rates approximately four times the average premium rate for all other industries, as a result of their poor claims performance relative to those industries (Farmsafe Australia 2003). While many individual farmers may consider their attention to safety quite adequate (rightly or wrongly based upon their own accident experience), the farming industry as a whole, has not to date been able to demonstrate an ability to effectively manage health and safety risks and minimise injury and illness (Franklin RC 2002).

The 4th National Farm Injury Prevention Conference (Franklin RC 2002) identified the need for farmers to be able to access skilled Occupational Health and Safety consultants to assist and work with farmers to implement greater safety on their farms. This conference recommended further research to define specific risks to the health and safety of farm women and families, and research to identify the psychosocial and other environmental factors that contribute to work-related risk taking behaviour, and their significance in relation to farm safety.
Fragar claims that workers compensation statistics provide a very conservative estimate of all work-related injuries occurring on farms, suggesting representing as little as 15% (Fragar L 2004), as 95% of farms are family owned and operated (Barr N 2004). Farms are unique places, in that they are not only work environments, but constitute living, and recreational environments as well, hence there are also significant numbers of injuries occurring to unpaid family members, including small children. Risk management and safe work practices are clearly equally relevant for small family operated farms, as failure to adopt safety measures places family members at greater risk.

Gladen’s study articulated the pathways placing family members at high risk of direct exposure to chemicals (Gladen BC, Sandler DP et al. 1998). The study found 21% of homes are within 50 yards of pesticide mixing areas, 27% of applicators store pesticides in their homes, and 94% of clothing worn for pesticide work is washed in the same machine as other laundry, 51% of wives of applicators worked in the fields in the last growing season, 40% of wives have ever mixed or applied pesticides, and over half of children aged 11 or more help with farm activities.

To date, farm safety efforts in Australia have focussed almost exclusively on injuries, which aligns with the focus of national occupational data (NOHSC 2002). Chronic conditions are rarely added to the register, and health problems associated with chemical use are limited to acute poisonings. Franklin noted that research or institutional response did not match the high levels of concern among agriculturalists regarding their chemical exposure (Franklin RC 2002). Chapter 2 reviewed the accumulating international evidence suggesting exposure to these agents is impacting severely on agricultural communities (Sanborn M, Cole D et al. 2004), yet few studies have investigated the risks and effects in Australia. In the absence of readily collectable data, injuries or symptoms relating to chemical exposure, strategies have been slow to emerge.

The high farming injury rates in Australia prompted the introduction of a national injury surveillance system, and an associated farm safety program. The Victorian Workcover Authority recently reported a 67% reduction in investigated tractor deaths, and a 17% reduction in total death claims (Victorian Workcover Authority 2002). Such success testifies that appropriate public health interventions can change farming practices to reduce health risks. The potential therefore exists, to reduce illness associated with other agricultural hazards through the introduction of appropriate population based, and targeted approaches.
Health care system for Rural Australians

Australia’s early dependence on agriculture and the subsequent rural economic decline both exert pressures on farmers to maximize returns, which have driven the increased reliance on AgVet chemicals. These factors help explain health status and health–related behaviours of agricultural communities.

Despite distinct health hazards in the rural sector, the rural health care system is not well equipped to respond. The reasons are multifactorial. Declining rural populations over recent decades have been accompanied by withdrawal of infrastructure, and the sense of rural disadvantage is very real. This serves to reinforce the reluctance of professionals to establish, and remain in rural areas. Health professional shortages, across all specialities, in rural areas are now well documented (Wells R 2000; AIHW 2003; Struber 2004), and result in higher patient loads for existing providers, working in environments offering fewer professional supports (Hanna L 2001). Health care practitioners experience difficulties maintaining educational currency, and despite rural socio-economic disadvantage, few rural doctors bulk bill. Exacerbating this situation, and although rural people have a higher ratio of complex needs, long consultations and health promotional activities occur infrequently (Johnston G and Wilkinson D 2001).

The Australian Health care system is characterised by a public-private mix in financing and delivery of all services (Donalto R and Scotton R 1999). Menadue argues Australia still has a highly institutionalised and medicalised system, rather than a ‘health system’ (Menadue J 2003). He adds that there is little disagreement about the directions public health reform should take — greater emphasis on primary and preventive care, workforce reform, community participation, improved governance and better application of information technology. It is clear that there are gaps and duplication in clinical services that reflect outdated population patterns and jealously guarded clinical territories. Hospital interests drive the funding debate at the expense of, primary care and illness prevention.

The national publicly funded universal insurance program Medicare is largely limited to hospital and medical services. The Australian Government, via the Medicare tax levy, funded 81.8% of the $10.3 billion spent on medical services in 2000–01, mostly via a ‘fee-for-service’ basis paid directly to the private medical practitioners. Other primary health care professions forming the primary health care workforce have unsuccessfully sought to have their services similarly supported within the universal health care system (Duckett SJ 2000). The Medicare tax levy pays General Practitioners (GPs) at a rate
of 85% of the fee set under Medicare Benefits Schedule (MBS), however this does not preclude GPs
from charging significantly higher fees (Donalto R and Scotton R 1999), and this trend is increasing in
rural areas (Phelps K 2003). Common practice in North East Victoria in 2004 was for patients to incur
costs of $25 - $40 per visit, and for GPs to also charge concession card holders. The National Rural
Health Alliance estimates that, due to the higher average rate of out-of-pocket expenses, rural and
remote Australians pay $43 million more in out-of-pocket costs on a proportional basis for their health
services than their urban counterparts (NRHA 2003). On average, people in urban areas receive about
$145 in Medicare rebates a year, whereas the average in rural areas is $92 per year, so that it would
take a shift of $250 million to give people in the bush their fair share of Medicare (Stratigos S 2003).

Access to public health care is universally available, yet true equity of access has been challenged in
view of diminished service availability, and the disincentives for people in rural areas to access due the
higher costs, financial and personal effort required (Smith J 2001; Furler JS, Harris E et al. 2002; Young
AF and Dobson AJ 2003). However out-of-pocket expenses for visiting GPs are still often less for the
uninsured than for seeing allied health professionals, whose services are not government subsidized
(Denniss R 2003; Struber 2004).

The cost effectiveness of multifaceted preventive strategies has been broadly demonstrated (McMichael
Services 2003). Despite this evidence, population based public health funding in Australia receives less
than 1.7% of the total health care budget (AIHW 2004), whereas Canada spends between 2 and 4%
(Canadian Public Health Association 2000), and the U.S. spends 4% (Baker SL 2004). Additionally,
national rural health strategies have focussed primarily on increasing the number of doctors to improve
rural health (Abbott T 2004), despite no evidence suggests this is effective in improving health outcomes
(Richardson J and Peacock S 1997; AIHW 1999).

Australia’s health system was ranked at 38 (out of 191) on the World Health Organization league table in
terms of performance on three criteria: good health, responsiveness to the expectations of the
population, and fairness in financial contributions (World Health Organization 2000). According to
citizen’s juries, the Australian public want more spending on prevention and public health ahead of
treatment of disease, increased spending on rural and remote health over urban health and a stronger
focus on community based health services (Mooney GH and Blackwell SH 2004). Australia’s highly
medicalised health care system, focussed disproportionately on the acute health sector at the expense
of primary health care, and which disregards exposure related illness, may well be failing rural populations.

**Primary Health Care**

Primary Health Care (PHC) forms the backbone of a health care system. It is a philosophical approach to health and health care, and this underpins strategies and a model of service delivery all aimed to maximise population health gain. The philosophy behind PHC is based upon:

- holistic understanding and recognition of the multiple determinants of health
- equity in health care
- community participation in and control over health services
- focus on health promotion and disease prevention
- accessible, affordable, and using acceptable technology
- health services based upon research evidence of success. (WHO 2004)

These philosophical ideals have been variously interpreted into a set of strategies and services which further the ideals. Primary health care strategies include needs-based planning and decentralised management, education, intersectoral coordination and cooperation, a balance between health promotion, prevention and treatment provided by a multi-disciplinary health team workers and a balance between health promotion, disease prevention and treatment.

Services to provide primary health care should be locally based to make them accessible, affordable and acceptable, offer a range of care including health promotion, disease prevention, illness treatment and rehabilitation services. PHC services need to be well integrated with the secondary and tertiary health care sectors, in order to provide continuity of care for people throughout all levels of the health care system. This involves attention to cooperation and communication. Primary health care services require cooperative efforts from a team of health care providers drawn from a range of disciplines.

Primary health care as defined in the 1978 Alma-Ata Declaration, sets a very demanding standard for health care(CHERE). Profound reorientation of health systems is required to fully incorporate this original ideal, so modified versions have evolved, which has lead to confusion in the dialogue. The Alma-Ata version has become known as comprehensive PHC. This is to contrast with the approach that has actually emerged, selective primary health care, which is more medically focused, with a reliance upon medical interventions and doctors for provision of and control over health services insert (Baum F 1999).
Development of PHC services in Australia occurred largely in an ad hoc manner, and a lack of uniformity across states/territories in PHC delivery exists at local level. Significant gaps and overlaps exist, as services are provided across diverse structural arrangements by a range of health professions, both within the government funded sector and other agencies. Lack of agreement on definitions and categorization of activities within the realms of PHC, and population health have added to the complexity of the task of monitoring or measuring PHC delivery in Australia (AIHW 2001).

The terms ‘community health’, ‘public health’, and ‘primary health care’ are at times used interchangeably, whereas within health specialisations the terms have distinct meanings, and are used to differentiate between paradigms and therefore practice. However several sectors in Australia, notably general practice divisions, government departments of health, some universities and research units, limit the definition of ‘primary health care’ to refer only to the first contact with medical practitioners, which some authors prefer to call ‘primary care’ (Keleher H 2000), or ‘selective primary health care’ (Baum F 1999). This interpretation gives primacy to treatment rather than prevention, and affirms Menadue’s critique that Australia needs to strengthen the health care system’s prevention focus.

Figure 3.2 below depicts an ideal conceptual map of Australia’s primary health care system. The model demonstrates the primary health care workforce working collaboratively to provide the necessary supports to promote the health and wellbeing of community members, assisting them to remain disease free, so they will not require the services of the acute health sector. Nurses are usually located within community health centres (CHCs) working alongside other health professional groups, or in GP clinics, whereas other specialties within the primary health care workforce are usually found in private practice, or providing outreach services to patients discharged from the acute sector. All services operate within the Australian legal framework, and in association with infrastructure and the services provided by other professionals also servicing to protect the health of Australians.

The model depicts primary health care (PHC) operating with strong intersectoral collaboration, in the sense that it recognises multiple health determinates, and the special skills of each provider group. The overarching philosophy of PHC is for all providers to work collaboratively to keep community members free of health complaints that would otherwise necessitate their entry to the acute care system (Kickbusch I 2003). Ideally, each professional group within the primary health care system provides services according to their specialty. Acknowledging their limitations, they refer clients to other providers for appropriate care, sharing the care, and sharing information, thereby avoiding duplication and oversight, and assisting community members in accessing appropriate services according to need.
Practitioners operate within the legislative framework and infrastructure, collaborating with other providers as a unified networked system to provide a protective barrier keeping community members from needing to access tertiary care. According to this model, the acute care sector exists as a safety net, to attend health needs beyond the capabilities of best practice in prevention delivered by the primary health care system.

**Acute Health Sector - Hospitals**

**Primary Health Care System with providers working in concert to prevent need for hospitalisation**

**Fig. 4.2 Primary Health Care System**

The Community Health Program was introduced across Australia by the Whitlam Labour government in 1973. It was designed to complement Medibank, the then new National Health Insurance Scheme, and
provide multidisciplinary health services such as specialist child health, mental health, family planning, dental services, health education, immunisation, social work, domically care and rehabilitation (Baum F 1999). Primary prevention and health promotion activities thereafter constricted during the 1980’s (Milio N 1992), and funding cuts during the 1990’s furthered this trend where service delivery as treatment episodes, replaced prevention as the primary focus (Baum F 1999).

Prevention initiatives attempt to ensure health problems, and the processes that culminate in health problems, do not occur (Beaglehole R, Bonita R et al. 1993). The PHC system has a leading role in strengthening communities’ capacity to tackle health concerns, and encouraging individuals to initiate and maintain health behaviours (Walsh M 2000; Schulz A, Arbor A et al. 2004). In the case of health hazards associated with AgVets, primary prevention can occur through their regulation, effective application of compliance monitoring programs, plus health education and promotion or even mandating attendance at courses to improve safe chemical handling practices (Arcury TA, Quandt SA et al. 2002). A role for secondary prevention involves screening, targeted health promotion programs, timely diagnoses of cases, surveillance and interventions to reduce the prevalence (duration) of the disease (Last JM 1998), whereas health expertise in managing symptomatology of exposure related disease comprises tertiary prevention (de Rosa C 2003).

The PHC system operating across Australia consists of a broad array of health professions, working towards health maintenance, but it has been argued that service coordination is lacking. The Centre for Health Program Evaluation found coordinated care to be most effective in addressing the problems of allocative efficiency (an inappropriate health service mix) and technical efficiency (poor quality or high cost care), but it needs to address both supply side and demand side issues (Segal L, Day N et al. 2003).

Direct service provision arrangements are largely similar across Australia, and occurs via various congregations of practitioners employed either privately or publicly, and some multidisciplinary clinics have emerged in recent years (Evans F and Hoodless M 1999). General practitioner visits are partly reimbursed via the Medical Benefits Schedule (MBS), but GP clinics largely operate as private enterprises, and charge an additional fee for their services, usually in combined multi GP practices. State and federal governments fund community health centres, district nursing services, palliative care, school nurses, and limited post acute allied health. State funded CHCs provide a range of primary health care services, largely delivered by nurses and allied health professionals. Relatively few centres include medical services by salaried general practitioners (Baum F 1999). Complementary and alternative
medicine (CAM) and other allied health services also operate privately, receiving minimal government support, and some limited health insurance coverage.

Hospitals provide outpatient allied health services for recently discharged patients, whereas health departments employ school nurses, and allied health staff to deliver community services to people with developmental disabilities. Environmental health officers (EHOs) are employed via local governments, and their role largely deals with environmental legislative requirements directed towards ensuring health promotive environments. EHOs have minimal direct community health contact (Yassi A, Kjellstrom T et al. 2001); they do not provide health care other than arranging immunisation programs which are delivered by nurses. They are not viewed as part of the health care sector.

CHC’s in Victoria employ staff to provide specific services in accordance with their health service agreement with the DHS. These agreements dictate which services are to be provided throughout the forthcoming financial year. Occasionally variations are made after budgets have been agreed, when the state governments allocate additional funding to provide specific programs. Funding is therefore tied to programs, and outputs are measured and reported to monitor that agencies are adhering to their service agreements. Variables contributing to outcome measures involve numbers of clients or groups seen, type of services provided, lengths of waiting lists, and cross subsidisation from one program to another is strictly discouraged. Health improvements are not measured. The DHS does not fund specific environmental health programs through CHC’s. (Chapter 4 outlines environmental health services operating within Australia.)

The structure of the primary health care system in Australia therefore is a complex arrangement primarily organized via funding sources, and coordination of services remains problematic. The interconnecting links between providers depicted in Figure 3.2, have been weak with regard to sharing of client information and coordination of care planning (Stone N, McNair R et al. 2002). Inter-professional referral rates are low, and virtually non-existent between some groups (Pringle M 1999). Intra - professional recognition and respect is a prerequisite to achieve effective rates of cross referrals.

Divisions of General Practice (Divisions) are established organisations of geographically grouped general practitioners. Divisions were first established in the early 1990s “to support networking among GPs and other health care practitioners, and to contribute to overall health outcomes for the population within a division by engaging in health promotion, illness prevention and population health activities at the local level, including coordination a of GP participation in regional and national programs” (General
Practice Consultative Committee 1992). A core role for all divisions is to ensure that general practitioner services are fully integrated with other primary health services, so that divisions can contribute to health service planning and provision at the local level in both rural and urban areas (General Practice Divisions of Victoria 2004).

GPs act as a 'gatekeeper', as referrals to specialists, prescriptions, and authorizations for additional government funded services must be authorized by GPs, so when people fall ill, GPs are commonly the first point of contact. Over 82% of the Australian population attend a GP as least once per year, and 70% of GP contacts are for chronic health conditions (Tibbles 1995; National Public Health Partnership 2000; Veale BM 2003). The Australian Institute of Health & Welfare (AIHW) report that 21.8% of Australians had consulted a GP in the preceding fortnight, whereas 13% had consulted other health professionals (Australian Institute of Health & Welfare 2004). General practitioners are seen as the ‘hub in the wheel’ of primary care, and for many Australians, GPs are the main health provider, and are therefore often the sole source of health information. This would indicate that GPs are well positioned to provide the preventive services their patients need, and also to appropriately refer patient to other primary health care professionals when their expertise is required.

However, the engagement of GPs in health promotion, and preventive activities has frequently been reported as less than optimal (Pringle M 1999; Baum FE and Keleher H 2002; Commonwealth of Australia 2003; Smith BJ, Eakin EG et al. 2003). Stratigos argues the comparative medical shortfall, and resultant heavier workload (average of 51 hours pw compared to 45 in metropolitan regions (AIHW 2003)), contributes to the fact that doctors are under-utilised in performing community – based health education roles (Stratigos S 2003). Others suggest that reluctance on the part of GPs to engage in health promotion is based on lack of confidence by GPs due to inadequate training in, and information on, health promotion (Girgis A and Sanson-Fischer R 1996).

Usherwood found that fee-for-service practices were less likely to have an explicit policy on disease prevention, and nearly half of such practices interviewed explained that the payment mechanism limited their ability to delivery preventive services as doctors felt these services were insufficiently remunerated (Usherwood T 2003). After many failed attempts to secure GP engagement in basic primary health care activities, the federal Government introduced a system of incentive payments. The Rural Doctors Association of Australia states that the raft of inducement payments has now “put an average of over $20,000 per annum into rural doctors' pockets” (Rural Doctors Association of Australia (RDA) 2004). GPs now receive financial inducement payments to provide specific services, such as effective aged
care assessments, diabetic management, immunizations, and management of veterans complex health issues, in addition to fees for standard curative medical care (Boyden A and Carter R 2000).

This policy has created tension between primary care provider groups. District nurses state that it is they who perform the aged care assessments, and diabetes nurses argue that they actually provide the complex diabetic management service, whereas GPs receive the inducement funds, for writing a letter of referral (Statements provided during data gathering phase of provider surveys). Meanwhile the policy allocates no additional funding to the CHCs to cater for the increased workload for the nursing staff to enable them to meet the additional demand generated. For example, diabetic nurses reported receiving letters of complaints from local doctors as their waiting lists had reached six weeks, which further intensified the inter-professional disharmony, and rejection of the policy logistics.

The World Federation of Medical Education has acknowledged the importance of building respectful and trusting relationships between multidisciplinary health care practitioners (Walton HJ 1995), in order to truly achieve collaborative primary care practice and to interact effectively within it (Cribb A 2000). In practice, and with few notable exceptions (Taylor J, Blue I et al. 2001), minimal attention has been given before or after qualification to promote inter-professional collaboration, even between core members of a PHC team (Stone N, McNair R et al. 2002). The Australian Medical Council (AMC) endorsed a position statement, which reviewed the status of CAM courses in Australia (Australian Medical Council 2000). This 2000 paper reflected the AMC’s attitude towards CAM, describing the 16 degree courses offered at a university level, colleges of technical and further education, and independent training providers, as qualifications in “unorthodox” practices (Owen D and Lewith GT 2004). Such attitudes do not enhance intersectoral cooperation.

Comprehensive preventive health services are most effective when provided by large interdisciplinary groups (Kinne S, Thompson B et al. 1989), but health care professionals often practice as individuals or small single specialty groups. Where practitioners operate in silos, the prospect exists for patients/clients to fall through the gaps in the system, and not receive health services, or advice appropriate to their needs. Coordination of primary health care services has been on the government agenda for several years (Department of Human Services 1988). The Victorian Government introduced the Primary Care Partnership (PCP) Strategy in 2000 (Department of Human Services 2000) as an attempt to create a genuine integrated primary care service system, coordinating the work of divergent provider groups to improve patient outcomes through a greater emphasis on health promotion programs. The PCP Strategy involved three key elements: service planning, service coordination, and voluntary service partnerships.
The aim of the PCPs is to promote health and wellbeing, and to prevent and reduce the impact of chronic disease in rural Victoria, especially for hard to reach population groups.

This strategy has been the subject of several government publications on guidelines and methodologies. However such a significant health services reorientation requires reprogramming of the mindsets of practitioners who are more familiar with operating in isolation. To realize translation into a fully coordinated primary health care system will take many years. Enthusiasm to embrace the changes has been variable. Attempts to move Australian general practitioners towards an inclusive primary health care model have frequently met resistance. The GP Divisions argue that imposing a new structure on divisions to make them ‘Divisions of Primary Care’ rather than ‘Divisions of General Practice’ is not likely to be the most effective way of achieving integration between general practice and the rest of the primary care sector (General Practice Division Victoria 2002). The Divisions reported that such a move risks losing involvement of GPs if they perceive that they ‘no longer have ownership of the division’ (Commonwealth of Australia 2003).

Australia is following the international trend towards greater utilisation of CAM (Bensoussan A and Lewith GT 2004). About half the Australian population now use CAM, with 1.9 million naturopathic and herbal medicine consultations recorded in 2003 (Bensoussan A and Myers SP 1996). Those with chronic disease are driving this trend, especially those who are seeking greater individual control over their health, or who have become dissatisfied with the treatment or outcome of standard western medicine (Braun K 1999; WHO 2002; Coulter ID and Willis EM 2004).

Practitioners identifying their work within the sphere of CAM include natural therapists, herbalists, Traditional Chinese Medical Practitioners (TCM), homeopaths, nutritionists, massage therapists, aromatherapists, meditation/relaxation therapists, osteopaths, acupuncturists, and chiropractors. CAM providers take an holistic approach to health service provision, perhaps to a greater extent than many other professional groups. An annual figure of 1.9 million consultations is estimated to give a turnover of $AUD85 million, excluding the cost of medicines (Bensoussan A, Myers SP et al. 2003). MacLennan estimated the cost of these medicines to be $AUD 2.3 billion in 2000, nearly four times the public contribution to Pharmaceutical Benefit Scheme (PBS) pharmaceuticals (MacLennan AH, Wilson DH et al. 2002). With average consultation rate at $45 (Bensoussan A, Myers SP et al. 2003), users tend to women, people with higher education, those with a heightened interest in their health, have higher disposable income or have some chronic illness (MacLennan AH, Wilson DH et al. 2002; Chesney MA and Traus SE 2004). However despite a substantial growth in the use of CAM in Australia over recent
years, practitioners have demonstrated a reluctance to establish their practice in rural areas (Expert Committee on Complementary Medicines in the Health System 2003).

**Access to Rural Primary Health Care Workforce**

Many factors limit access to primary health care services for rural Australians (The Australian Health Ministers Conference 1994). This demonstrated reluctance for many health providers to live in rural areas applies to GPs, Pharmacists, and the full range of Allied Health specialties in addition to medical specialties (Golding S 2000). Many services, common to metropolitan areas, are simply not available in rural areas (AIHW 1998; Australian Rural and Remote Allied Health 2002; Struber 2004).

Access to health services across Australia has reportedly always been uneven, analysis of the data generated by the first full year of universal health insurance (1976) revealed per capita use of GP and specialist services varied by 47 to 58 percent between the States (excluding the Northern Territory) and by a factor of 3.1 and 15.7 between the 58 statistical divisions in the States (Richardson J and Deeble J 1982; Richardson J 2001). Despite a recent increase in the number of GPs per capita in Australia, their distribution became increasingly unequal and inequitable between 1986 and 1996, such that rural and remote areas became increasingly poorly served (Johnston G and Wilkinson D 2001). There is little evidence to suggest that the subsequent increase in the doctor supply has reduced health inequalities (Richardson J and Peacock S 1997), however successive federal governments continue to focus rural health strategies on addressing the shortage of GPs (Abbott T 2004).

Nurses comprise the largest segment in the health care workforce with 1,024 full-time equivalent (FTE) nurses per 100,000 population in 2001 (AIHW 2003), compared to GPs at 110 per 100,000 population (AIHW 2003). In the metropolitan regions nurses comprise 78% of the health care workforce, 87% in rural regions, increasing to 90% in remote areas (AIHW 1998; AIHW 1999). Whereas medical workforce shortfalls either exist solely, or are greatly exacerbated in rural areas, the nursing workforce is more evenly spread across the geographical spectrum than any other health profession. Excluding large rural centres, the ratio of Division 1 Registered Nurses\(^7\) per capita is also less in rural areas than capital cities (AIHW 2003). Although an acute shortage exists in all rural areas, for certain specialist trained nurses; this unmet demand also exists in major cities, reflecting a somewhat different situation for the nursing workforce. Nursing shortages in rural areas therefore reflects national shortages, rather than a group holding a personal or professional aversion to living and working in rural areas. Willingness of nurses to

\(^7\) Division 1 Nurse is the title replacing SRN, State Registered Nurse
work in rural areas is relevant when considering introducing a new health practitioner. Recent strategies have been introduced across Victoria to increase the number of practising nurses. This includes rural areas (Pike B (Health Minister for Victoria) 2004).

The shortfall in rural allied health workforce severely limits the range of specialized services available to rural communities, although 36% of rural practitioners work across several locations in spilt employment arrangements (Australian Rural and Remote Allied Health 2002). Most allied health staff (75%) are employed in the hospital system (Struber 2004), hence the proportion of allied health professionals working in primary health care is relatively small. Neurological conditions are seen by physiotherapists and occupational therapists. Dietary intolerances can be managed by dieticians and nutritionists, but access can be problematic for those who are unaware of their services, are not referred or cannot afford to pay for services.

Paucity of primary health care funding and shortage of health care practitioners in rural areas is not the only issue. A study by Furler et al revealed that the extent of care delivery by general practitioners was less for rural people (Furler JS, Harris E et al. 2002). They describe the situation as one representing an example of the ‘inverse care law’, where medical care is least likely to reach those most in need. Their study found that people from disadvantaged areas are less likely to have long consultations with their GPs, despite the fact that, as a group, rural people have a significantly higher need for care.

People living in rural areas consume less government funded medical services and pharmaceuticals than those living in urban areas in terms of service per capita (AIHW 1998; Denniss R 2003). Sadkowsky et al suggest this implies a difference in level of accessibility to and availability of health services between the urban and rural areas (Sadkowsky K, Hagan P et al. 2001). His report also notes that this lower utilisation is accompanied by a relatively higher utilisation rate of acute hospital care, arguing this could be explained by delayed diagnoses, resulting in increased severity of the condition when health care was eventually accessed.

Delayed diagnosis is also partly a function of the reluctance of farmers to access services, often mediated through a lack of funds, as rural people are less than half as likely as urban dwellers to have all their consultations bulk-billed (OR=2.4) (Young AF and Dobson AJ 2003). Additional barriers limiting accessibility to primary health care for rural people are distance and time constraints (Jong KE, Smith DP et al. 2004), plus the stoicism that characterizes “people from the bush”. Personal health competes
with other priorities. The tendency to regard minor health complaints as trivial, and therefore not warranting attention, is greater in rural areas (Hanna L 2001).

Access is not the only consideration, health services must also be appropriate, that is, provide the services which match the local needs (World Health Organisation 1978). American College of Occupational and Environmental Medicine (ACOEM), argues that safety considerations in the selection and application of pesticides has become a worldwide concern (American College of Occupational and Environmental Medicine (ACOEM) 2004). As described in Chapter 2, the causative role of pesticides in cancer production and numerous other serious health conditions has been the topic of extensive international epidemiologic research, demonstrating significant health impacts among farming communities. Appropriate primary health care for rural populations must therefore cater to, and help prevent health problems associated with exposure to AgVets.

Access to appropriate, affordable primary health care in rural Australia is currently limited, and efforts concentrating on reducing the urban-rural health inequalities via expensive attempts to increase the number of rural GPs, has done little to address the problem. Other strategies are required.

**Education of Australia’s Primary Health Care Workforce**

Historically the bulk of health professional training in Australia occurred in tertiary centres in metropolitan regions. The average age for medical practitioners in Australia was 47.7 years in 1999 (AIHW 2003), and for Victorian nurses in 2001 was 40.6 (AIHW 2003). The bulk of the primary health care workforce were therefore trained in the 1970’s and early 1980’s, with a heavy focus on acute care. The health differential between rural and urban dwellers emerged over recent decades prompting political action, which included the development of a National Rural Health Strategy in 1994, the establishment of six University Departments of Rural Health (UDRHs) across Australia, and addition of rural health units in general training programs (NRHA 1996). Further decentralization of tertiary training institutions, and an injection of a rural health focus in education programs for health professionals has occurred in Australia over recent years with medical and other health professional training schools offering a strong rural focus operating in all states, and the territories (UDRH 2004).

Examination of curricula contents for universities offering health professional education was conducted via on-line searches of the universities involved, and an examination of the Rural Health Curriculum

---

8 Population health impacts resulting from recent strategies to increase in nursing workforce are unavailable.
Audit (Mahnken J, Han G-S et al. 2003). None of these programs incorporate environmental health issues, or training on exposure to hazardous chemicals that are specifically pertinent to rural people. Instead these education programs encompass inequities in health status, lower socio economic status, injuries, issues relating to distance and relative lack of services available to rural people (Hays R and Sen Gupta T 2003). Rural specific training programs such as the Rural General Practitioner curriculum does not include units covering AgVet chemicals (Australian College of Rural and Remote Medicine 2004). Australian medical students study toxicology in their third year of preclinical training, with an emphasis on pharmaceuticals. Rural GPs have therefore not been exposed to adequate training to identify and manage AgVet exposure health problems.

In 1998, the National Occupation Health and Safety Commission published a set of competencies for health surveillance to support legislation to be introduced in all states and territories. The objective was to minimize the risks to employees of adverse effects due to occupational exposure to hazardous substances (NOHSC 1998). Health surveillance includes biological monitoring, assessment of individuals for the purpose of identifying changes in health due to occupational exposures. The employer must engage an appropriately trained medical practitioner to manage occupational health of the workforce. The introduction of National Standards (National Standards for the Storage and Handling of Workplace Dangerous Goods 1015-2001) was to allow for this doctor to refer to an occupational physician, or delegate to occupational health nurses to perform the specified tasks of detailed health exposure assessments and surveillance (NOHSC 1998). However, that 95% of Australian farms are family owned and operated has meant that adoption of this legislation, and an environmental health workforce model, has not permeated though to the agricultural sector, nor to the rural primary health care workforce.

Mundinger demonstrated that primary health care services provided by specialised nurse practitioners produce the same health outcomes as primary health physicians (Mundinger MO and Kane RL 2000). The validity of these findings have been rigorously supported (Sox HC 2000). Australian Occupational Health and Safety (OH&S) Nurses are currently conducting assessments, screening, and providing the required health promotion for the industrial setting (Radcliffe JC 2002). OH&S Nursing curricula include health assessment, health promotion, occupational health legislation, and background skills and knowledge necessary for analysing the major types of hazards found in the Australian working

---

9 A hazardous substance, as defined in this report, is a substance listed on the NOHSC List of Designated Hazardous Substances. This database has been superceded by the Hazardous Substances Information System (HSIS)
environment. Topics include the biological, physical, chemical and psychological stressors in the workplace including noise induced hearing loss, ionising radiation, lighting and the protection of eyes. Other subjects cover hazard detection, monitoring techniques, control measures and relevant legislation and standards (University of Southern Queensland 2002). Training therefore exists for OHS nurses in the management of chemical hazards, and the delivery of appropriate health care, but AgVets are not included.

General nursing curricula, even in rural based training programs, restrict their limited toxicological education to pharmacology. Florence Nightingale viewed the environment as a fundamental aspect of nursing practice. Nightingale’s interventions focused on modifying the environment as a primary means for prompting health, which bought significant improvements in patient health during the Crimean War. This model subsequently became the mainstay of nursing education. Nightingale cited five essential points in securing the health of individuals: pure air, pure water, efficient drainage, cleanliness and light (Rogers B and AR. 1998). Alongside the shift towards increasing technology in health care, Nightingale’s parameters of environment eventually disappeared from general nursing curricula, other than as a brief cursory introduction of nursing history in first year.

Other than pharmacists, who deal almost exclusively with pharmaceuticals, allied health professional practice rarely involves chemical therapeutics, so toxicology, and the various health impacts resulting from chemical exposure does not fall within their practice paradigm. The range of professional qualifications obtained by CAM practitioners requires from 6 months to 6 years, 11% have ‘other’ health qualifications, although less than 8% listed either medicine, nursing, pharmacy, osteopathy, or physiotherapy (Bensoussan A, Myers SP et al. 2004). Providers of courses in Traditional Chinese Medicine are currently engaged in the process of accreditation to proceed towards national registration. The Australian Institute of Environmental Health released a draft Accreditation Policy in April 2005 (Australian Institute of Environmental Health 2005). Completion of a course accredited by the Australian Institute of Environmental Health (AIEH) permits membership of the Institute. None of these courses offers toxicology, health assessment, health promotion and primary health care.

The situation therefore exists whereby signs and symptoms associated with exposure to AgVets are not part of the education repertoire of Australian primary health care workforce, leaving patients at risk of not having these ailments correctly diagnosed or effectively managed by the mainstream primary health care workforce.
There are strong links between determinants for agricultural injuries and chemical exposure patterns for farmers and their families, as the pressures forcing unsafe decisions, and deployment of family members are identical for both. The 2000 Commonwealth Rural Health Stocktake made a series of recommendations to redress the health disparities between rural and urban populations (Best J 2000). The Stocktake recommended that the health plan for rural Australia should pay specific attention to the current configuration of regional health services to ensure that the services being delivered are both appropriate and effective. Although a significant proportion of agricultural work involves handling dangerous chemicals, none of the recommended strategies in this report attempted to reduce ill health resulting from unsafe chemical handling practices (Best J 2000). Instead the Stocktake argued that more doctors would improve the health of rural people, by emphasizing strategies to attract and retain GPs in rural areas. It did not consider whether GP skills were appropriate to the specific health risks confronting rural populations.

**Conclusion**

Rurality in Australia presents a special set of health determinants. Economic pressures, inherent challenges emanating form the Australian landscape and climate necessitate that to remain economically viable farmers must incorporate strategies to maximise returns. Application of AgVets has proven very effective to date, but exposure to these agents carries significant health risks. Varying shortages exist among specialities within the primary health care workforce in rural areas, but a range of services are available. The bulk of the existing workforce was trained several decades ago, before the emergence of an understanding of the hazardous nature of AgVet exposure, and an examination of curricula from education providers currently involved in training Australia’s primary health care workforce, revealed there is still little environmental health content. This leaves rural communities vulnerable to having diagnoses of their conditions resulting from exposure to AgVets missed. Occupational health and safety specialists, skilled in hazardous substances, do not exist for the largely self-employed agricultural sector. Additionally, the limited intersectoral collaboration between the primary health care workforce specialties, further potentiates the lack of identification of emerging trends in health problems, as cross referrals are limited.

These features preclude the establishment of a system of health surveillance or monitoring to determine if and where any ‘hot spots’ might be occurring. The reality therefore, is that the impact of exposure to these agents on Australian rural health populations is unknown. This would suggest that existing rural
health strategies are missing one or more key health determinants. Chapter Two presented a substantial body of international evidence demonstrating that exposure to these agents is associated with significant health complaints in agricultural regions. It is highly plausible that exposure to AgVets is contributing to the ill health of rural Australians, which the existing primary health care workforce is ill equipped to manage.
CHAPTER 5
METHODOLOGY

Introduction

Exposure to AgVets was identified as an emerging environmental health issue potentially attributing to some of the poor health of rural Australians. The research question asks ‘How well does the Australian primary health care system perform in addressing emerging problems in environmentally induced ill-health?’ Teasing out this question raises several subsidiary questions about the systems responsible for maximizing population health in the human-environment interface. This further expands to ask what specific infrastructure and which workforce carries this responsibility. The previous chapter described the systems other countries have introduced to address this issue.

Having established that exposure to AgVet chemicals can pose significant human health risks, especially to rural populations, the next step was to examine whether this could be occurring in Australia. This raises further subsidiary questions to this research problem:

- What is the risk (real and perceived) to rural Australians of harmful exposure to AgVets?
- How prepared is the existing primary health care workforce to respond to this risk?

Two studies were devised to answer these two questions. This chapter describes the methodological approach adopted for each.

Linking with these is the question of how well Australia’s existing health information infrastructure captures the intelligence needed to manage this, and other environmental health issues, to enable appropriate health planning to be undertaken. Examination of Australia’s current environmental health is covered in Chapter 4, and existing health data capture, and occupational health monitoring is provided in chapter 3. The U.S. and Europe have established, or are establishing, biomonitoring and population surveillance systems within their public health portfolios. They have also instituted training programs to increase environmental skills of their primary health care workforce. The primary health care workforce needs sufficient environmental health expertise to enable it to detect and respond to the emerging problem of chemically induced harm. Failure to recognize exposure related illness entails a lack of reporting, which limits information available for health planners.

To determine whether this is happening in Australia, a study was devised to essentially investigate whether an unmet need exists. Hawe et al. defines need as ‘those states, conditions or factors in the
community which, if absent, prevent people from achieving the optimum of physical, social and mental health’ (Hawe P, Degeling D et al. 1990). Firstly, it must be established whether substantial demand exists for primary health care service provision to ameliorate exposure risks, and to manage AgVet exposure related health problems in Australia, and secondly, whether the current system meets that demand. An unmet need can occur when existing services lack appropriateness, or the quality or quantity to meet such needs (Lloyd P 1998). Alternatively, a required service may simply not exist. If the evidence gathered suggests the existence of unmet need, then the final component of the study was to explore what solutions might redress the situation, based on the evidence of the type and level of need demonstrated. The anticipated study objective therefore is to identify strategies to improve health status of rural populations.

This chapter starts with an overview of the methodological approach adopted to answer these questions, and provides rationale for selection of a suitable study region in which to test whether services match health needs. The chapter then details the two studies conducted, beginning with the study to investigate community perspectives. In the following sections, the reasoning for selecting a survey methodology using a Computer Assisted Telephone Interview (CATI) technique is explained, and a broad outline of the question topics is given. Also covered are the various strategies adopted to maximise response rates. The final parts of the community study section describe the rationale and methodology applied to also gather the perspectives of other relevant groups who work with AgVets, which were not captured in the CATI survey.

The second part of this chapter describes the methodology applied for the second study, designed to gain the perspectives of various groups of primary health care providers servicing the study regions. Also discussed are the various strategies employed to maximise provider input. The chapter’s final sections describe the analysis techniques applied to the quantitative and qualitative data gathered during both studies, and the ethics approval gained to conduct the studies.

**Rationale for the Study**

The initial impetus to conduct this study arose out of increasing evidence of community concern about a lack of primary health care expertise and associated lack of health information about AgVet exposure existing in the Goulburn Valley and North East regions. Evidence indicating a problem existed in the Goulburn Valley evolved from discussions with Post Graduate Nursing students at the La Trobe
University, Shepparton Campus. Many of these senior nurses believed the health of their own families had been compromised by exposure to AgVets, and they reported feeling inadequate to personally diagnose and manage the health problems. They were also concerned that their GPs were not attentive to their suggestions that the conditions were linked to exposure, and argued these views were widely shared among the community.

Similarly, the knowledge about long standing health concerns in the Ovens and King Valley regions arising from the tobacco farming was widespread. The matter was discussed regularly at regional health meetings, such as Hospital Board, Community Health Committee meetings, and other regional health planning meetings. It became increasingly evident that health planning was hampered by the lack of systematic health intelligence about exposure problems.

A preliminary investigation was carried out to determine whether these views were isolated anecdotal reports, or represented broadly held views. This was in the form of arranging interviews with the Post Graduate nurses and staff at the La Trobe Shepparton Campus, Chief Executive Officers of local hospitals, and Community Health Centres across both regions, all of whom agreed the issue warranted further investigation. The final step in this preliminary investigation was a literature search to identify environmental contamination studies conducted in the region, and studies exploring regional human health exposure. Two studies were located which confirmed environmental contamination existed in both regions, and no studies investigating human AgVet exposure human health were located in these districts. On this basis the decision was made to proceed with study. Reports provided by the nurses are included with the community data in Chapter 7.

**Methodological Rationale**

Public health problems can rarely be formulated into simple questions about a straight forward cause-and-effect relationship (Daly J, Kellehear A et al. 1997; Kavanagh A, Daly J et al. 2002). Hence the integrated assessment approach was adopted to explore this problem, as a study designed to broadly examine the alignment of primary health care service provision with emerging environmental health care needs in rural Victoria could not be effectively executed via a single methodological approach.

The intent of the study was to identify strategies to enable the health care system to effectively identify and respond to emerging environmental health issues, by examining the interface between chemical exposure and public health infrastructure. A mere replication of causal studies described in Chapter 2
would add little to our level of understanding of what needs to be done to manage the risks facing Australia’s rural communities. We need to know what exposure risks exist (or are perceived to exist), in rural Australia, and what gaps exist in the public health workforce in terms of identifying, monitoring and reducing these risks. Descriptive studies assist with the process of establishing priorities for public health action designed to address disease conditions and their risk factors (Taylor R 1998), and enable channelling of resources into particular areas of need.

Direct measurement determining an individual’s exposure to an agent can be performed in two ways. One involves testing contaminant levels in the individual’s environment. This provides a degree of certainty, but is limited only to present exposures and presumes contact (Hardt J and Angerer J 2003; Molocznik A 2004). Alternatively, individual biological assays tests current or recent actual chemical burden, but this method can be prohibitively costly for large population studies (Hardt J and Angerer J 2003). The methodological design selected to answer the research question therefore did not attempt to directly measure environmental contamination, nor measure individual chemical burdens in order to link exposure with health outcomes.

The research question necessitated gathering data from a variety of information sources, by directly accessing rural communities, and their health care providers. The project therefore consists of a synthesis of two separate studies exploring this issue from different perspectives. A mixed - method research design was designed to address the research question. Although adding complexity to the design, a mixed - method approach utilizes the advantages offered by qualitative and quantitative paradigms. Creswell suggests this method best mirrors the research process of working back and forth between inductive and deductive models of thinking in a research study (Creswell JW 1994).

This methodology compliments the traditional epidemiological approach, as these studies do not take into account the personal subjective views. Public health solutions need to address objective exposures and risks, but also understand how people respond to and deal with these risks. Firstly, to establish whether exposure to AgVet chemicals is posing a significant risk to Australians, a large community telephone survey was undertaken to ascertain: (See Appendix 1)

- exposure history of rural populations to potentially hazardous AgVets;
- community knowledge of risks associated with exposure to AgVets;
- personal protection strategies adopted over time,
- health and well-being of rural communities,
- whether community members linked their family ill-health this with exposure, and
- experiences arising from engagement with the health care sector.
Secondly, to ascertain whether this exposure risks were being adequately addressed, the perspectives of regional health service providers were sought with regard to their understanding of regional environmental hazards, their attitudes and knowledge of the impacts of AgVet exposure among their client group, and their own professional response in terms of self education and referral.

The study adopted a multi-method approach which integrated qualitative and quantitative data. A situational analysis was performed by applying these findings to the background research on contemporary rurality in Australia, health sector workforce issues and educational preparation, public health infrastructure, and existing chemical management frameworks. The use of both qualitative and quantitative data has been described as applying complementary methods, where the weakness of a single approach may be diminished or overcome (Polit DF and Hungler BP 1997). The benefit for this study is enhanced validity by investigating the problem from two angles, patient or client and provider. Quantitative data on exposure and health status were enhanced by text responses from the community members, and these were compared to discourses provided during the interviews. Sourcing information from a variety of sources provided a perspective from all key stakeholder groups involved in the primary health care delivery – recipient interaction. Framing against the detailed background information given in Chapters 2, 3, and 4 set this data in its situational context.

**Selection of study region**

The study was conducted in North East Victoria, entirely within the Department of Human Services Hume Region. Two localities were selected to provide contrast and diversity in agricultural pursuits and therefore diversity in farming practices, yet which represented 'typical' Victorian agriculture. The Ovens and King Valley regions were once dominated by tobacco and hops, but now also produce wine, nuts, forestry, sheep, beef and dairy cattle. Geographically, the area consists of hills, valleys and small flood plains, whereas the Shepparton East region is flat with a lower rainfall and relies on irrigation to support its intensive fruit and dairy production. Shepparton East forms part of the Goulburn Valley region, and is recognized as being highly significant to the Victorian economy for being the ‘Fruit Bowl’ of Victoria, if not Australia (Cameron B. The Hon Victorian Minister for Agriculture). Farming practices in both areas entail high AgVet utilisation. A more detailed description of these regions is given in Chapter 6.


**Study 1: Community Health Survey**

**Selection of survey methodology**

A variety of methodologies to elicit community perspectives were considered. The type of the data required determines the methodology. The specific information sought was the communities’ reported exposure to a broad range of AgVet groups, frequency of exposure, again in broad terms, adoption of personal protective measures, self-reported health status, and perceived links between exposure and health status. Quine recommends surveys for descriptive enquiry in public health practice in situations where research questions are derived from public concern regarding a particular health hazard (Quine S and Taylor R 1998). A community survey offers the advantage of providing in depth responses, in a cost effective manner, over a short time period. Surveys also permit the collection of data on past as well as present exposure, although both are subject to errors in recall (Wilson NK, Chuang JC et al. 2004). Quine explains these benefits have made the personal interview, whether face-to-face or by telephone, the most commonly used method of obtaining data about subjects themselves or their environments (Quine S and Taylor R 1998). A cross-sectional survey technique of regions known to have high AgVet utilisation was chosen as the most cost-effective methodology to generate data of the personal nature sought by the research objectives, from a random cross section of two rural communities.

Selection of a data gathering mechanism had to incorporate the consideration that specific health disorders could potentially occur at relatively low frequencies, therefore necessitating a sample size large enough to generate sufficient power to produce significance in the findings. This requirement negated face–to-face interviews.

The sample size required would be large, producing considerable volumes of data, costs were limited, and a fast turn around time was necessary. Benefits of a cross-sectional study, when based on large, well defined, and broadly representative populations include further hypothesis generation, and provide strength as disease and exposure status is usually known to the subjects (Bowling A 1997). Disadvantages of surveys include the inherent uncertainty over the time dimension, so that causal associations can be lost or underestimated. Alternatively recall bias can suggest associations that do not exist. McDonald argues that despite these limitations, the results generated by this method are seldom seriously incorrect (McDonald C 1995).
Telephone surveys have increased in popularity over recent years as they are cheaper and less intrusive than face-to-face surveys. Coverage of telephones across Australia is 97% of households (Wilson DH, Starr GJ et al. 1999), and this figure could be even higher in rural areas where greater distances increase telephone dependence. The growth in silent numbers is reportedly posing a threat to sample stock generation, however this practice is limited in rural areas (Blyth FM, March LM et al. 2002). Additionally, for the regions under study, replacement of landline telephones by mobile phones as a primary mode of communication is unlikely as rural mobile coverage remains poor.

Australian community surveys are well suited to telephone interview techniques (Wilson DH, Taylor AW et al. 2001). Response rates approaching 70-80% could be anticipated. Rural populations and females have been reported as most receptive to this methodology. Rural regions were also highlighted as being particularly suitable given the lower rate of non-English speaking peoples, low rates of business numbers, and greater community willingness to participate (National CATI Technical Reference Group 2000). A 1998 telephone survey conducted in the North East and across Victoria returned response rates in excess of 80% (Siahpush M and Singh GK 1999).

It is acknowledged that a telephonic mode of survey excludes various population groups, such as the homeless or itinerant, and those persons in hospital or institutions (Lavrakas PJ 1993). The frail, the aged, and those persons having certain disabilities may also be unable to participate in the interview (Quine S and Taylor R 1998). Most survey methods exclude some community sectors, and it was determined that these groups are also likely to be excluded by alternative strategies.

CATI technology streamlines the surveying process by reducing time and costs, thereby permitting a larger sample size (Blyth FM, March LM et al. 2002). Broad agreement now exists about the benefits achieved by large scale data collection of community perceptions and self reported health status (Serraglio A, Carson N et al. 2003). Several State Government health departments have now adopted CATI surveys to inform health planning strategies aimed at chronic diseases prevention, and to ensure good management of health services for the community (Mathers C, Vos T et al. 1999; Centre for Population Studies in Epidemiology 2002).

Evaluation of CATI as a methodological approach is developing into a supportive literature base (Armstrong BK, White E et al. 1992). Across a range of research topics, the CATI technique has demonstrated high reliability and validity, with response rates significantly exceeding other
methodological approaches (64%- 82%) (Anie KA, Jones PW et al. 1996; Leino T, Tammilehto L et al. 1997; Ketola E and Klockars M 1999; Blumberg SJ, Olson L et al. 2002; Blyth FM, March LM et al. 2002; Buckwalter JG, Crooks VC et al. 2002; Corkrey R and Parkinson L 2002; Sug Yoon S, Heller RF et al. 2002). Heath observed a 73% response rate in a CATI interview compared to a 59% response rate for a questionnaire survey in their Australian twin study (Heath AC, Howells W et al. 2001).

Specific features inherent in CATI technology add to the suitability of this technique. The CATI technology allows the interviewer to see their instructions on screen and read verbatim the survey questions to the respondent, and also enables recording of responses directly into the CATI computer, thereby maintaining consistency, and reducing transcribing errors (Lavrakas PJ 1993). The system also allows a variety of question formats, including free text and multi-choice answers (Wilson DH, Taylor AW et al. 2001), the use of more complex branched questionnaire, and the ability to automatically skip to the next segment when specific answers are given. This further increases efficiency and dialogue flow.

The pilot study for this research revealed that a pattern of community fatigue is rapidly rising as agricultural machinery, and rural produce companies frequently telephone farmers. Other callers include banks, charity organisations, service providers, in addition to regular and routine market research and telemarketing. Interviewees reported being solicited or surveyed almost weekly. The impact of survey fatigue diminishing response rates was therefore expected to reduce the response rate slightly, however in view of the potential benefits; data collection via a CATI was still viewed as the best available option. The CATI methodology was selected, using a random dialling process from numbers sourced by the Electronic White pages for the two communities, and returned 1050 completed surveys.

**Unit of analysis**

Assessment of disease and injury among agricultural workers presents a substantial challenge to the epidemiologist and health researcher. Figures available for America indicate that whereas only 3 million, or 2% of Americans, are fully engaged in agriculture, a further 9 million are exposed to agricultural chemical risks as seasonal workers, part time farmers, and family farm members who contribute substantially to farm work (Merchant J, Reynolds S et al. 1995). This factor significantly increases the numbers of people at risk of exposure, and adds to the complexity of capturing information from these additional groups. A similar ratio could be anticipated for the Australian setting, although we can anticipate that the Australia farm labour force involves a higher proportion of family members rather than immigrants, than is the case for the United States (Villarejo D 2003). Among broadacre and dairy farms
in Australia, over 95% are operated by families (Gray I and Lawrence G 2001). Neighbours are also exposed to AgVets applied to farmlands via spray drift (APVMA 2003).

Given the high level of family involvement in farm work, and therefore risks of exposure, the unit of study chosen for this study was the household. The survey allowed for further drilling down to enable linkage of household members having greatest exposure, with health system conditions. The question of validity of the reporting then arose. Self-rated health has been repeatedly found to be a strong predictor of subsequent mortality (Ilder EI and Benyamani Y 1996), and this has been demonstrated to occur across different groups, age, gender, socio-economic group and degree of chronic illness (Burstrom B and Fredlund P 2001). The person answering the telephone could readily answer for themselves, but would be providing a proxy response when answering on behalf of other family members. Use of proxy respondents allows an increase in the number of subjects available and provides more representative groups for study (Nelson LM, Longsteth WT et al. 1990).

Validation of data elicited from proxies has been established. When the proxy is a parent or spouse, collaboration is generally very high across a range questions, including the very sensitive, demographics and health conditions (Armstrong BK, White E et al. 1992; Gilpin EA, Pierce JP et al. 1994). The observed misreporting varied by level of education, where greatest under-reporting occurs among less educated persons (Mackenbach JP, Looman CW et al. 1996). Occupational exposures in the workplace setting and number of occupations were under-reported (14%) by proxy respondents (Armstrong BK, White E et al. 1992). It could be anticipated that this discrepancy would be less when the workplace setting was the family farm as family members frequently assist in activities involving chemical exposure (Gladen BC, Sandler DP et al. 1998).

Respondents self reported a range of specific and general health problems among themselves and for their family members. Cross tabulation analysis of these reports was performed, which compared growers of certain products against other growers and non-farmers, and also compared health complaints among those using specific chemical groups against those who had not. The design of this study was to investigate community level exposure to multiple chemicals groups, not individuals exposed to single a chemical. Serious challenges confront any search to find rural people free from chemical exposure given the ubiquitous nature of chemicals in the rural environment. That the comparative groups used AgVet chemicals in the domestic environment, or engaged in differing agricultural production entails that they were exposed to other agents. They cannot be truly classified as free from contamination, hence they were treated as a comparison group.
**Strategies to ensure rurality**

All surveys are subject to errors arising from a number of different causes. Sampling error is inevitable in all sample surveys (Groves RM, Biemer P et al. 2001), and leads to biased estimates when the sampling error is systematic. The key focus of the community survey was to gain the perspective of community members to ascertain whether exposure to AgVets was occurring at levels sufficient to pose health risks. The survey therefore sought to maximize representativeness of agricultural workers, past and present, and people living on or near farms. Features for consideration for determination of the sampling methodology included:

- Rural dwellers are farmers, hobby farmers, and those living on small rural “blocks”;
- Hobby farmers also use AgVets, and neighbours can be exposed to spray drift;
- Older farmers, previously exposed to highly hazardous substances, move to neighbouring towns so that town dwellers may have a history of AgVet exposure.

Strategies were then devised to maximize rurality, and allow for the inclusion of some local small-town residents. Screening questions were added to the survey to ensure rurality by asking whether household members had a) worked on farms, or b) lived on or very near farms (“near” was defined as “within a few kilometres – up to 3 km).

The method adopted for securing the contact details for the residents of those geographical areas to be studied involved mapping the regions on the Country Fire Authority maps, locating study area boundaries, scanning the local telephone directories to determine the telephone prefix allocated to those specific districts. Allocation of rural Australian telephone numbers follows a drill down pattern. The Ovens & King Valley regions have the Victorian prefix of 03, then 57, whereas the Goulburn Valley begins 03 58. The next three digits designate the local rural telephone exchange, which then allocates the last three digits within a specified range. Telephone exchanges covering the orchard and dairying regions near Shepparton, and Ovens and King Valleys were selected, and their allocated telephone number ranges obtained form the Telstra Sales Office.
**Sample selection**

Two broad telephone methodological sampling methodologies are currently employed in Australian surveys, random digit dialling (RDD), and the electronic white pages (EWP) (Blyth FM, March LM et al. 2002). EWP is a directory of all listed household telephone numbers and is available on CD, however the weakness is that the list is at least one year old, so that by the time of release, up to 15% of the telephone numbers from a new telephone directory list have changed status (Wilson DH, Taylor AW et al. 2001). This implies that a potential bias exists towards people who do not change their number.

Wilson et al. compared RDD to EWP and found that EWP was cheaper, required a quarter of the number of telephone calls, returned a higher response rate (83% compared to 65%) and enabled introductory letters. Whereas RDD provides a more inclusive sampling frame, it also includes non-connected and business numbers (Wilson DH, Starr GJ et al. 1999). The recent growth in internet usage can be expected to have a greater impact than in previous studies using similar methodology.

Data were gathered via random digit dialling performed by the CATI system, with telephone numbers accessed from the EWP limited to prefixes within the specified rural regions. These prefixes, due to their rurality location, have very few business numbers. Randomisation was not extended through to persons within the household. Randomisation is recommended where person answering the telephone is in some way different to the population under study, thereby introducing an element of selection bias or volunteer bias (Shellard D and Searles A 2001). In sharing the farm labour, farming households function as a unit in terms of exposure, so it was deemed that volunteer bias would not be significant for the nature of the proposed study.

Content bias, due to varying knowledge of the chemicals used, protective equipment worn, and family health status was considered a potential threat. It was assumed that women would have a greater knowledge of household health status, whereas men might be more familiar with chemicals used. Questions therefore did not enquire about specific chemical brand names, but rather focussed on farming activities, such as drenching, which would be known to all household members. The interview was conducted with the person who answered the telephone. The only exception to this was when a child answered, or the person specifically suggested another would be in a better position to answer questions.
**Sample size**

Sample size calculations are performed to ensure sufficient numbers to determine effect size with sufficient power to provide confidence intervals of 95%, exclude beta errors (type II or false negatives), and alpha errors (type I or false positives) (Jekel JF, Elmore JG et al. 1996). This community survey was not designed to be an epidemiological study, rather it sought to canvass community views and experience. It still remains that the greater the penetration of the communities under study, the higher the confidence in producing valid results (Bowling A 1997). The largest sample size afforded by the available funding then became the critical issue. A budget of $20,000 (via a Collaborative Industry Grant - DHS & La Trobe University) allowed for 1000 completed surveys, calculated at an interview duration of 20 minutes. A technical oversight by the surveying company resulted in a discrepancy of 50 surveys, giving a total of 1050 surveys, 500 surveys from the Ovens and King Valley region, and 550 surveys from the Shepparton East region. All responses have been included in the analysis.

Calculation of the sample pool size of potential participants required to deliver 1000 surveys was calculated according to the Lavrakas formula (Lavrakas PJ 1993). This figure was used to generate the CATI randomised sample pool of names, telephone numbers, and corresponding addresses to post the introductory letter.

**Lavrakas formula:**

\[
\text{Estimated size of sampling pool} = \frac{\text{FSS}}{\text{HR}(1-\text{REC})(1-\text{LE})}
\]

Where:

- **FSS** = the Final Sample Size = the number of completed interviews desired
- **HR** = Hit Rate = an estimation of the proportion of numbers that is likely to be domestic telephone lines.
- **REC** = Respondent Exclusion Criteria = the proportion of households that will be excluded due to a selection criteria.
- **LE** = Loss of Eligibles due to non-response.

Lavrakas discusses the problem of restricted allocation of telephone numbers within a set prefix, which could reduce the HR to 0.3. Maximization of this figure was achieved by contacting Telstra, to ascertain the allocated range of telephone numbers within a specific prefix or locality. For example the Mollyullah telephone exchange in North East Victoria carries the prefix 57 666. It is a small exchange so it limits the
allocated range of the last three digits to 400 numbers (000-400), out of the possible range of 1000 (000-999). Without this information, the probability of connection with a random call could be at best 40%, making an HR less than 0.4. The CATI computer was provided a list of telephone numbers which had been previously edited to contain only allocated number range. HR was estimated to be 0.8

Lavrakas cites that the best group of well-supervised and experienced telephone interviewers would expect to return an LE value within the range of 0.15 - 0.25 due largely to refusals. Given the higher reported rate of rural CATI responses in Australia, the LE was conservatively estimated to be 0.3. Surveys not seeking to target a specific segment of the population other than persons over the age of 17, can expect an REC at or near zero. The REC figure for this study was expected to be low, less than 0.15, as only rural areas were selected for inclusion according to telephone prefix, and no gender requirements were sought. These figures were applied to the Lavrakas formula.

\[
\text{Estimated Size of Sampling Pool} = \frac{\text{FSS}}{(\text{HR}) \ (1-\text{REC}) \ (1-\text{LE})}
\]

\[
= \frac{(1000)}{(0.8) \ (1-0.15) \ (1-0.3)}
\]

\[
= \frac{1000}{0.476}
\]

\[
= 2,100
\]

According to recommendations of Lavrakas, based on the estimations applied to the formula above, a sample pool of telephone numbers of 2,100 would return a sample of 1000 completed surveys. A larger margin of error was sought to cover errors in estimations. Slight alterations of the estimates of HR to 0.7, REC to 2.5, and LE to 0.4 resulted in a requirement for 3,174 numbers. Driven by a cautious approach, a total of 4000 numbers, double the original calculated estimation, was submitted to the CATI automatic dialling system, giving a ratio of sampling pool telephone numbers to the desired sample size of 4:1.

The CATI computer was set the task of randomly selecting 4000 telephone numbers from the EWP, 2000 from each region. This was counterchecked to the prefixes relating to the areas under study, and latter digits which have been allocated. To achieve this number, the designated areas need to be expanded, therefore a very high penetration of one in four households contributed to the survey.

The following formula was used to calculate response rate.

\[
\text{Response rate} = \frac{\text{Number of completed interviews}}{\text{Number (complete + refusals + incomplete)}} \times 100
\]

\[
= \frac{1050}{1050 + 526 + 2} = 66.5\%
\]
Table 5.1 Results of CATI sampling

<table>
<thead>
<tr>
<th>Phone sample loaded</th>
<th>3998</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialler problems / Telstra Messages etc</td>
<td>324</td>
</tr>
<tr>
<td>Available numbers</td>
<td>3674</td>
</tr>
<tr>
<td>Language, hearing, comprehension problems</td>
<td>45</td>
</tr>
<tr>
<td>Ineligible in screener</td>
<td>74</td>
</tr>
<tr>
<td>Total Ineligible</td>
<td>119 = 3.2%</td>
</tr>
</tbody>
</table>

| Refused | 526 |
| Abandoned interviews | 2 |

| Completed Interviews | 1050 |

Interviewers were requested to enquire the reason for refusal. Results are presented in Table 5.3 below.

Table 5.2 Reason given for refusal to participate

<table>
<thead>
<tr>
<th>Reasons for refusal</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t do interviews / too many requests / busy</td>
<td>181</td>
<td>34</td>
</tr>
<tr>
<td>Distrust bureaucracies / agencies</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Meal time</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Refusal - no reason given</td>
<td>164</td>
<td>31</td>
</tr>
<tr>
<td>Other reasons: bad line, visitor, depressed, angry, no chemical usage</td>
<td>147</td>
<td>28</td>
</tr>
<tr>
<td>Not asked</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>526</td>
<td>100</td>
</tr>
</tbody>
</table>

Strategies to increase response rates

Several strategies were employed to maximize response rates. Summer is harvest season. This was especially pertinent for the GV fruit growers, as harvest time entails consecutive weeks of 14 hour days, leaving orchardists and their families exhausted, and otherwise distracted. The study was timed to occur outside this peak busy period. A factor considered crucial to devising a survey methodology to maximising cooperation was for the interviewers to have an understanding of the current concerns and issues facing the community to be surveyed. Other strategies involved ensuring the survey terminology was appropriate to rural communities, strategies to target the required sample group, a publicity campaign, and factors promoting willingness to participate. Rural people, as with indigenous communities, have developed a scepticism about research. One pilot participant described this sentiment:
“Many of us are tired of those professional city based do-gooders who think they can come in here, ask a barrage of silly questions, which clearly show they haven’t got a clue as to how life works out here in the bush. They take our stories, and that’s it! We never hear from them again. They get their qualification. They’re satisfied. But nothing changes!”

(NE Farmer - Pilot survey)

Chapter 3 outlined how the social context in which the study was taken cannot be ignored. Decades of withdrawal of government and business infrastructure in rural regions have lead to a broadly held scepticism and mistrust of bureaucracies, which needed to be allayed in order to maximize community cooperation. Also, immediately prior to the survey going live, a series of catastrophic events was unfolding. These included the worst drought in 100 years, raging bushfires unabated for over seven weeks in the North East region, the aftermath of 9/11, and insurance crisis. The magnitude of these catastrophes clearly competed for community attention, and diminished perceptions of the relative significance of chronic health conditions. An appreciation was required of how these events impacted on the specific outlook and complexities of rural life, in order to draft the survey dialogue and embedded conversation to engender community willingness to participate in a government and university funded study.

The events in 2003 were not conducive to achieving high levels of response. On this basis, it was deemed paramount to scale up the planned publicity campaign in an attempt to build trust and promote pre-survey community discussion. The introductory letter was therefore considered crucial. The dialogue was framed to elicit trust, assure credibility, and to convince the sceptical that the underlying objective was to gather community knowledge to inform future health planning decisions that were rural specific, and would meet their health needs. The timbre was also designed to (as much as possible) portray a “friendly, caring, benevolent, authority”.

To heighten awareness, information about the impending survey was targeted to farmers via posters placed in stores such as primary produce stores, repair shops, hardware supplies, and veterinary agencies, in addition to local supermarkets, bottle shops, chemists, hairdressers, newsagencies, pubs and local police stations. Only one establishment openly refused to display the A4 posters. The proprietor, a middle aged male, refused on the grounds that he and his family had “... been tobacco farmers for over 30 years, and have used all the worst chemicals, and (we are) are still OK, so it is all rubbish.” He then added that “The real problem is the (specific nationality) living here. They’re the trouble makers”. During a return visit to the district prior to the survey, it was observed that two other outlets had since either relocated or removed the posters.
Advertisements were also placed in the local newspapers. The ‘Shepparton News’ ran a series of three, supplemented by a news item and photograph. A series of single advertisements were placed in ‘The Wangaratta Chronicle’ and the ‘Alpine News’. The Chronicle published an article outlining the study alongside a special feature on “The Health of You and Your Child”.

Interviews with local health care providers were scheduled to occur prior to the community survey, so that any queries would be met with recognition and confirmation as to the aim and validity of the study in the anticipation this would further add credibility to the survey. This was difficult to achieve, so some were conducted after the community survey had been completed.

**Letters of introduction**

Once the randomised sample was drawn, 4000 introductory letters were posted, 2000 per study area, timed for delivery one week before commencement of the survey. See Appendix 2 for these letters. The number of letters returned stamped “Return-to-sender” or “Unknown at this address” (14%), was higher than anticipated. Transience is considered to be low in rural areas compared to metropolitan regions. The contracted mail company indicated usual return rate to be considerably less than 10% for mail-outs, including rural urban sectors where mobility approximates metropolitan cities. A check of a sample of the addresses against current telephone books indicated that the EWP used by the market survey company was not current. This highlights the necessity for ensuring currency of the EWP database.

Across the two regions, an average of 17% reported they could not recall seeing a copy of the introductory letter, 20.2% from the Goulburn Valley compared to 14% of respondents from the Ovens & King Valley region. Evidence suggests that introductory letters increase participation rates (Anie KA, Jones PW et al. 1996), so it can be assumed that a higher proportion of those who refused to participate did not receive the letter. However it is also plausible that a certain proportion will not have sighted letters which reached households, and that others will have forgotten. Exact figures cannot be determined, so the refusal rate attributable to not reading the introductory letter cannot be estimated with any accuracy. Refusal rate approximated 30%, which lies at the upper rate of other published CATI studies.
CATI surveys are by their nature anonymous, other than an exchange of names during the introduction. No physical meeting occurs. The basis of a relationship therefore depends entirely on characteristics of the conversation, the voice, the dialogue, and the empathy of the caller who sits in a crowded basement, gazing into their computer screens, wearing headsets, and deeply immersed in a “telephone relationship”, discussing personal matters with a person they would otherwise be unlikely to meet. Successful interviews are created when rapport is built between the interviewer and interviewee (Wilkins C, Casswell S et al. 2003). The interviewers received project specific training which included a briefing and background paper describing contemporary issues facing the community, explaining the study and its aims. Considerable attention was also given to ensuring the interview team fully understood the rural specific language, the questions, and the activities they covered, and had sufficient understanding of the terminology and likely responses, and differences between them to ensure accurate coding.

**Telephone interviewers**

The number of telephone interviewers participating in the study was restricted; this was to maximise standardization and continuity (Siahpush M and Singh GK 1999). After consultation explaining the criteria, 8 interviewers were selected to work across shifts during the 13 days of surveying. The CATI system allows for close monitoring of calls and interviewers technique. As part of the quality assurance process, staff supervisors routinely listen-in to interviews and monitor each interviewer at random during each of their shifts. The project manager supervised the interviewing process, and was on site to answer questions, provide guidance and ensure appropriate coding of responses. This also led to the removal of one interviewer from the project.

**Questionnaire**

The community survey was conducted using a purpose-designed questionnaire. (See Appendix 1) A survey instrument was designed to determine what is the risk (real and perceived) to rural Australians of harmful exposure to AgVets? The literature demonstrates that risk is associated with exposure, and that AgVet users, and their families fall into the high risk categories. Determination of risk necessitated asking the study communities about exposure history for themselves and their families, also, what chemical groups were used, and how often. Evidence suggests that exposure risks are greatest when chemical handling techniques are poor, and personal protection is not worn, and that having an understanding of the hazardous nature of exposure to chemicals is a recondition to the adoption of strategies to avoid exposure of self and others (Sanborn M, Cole D et al. 2004). Questions were
therefore added to determine the level of awareness and what strategies were adopted to avert exposure. It was also relevant to know the health status of the respondents, and whether they linked their own family ill-health this with exposure. The final aspect to be determined was whether primary health care providers were attendant to the issue of exposure, so a range of questions were included.

The questionnaire was designed to incorporate these major themes. Attention was taken to not lead the participant into believing that any specific viewpoint was being sought. This was achieved by including a mixture of questions such as exposure as a result of others actions and exposure resulting from personal behaviours, that is self-imposed risk, and asking whether they perceived a variety of environmental agents, other than chemicals, contributed to their own ill health, such as radiation, and climate change. The survey contained 100 items in 80 questions. Questions consisted of a range of styles: direct factual, with a list of options visible for the interviewer to record; likert style; and open ended questions, allowing for free text responses. The CATI computer has the ability to randomize the selections for multiple choice questions. This option was selected.

The draft instrument was tested for face validity via extensive pilot testing, and peer review. Questions were devised and refined by a process of five meetings with a group of regional farmers. The initial drafts were then pre-tested by a broad cross-section of 40 farmers, users of agricultural chemicals and known to the researcher. This continued until it was established that technical terminology was correct, and that chemical usage questions were contextual and realistic, such that interpretation of the content between the researcher and the test farmers matched. Content validity is threatened where discrepancies occur in interpretation (Christie D, Gordon I et al. 1997). Agricultural work involves, as with any other industry, a content specific jargon, and a mutual understanding exists about work practices. In Australia, this acts almost as a rural code, which can exclude metropolitan people and serves as a marker to indicate that ‘city dwellers’ do not understand the bush, or bush people. This factor heightened the need for a precise questionnaire design in order to achieve credibility, respect, and therefore cooperation from the participants.

Once the questionnaire dialogue was appropriate, the draft instrument then underwent a formal piloting process to test validity with 100 persons, by which time few new themes, difficulties or discrepancies were emerging. Tailoring of the instrument to the reference population therefore occurred via continual ever-diminishing modification during the pilot phase, seven versions in total. During this process the tool was also subject to wide review by peer researchers, whose focus was methodological rigour in the question design.
Table 5.3  Strategies to Maximize Completion of Survey.

Factors capable of exerting a negative impact on response rates were identified, and the following strategies to minimize their potential impact were employed.

<table>
<thead>
<tr>
<th>Potential barrier to participation</th>
<th>Barrier minimization Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community fatigue to market research and telemarketing.</td>
<td>Acknowledge. Stress no profit gain &amp; community benefit</td>
</tr>
<tr>
<td>Dislike of disruptions during meal times, or other specific times of the day. Some families dine at 5pm whereas others not until 9pm, avoiding meal times was therefore difficult</td>
<td>Calls available throughout the day, week-day and week-ends. Call back later by arrangement</td>
</tr>
<tr>
<td>Busy lifestyles, especially significant in the Shepparton region as timing coincided with the end of harvest.</td>
<td>Reduce duration of survey to minimum, offer to call back at time or date more suitable. Offer to speak with another household member.</td>
</tr>
<tr>
<td>Lack of interest or suspicion of the survey topic</td>
<td>Broad publicity, letter of introduction, description of project including funding support from DHS, LTU &amp; NHMRC. Assurance that information was anonymous and could not be used for WorkCover litigation.</td>
</tr>
<tr>
<td>Lack of understanding of the value or potential benefits of survey</td>
<td>Broad publicity, letter of introduction. Reassurance of public health motivation via benefits paragraph available for read out by the interviewer if required.</td>
</tr>
<tr>
<td>Caller factors; inexperience, deficits in skill and friendliness</td>
<td>Selection of reputable experience survey firm, selection of participating interviewers, individual training sessions pre commencement of project. Supervision &amp; support of interviewers, researcher on site, listening in to answer queries and guide interviewers.</td>
</tr>
<tr>
<td>Time of day, or day of the week when telephone calls are made</td>
<td>Calls available throughout the day, week-day and week-ends. Call backs later possible by arrangement</td>
</tr>
<tr>
<td>The length of the survey. People are less likely to finish unduly long surveys</td>
<td>Reduce duration of survey to a minimum. Offer call backs at time or date more suitable. Advise interviewers to limit non-essential conversation, especially if impatience is detected.</td>
</tr>
<tr>
<td>Language difficulties</td>
<td>Interviewers articulate clearly. Language problems not anticipated to pose significant barrier. Less than 3% non- English Speaking. Invite other household member to participate</td>
</tr>
<tr>
<td>Hearing difficulties</td>
<td>Interviewers articulate clearly &amp; loudly. Invite other household member to participate</td>
</tr>
<tr>
<td>Low social capital; less trust about people being contacted by telephone callers. This is reportedly more common in the older age group. Some people have issues with privacy and are reluctant to discuss personal matters over the telephone to a stranger.</td>
<td>Interviewer self introduction, stating name organisation and purpose, stress community benefits of participation, anonymity of responses, and that reporting of findings will be amalgamated.</td>
</tr>
</tbody>
</table>
Additional targeted community interviews

The final question in the survey was an invitation for further explanation. It asked the interviewee whether they were willing to discuss their experiences in greater depth. Twelve respondents received follow-up calls to gain more detailed data on their exposures, health outcomes, and experiences engaging with the health care system. Community meetings were then hosted in both regions seven weeks after completion of the survey. Promotional strategies included placing of advertisements in the local papers, funded by the APVMA. Posters were again placed in local shops and venues. Regional Community Health centres were informed and encouraged to help promote the events. At these meetings, initial study findings were presented, followed by a presentation from the APVMA, then the floor was opened to discussion. Paper surveys were placed on the seats asking attendees to provide additional information which they may feel unwilling to share publicly.

The rationale for adding public meetings to the data collection strategy was based on several factors. Primarily, the large numbers of people (34%) expressing willingness to add further to the information provided during the telephone interviews, meant that most would not be contacted. It was felt that the study had an obligation to further engage with the community given this widespread desire for further contribution. CATI participants indicating desire to contribute further were usually those who felt strongly about the link between their health and AgVet exposure. Conducting public meetings provided the opportunity to deliver some community feedback on the initial findings, with the hope that this would serve to help quell the belief that researchers “take, but do not give back to the community”.

Secondly, it was believed that a public forum would enable the prospect of collating in depth qualitative data. Recent similar events however cast doubts about the effectiveness of this strategy, as extremely low numbers had attended community meetings following the bushfires. Attendance at both meetings was small (less than 15), despite in excess of 180 respondents from each region volunteering to contribute further to the study. The dates of the meetings were July 2nd and 3rd 2003, these nights were unseasonably cold (sub zero degrees).

The third reason was the announcement the APVMA’s Adverse Event Reporting Program – Agriculture Chemicals (AERP-Ag). A similar program covers adverse events relating to veterinary medicines. The aim of these programs is to collate data relating to adverse events resulting from use or misuse of AgVet chemicals. The definition for ‘adverse events’ includes adverse human health outcomes, in addition to unwanted effects upon native flora and fauna, commercial stock or crops, and lack of efficacy of the
Another vulnerable sector targeted for interviews was the transient fruit picker workforce. Harvest season, from mid to late summer throughout the Goulburn valley region, creates an explosion in demand for orchard labour force. Local workers are supplemented by an influx of casual labourers as workers travel in from around Australia, and groups of young foreign backpackers arrive. Specific hostels are annually established throughout the region to cater for backpackers. A series of interviews was held with fruit pickers after work at these hostels. Interviews were usually short and semi-structured, and covered work patterns, exposures, perceived risks, training, safety equipment provided and personal protection offered and worn.

Fruit pickers were targeted as U.S studies demonstrate that farm labourers suffer significant health impacts due to AgVet exposure. However, Australia differs from the United States by not having access to the large Mexican (or equivalent) labour force who are prepared to work for extremely low wages (McCauley LA, Lasarev MR et al. 2001). Nation wide public education campaigns have raised general awareness of occupational health and safety requirements, building on Australia’s long history of union movement dictating workers’ rights and conditions, but the working conditions of these itinerant workforce is largely unregulated, and not represented by unions. No studies investigating occupational health risks facing itinerant fruit pickers in Australia could be identified.

Several attempts were made to interview members from fruit growers’ associations. Two telephone interviews were achieved, these were also semi-structured, and covered the areas of personal exposures of those working within the industry, awareness of risks, adherence to personal protection guidelines, and experience when requiring health care services.

Study 2: Health Provider Survey

All primary health care clinics servicing the two study regions were contacted and invited to contribute to the study. This included general practitioners, community health centre staff, allied health professionals, natural therapists, and discussions were also held with Environmental Health Officers servicing the regions. Enlisting general practitioners to contribute to public health reach studies presents several challenges (Gunn J, Morris K et al. 2002; Gunn JM 2002; Commonwealth of Australia 2003), hence
strategies to maximise GP input were given a high priority. A variety of participation options were offered, such as focus groups, semi-structured face-to-face or telephone interviews at a time of their choosing, and lastly written questionnaires were delivered to each clinic. The Goulburn Valley Division advised that offering GPs financial incentives would improve response rates, however additional funding was not available.

Information sought from primary health care providers included the following:

- Perception of local environmental health issues based on client / patient load;
- Environmental health issues raised by clients / patients;
- Awareness of local industry activities and potential exposure risks;
- Level of activity conducting environmental health exposure assessment;
- Self-assessment of likelihood / ability to recognize environmentally related health problems given numbers of consultations, presentations and client history, and time constraints;
- Referral patterns with regard to client management and professional development in environmental health; and
- Recommended primary health care infrastructure or workforce strategies to cater for health issues related to environmental exposures.

**General Practitioners (GPs).**

In the Hume Region of Victoria, the North Eastern GP (NEVDGP) Division services the Kiewa, Ovens & King Valley GPs, and Goulburn Valley GP (GVGP) Division services the Shepparton based GPs. Attempts to recruit GPs were made directly through the respective Divisions, yet this drew variable success. Enthusiasm for the objects of the project, and a willingness to assist in recruiting GPs was offered by the NEVGP, and less so by the GVGP. Other researchers have met challenges recruiting via the divisions. Despite an expectation that contacting the GPs via general practice divisions would be the most successful recruitment strategy, Gunn, (herself a GP) found direct contact with GPs resulted in a three fold higher rate of uptake than access via divisions. Her study reported the most ‘striking’ finding was the extremely low uptake for both groups (1.1% and 3.6% participation rates) (Gunn J, Morris K et al. 2002).

The Divisions operate an internal communication system, known as the “Friday Fax”. It is well understood that GPs, and rural GPs in particular, feel swamped by the information available, and frequent requests for their time and input (van der Weyden MB 2003). The Divisions act as gatekeeper to the information disseminated to GPs, and are therefore regarded by GPs as a trusted source, sending
only information deemed of relevance to the GPs. Gaining access via their internal networks was viewed as a valuable method to increase the likelihood of GPs reading the information, by learning about the project from an ‘in-house’ source. Support was sought from the Divisions to encourage participation rates. Background briefing notes explaining the nature and purpose of the study, and inviting participation were provided to each division for dissemination through the Friday Fax. (See Appendix 2)

Wording was couched in terms of seeking GP input into primary health care infrastructure decision-making, and improving the health of their client group. Appointments were made with Practice Managers to assist in arranging focus groups during regular GP meeting / discussion timeslots. Some individual GPs and GP clinics were contacted directly where professional relationships had already been established, as they were already known to the researcher. Clinics unknown to the researcher were contacted via the clinic manager. Each practice was contacted 3 or more times to invite participation, and when interviews could not be achieved, copies of the interview questions formatted as self-administered surveys were delivered to each practice.

The relative shortage of rural GPs compared to cities is well documented (Wilkinson D 2000; Johnston G and Wilkinson D 2001). In the practice context, GPs report this translates to long hours, complex case content, limited support, reduced leave time, and a reported sense of frustration in compromised ability to provide quality of care due to the necessity to maintain high patient throughput (van der Weyden MB 2003). Compounding this is the sense that extraneous requirements are not seen as crucial to direct patient care delivery. When contributing to research studies, they are not seeing patients, arguing this therefore jeopardizes patient care and their own personal income, hence the observed low participation rates in surveys and research activity (Del Mar CB, Freeman GK et al. 2003).

General Practice clinics servicing the North Eastern area of the study are located in Myrtleford, Bright, and Benalla, with eleven participating from a total of the 17 invited. GP clinics servicing the Goulburn Valley section are all located in the city of Shepparton, where only two responses were received from a total of 33 GPs invited to participate. Regional demographic differences are reflected in size of the practices, whereby in the smaller North East townships, GP clinics tended to be smaller, with several employing less than five GPs, whereas most GV practices employed in excess of 10 GPs.
Non-medical health care providers

The shortfall in health care providers in rural areas is not restricted to doctors. Despite the higher health needs among rural communities, the range of primary health care practitioners servicing this area is limited. Interviews were sought from Community Health Nurses, School Nurses, District Nurses, Dieticians, Social Workers, Occupational Therapists, Natural Therapists, and Environmental Health Officers servicing the regions under study. A search of the Chinese Medicine Registration Board Website revealed that no Traditional Chinese Medicine Practitioners practiced in either region (Chinese Medicine Registration Board of Victoria 2005).

All community health centre staff approached, participated willingly in the study. (For salaried staff, participation did not incur financial disincentives.) In total, 25 non-medical health providers, plus two EHOs, servicing the Goulburn Valley and North East contributed to the study. Chapter 8 provides a breakdown of the specialties involved, and summarizes their responses (Table 8.1). The majority of non-medical primary health care providers were employed through Community Health Centres (CHC), most of whom who received their initial health training as Registered Nurses. Data were gathered by semi-structured face-to-face interviews, with individuals and small focus groups. Interviews ranged from one to almost two hours. Content of the interviews varied from the information sought by the GPs only in less questioning of recognition of signs and symptoms of exposure related illness. Interviews were not sought with Physiotherapists or Speech Therapists.

Additional information was sought from Occupational Health and Safety Nurses, at their annual conference in Melbourne. The majority of these nurses were employed in industrial settings, and were metropolitan based. As the environmental health nurse role does not currently exist in Victoria, the workload of these nurses most closely approximates the role undertaken by environmental health nurses in the United States. The rationale for including this group was to ascertain their perceptions on the ease of transfer toward a practice realm of environmental health. Survey questions included sections on the level of environmental health involvement in their existing practice, whether they currently conducted environmental health assessments and exposure assessments, their chemical awareness, knowledge of toxicology, and preparedness to expand their environmental health repertoire.
Analysis

Quantitative data gathered through the community CATI survey were analysed using SPSS. The major focus of the analyses centred on comparing exposure levels, health status, and perceived association between these two factors. Exposure was measured in terms of years of working with AgVets, numbers of chemical groups used, and frequency of exposure, via likert scale responses - from sometimes daily, to rarely. Other themes explored were: knowledge of the hazardous nature of AgVet exposure; whether the primary chemical user had undertaken a chemical users’ course; efforts to avoid exposure to chemicals; whether health service providers enquired about their exposure levels to AgVets when presenting with health complaints; and if an exposure related health problem occurred, which professional groups they would choose to seek advice and treatment. Where analysis by location demonstrated that differences between the two regions were not substantial, the data were pooled in the presentation of findings.

Using the semi-structured interview technique, health providers were asked to provide their responses to the series of six questions listed earlier, and their answers were transcribed. Transcripts of the qualitative data collated were then analysed using NUD*IST NVivo software and key themes were extracted and analysed thematically. Similarities and divergence between the two regions under study, and between professional groupings, in their attitudes and responses to each topic discussed were reported in the findings. Verification of the extracted themes was achieved by returning to the interviewees for validation.

Limitations of the study

All studies are subject to limitations (Bland M 1991). Validity of the findings is related to representativeness of the sample, and whether the responses gathered reflect the true views of the total population. The CATI community survey canvassed 1050 households to captured data from over 3,400 people. This provided a very high penetration of the total population of these small regions. Refusal to participate was asked, however it is difficult to determine whether the refusals were cross sectional or representative of a particular group, such as lower socioeconomic category. Conversely, it can be anticipated that willingness to participate was influenced by concern about exposure risks. Refusals, without a reason given, totalled 164, which is 10% of the number of households contacted, and only two interviews were abandoned midstream. It is likely that some of these people refused because they were
definitely not interested in the topic. This would skew the results towards being concerned about risks associated with AgVet exposure.

All non-medical providers approached willingly responded. The fact that no personal gain or disadvantage would follow from the non-medical group in providing specific answers reduced the pressure to provide biased responses. The potential existed for greater content bias within the GPs provider study. GPs would also not stand to gain, but could be at risk of revealing a lack of clinical expertise. The proportion of participating GPs servicing the regions was less than optimal, which carries the potential for bias of retrieving data only from those sufficiently interested in the topic to provide their time. Responses from these potentially more interested GPs revealed limited knowledge of the health impacts of AgVet exposure. Low GP participation rates, if based on self selection on this basis, would serve to eliminate GPs from the sample with less knowledge of AgVet health impacts. The likely impact of such skewing of GP selection would be an under reporting of lack of clinical expertise in environmental health. Lack of GP interest in the subject of environmental health issues in general, and AgVet exposure in particular, lies at the core of the study’s research question.

Content bias in relation to this study could derive from several angles. Respondents to the CATI survey may modify their answers in response to interaction with the interviewer; the risk is gathering information that the interviewees believe the interviewer ‘wants to hear’. Outsourcing the CATI survey helped minimize this risk, as it entailed that the interviewers were metropolitan based, and had limited prior knowledge of AgVet usage, or of related health issues. Interviewers read the survey verbatim from the computer screen. Potential existed for bias in recording answers if the interviewers “took a stance” during the course of the survey, however they were trained to write exactly the words spoken by the interviewee. Lastly, interviewers were randomly monitored throughout each shift to ensure they were not ‘leading’, nor re-wording the responses.

Drafting of the survey and provider interview questions involved a lengthy process of piloting, and scrutiny by professional colleagues. This was, in part, intended to ensure that the survey design did not steer the respondents to any direction. Strategies adopted for this were inclusion of questions relating to other non-chemical hazards. Questions also asked about personal responsibility for risk reduction, which shifts the locus of control from external to internal, and hence, away from being a victim. It was anticipated that this may enhance honesty in responses.
Animosity between provider groups does exist, and this may have provoked the comments from the non-medical group about the performance of the GPs. However, this study was sparked by the comments from Shepparton nurses who were concerned about the lack of medical response to their personal experiences as patients. The potential exists for nurses to share the community view that doctors should have all the answers to health problems, and express frustration when they do not. Measurement of this effect was not possible in this study, but is an area for future study.

Recall bias is a limitation for all surveys, and the impact of the resent fires and prolonged drought may have also impacted on the responses, and must be considered in interpretation of the findings.

Adoption of a multi-method approach brings challenges of increased complexity to a study. The critical task is to include all relevant information, but only critically relevant information. The risk is loosing focus if the scan becomes too broad, by including material marginally relevant, or distracting. Another risk is selection bias in determining information to be included. Efforts were made to maintain objectivity in this selection process, and to present a fair representation of the impacting issues. However, this is difficult to achieve completely. Analysis of the findings from the survey and interviews carries limited risk for researcher bias, however synthesising these against current Australian frameworks involves a higher degree of interpretation, and therefore carries greater risk. This must be accommodated in interpretations of the findings.

**Ethics Approval**

Ethics approval (reference number 02-92) to conduct the study was granted by the Human Ethics Committee La Trobe University. This clearance satisfied the requirements for the Victorian Department of Human Services. A six-month extension of ethics approval was sought and gained.
Conclusion

This research explored the match between the emerging health problem of AgVet exposure, and the capacity of Australia’s existing primary health care workforce to effectively respond. This, like many public health research problems, necessitated retrieval of evidence from those affected, and from those providing direct care. This range of data types determined a methodological approach using a mixture of quantitative and qualitative methods.

The research question investigated in this study therefore necessitated sourcing data from a large rural sample drawn from two communities. The nature of the data sought covered factual information, with the capacity to drill down further to further explore health impacts upon individual household members. Selection of CATI survey technique enabled the accumulation of a large database over a short time period of 13 days, and presented the findings in a format readily suited to SPSS analysis. Views of health providers required direct questioning of those servicing the study communities. This was achieved via an array of interview techniques, applied accordingly to maximise response rates.

Findings from the community survey are presented in Chapter 7, and the views of the primary health care providers are given in Chapter 8. The analysis in Chapter 9 integrates these findings with the contextual background material provided in Chapters 2, 3 and 4.
CHAPTER 6
STUDY COMMUNITIES DESCRIBED

Introduction

Chapters 7 and 8 report findings from community and PHC provider surveys. In setting the scene, this chapter gives a detailed description of the communities involved in the study. The chapter starts with an examination of the significance to the state’s of the region’s agricultural production, and describes the communities’ understanding of their contribution to the state’s wealth, and how they interpret governmental or bureaucratic, recognition of their special needs in return. To gain a deep understanding of community health determinants, and their perceptions, also requires examination of the significant contemporaneous external elements impinging on them at the time the data gathering process took place. The three major events of drought, fires, and insurance crisis impacted heavily on the minds of these rural communities. The potential influences of these events on the survey are discussed.

The second part of this chapter describes the regional demographics, outlines the regional health profile drawn from existing sources, and describes the primary health care services available to the study communities. In the latter sections, the expressed community health concerns ascribed to environmental factors, and their preferred source of health advice as recorded in a DHS funded survey conducted after the bushfires are given. Highlighted is the lack of environmental health expertise among the primary health care providers, which contrasts against the community preference for health advice to be sourced from health providers.

Victorian Agriculture

Located in the south-eastern corner of the continent, Victoria is Australia’s smallest mainland state, covering 227,416 square kilometres. Australia has a largely urbanized population, and this demographic pattern is reflected in Victoria. The estimated resident population for Victoria at 30 June 2000 was 4,765,900 of whom 73% reside in the Melbourne Statistical Division. In June 2000, the Victorian population made up 24.9% of the Australian population (ABS 2001; Australian Bureau of Statistics 2001), making it the second most populous state. The Victorian agricultural industry generates a significant proportion of the state’s wealth, and much of this emanates from the agricultural activities conducted in the two regions studied.
Victoria's temperate climate is conducive to agriculture, enabling the 37,000 farmers to produce over $A15 billion worth of food a year. Fresh fruit was Victoria's largest horticultural export in 2000, which is increasing at 14%, and fruit juices are growing at 44% per annum. This volume makes Victoria the major fruit producing state in Australia, with an industry valued at $520 million per annum at the farm gate, and exports valued at $319 million. Victorian vegetable production is the second largest commodity ($499 million) and accounts for 27% of Australia's total. This industry has increased 72% over the past four years. The food and agriculture sector produces 35% of Victoria's exports (predominantly wine, grapes, citrus fruit, apples, pears, asparagus, and wool) (Department of Primary Industries 2004). The Goulburn and Murray valleys are the major centres for producing and processing fruit and vegetables (Cameron B The Hon Victorian Minister for Agriculture 2004), hence these regions' farmers generate a substantial proportion of the state's economic prosperity. Food production is not only valuable in terms of export earnings, but also helps ensure Australia's self-sufficiency in food.

The regions are also important for other raw commodities. Wool is one of Australia's most important agricultural exports, with about one third of Australia's commercial farms producing wool as part of their enterprise, and 90% of this wool is exported. Victoria accounts for 19% of the Australian sheep flock (Australian Bureau of Statistics 2003). In 2001/02, the wool industry accounted for approximately 7% of the gross value of Australian agricultural production and $3.8 billion in export income (Truss W Minister for Agriculture Fisheries and Forestry 2003), although this figure has fallen significantly with the recent droughts (Australian Bureau of Statistics 2003).

Victoria has 19 distinct wine regions, around 370 wineries and over 2000 grape producers producing 17% of Australia's total wine output. Wine sales have experienced spectacular growth over recent years, exceeding $1 billion in 2003 (Department of Primary Industries 2004). North Eastern Victoria produces a significant proportion of Victoria's premier wine, and remains the largest tobacco growing region. The study regions also produce beef and dairy products.

As with most agricultural produce, key issues for the fruit and vegetable sector are gaining and protecting market access, protection from exotic threats, and the development of new varieties. Recognising this, the Victorian Department of Primary Industries is helping the industry manage pest and disease control (including fruit fly), spray application, breeding and evaluation of new varieties and crop forecasting (Cameron B The Hon Victorian Minister for Agriculture 2004). The marketing advantage presented by the 'clean and green' image of Australian food products is broadly recognised and
vigorously maintained by industry-wide promotion of compliance with quality standards for pesticide and chemical usage.

The economic imperative that Australia’s exports to other countries is not prejudiced by chemical residues in food drives a series of programs monitoring the chemical safety of agricultural produce. These work to ensure that residues remain within the Standard for Maximum Residue Limits\(^1\) (MRLs) for pesticides (APVMA 2004). These chemical safety programs include the APVMA Chemistry and Residue Program, The National Residue Surveys (Department of Agriculture Fisheries & Forestry 2004), and the Victorian Produce Monitoring Program, which targets Victorian produce only.

The DPI’s promotional material argues it is leading the development of efficient, sustainable strategies for controlling pests and diseases without compromising the production of clean, healthy horticultural products (Department of Primary Industries 2004). The interest in keeping residues low is underscored by the economics of maintaining market share, and the efficacy of this as a driving force is evidenced by the high compliance levels observed (Department of Agriculture Fisheries & Forestry 2004). Although bearing positive subsidiary advantages, the health benefits to be gained from minimizing pesticide residues, and minimizing applicator exposure or from reduced reliance on chemicals, is not a consideration for the DPI. Pressing these issues further, to ensure satisfactory safety outcomes for farmers is a health issue, and therefore falls under the jurisdiction of health departments.

An obvious alternative is to avert the dangers of AgVet exposure for agricultural producers, their neighbours, and consumers alike, by making the shift towards organic production. Health benefits in avoiding chemical exposure are clear, and evidence suggests the nutritional value is higher (Leu A 2004; Nutrition Australia 2005). Expansion in value of Australian organic production between 1990 and 2000 was ten-fold, and the amount of land under certified organic production, now exceeds 7.6 million hectares, which represents a 50 fold increase since 1990 (Lyons K 2001). Consumer demand is growing at a rate of 20–30 per cent per year, with retail sales increasing 670 per cent between 1990 and 2001–02 (DHS 2001). This shift towards organic is therefore occurring, but organic food production still remains less than one percent of the total value of agricultural production in Australia. The Organic Agriculture report conducted for the Rural Industries Research and Development Corporation suggests this is due to low demand, as farmers find it harder to sell their livestock than crops in the organic market (RIRDC 1996). In 1996, only 10% of the organically grown sheep meat and wool is sold in the organic market. The figure for beef is substantially higher at 63 per cent, and about half the organic milk is sold in the organic market. In contrast, for many crops the percentage of produce sold in the organic market is

\(^1\) The MRL is the maximum level of a chemical permitted to be present in a food, expressed in milligrams of the chemical per kilogram of the food (mg/kg). It represents the level of residue that should not be exceeded if good agricultural practice is followed, and constitutes a proportion of the amount of chemical applied.
close to 100, especially for fruit and vegetables. Although demand may have increased since these reports, the reality is that the organic industries currently comprise a small fraction of the Australian agricultural market, and industrial farming practices which use AgVets are likely to remain dominant in the near future. The issue of AgVet exposure can be expected to persist.

The DPI has established a food export target of $12 billion by 2010 (Cameron B. The Hon Victorian Minister for Agriculture), and hence pledged $70 million investment in horticulture infrastructure to achieve this goal. The population of rural regions is small compared to urban populations, and their political voice has diminished over time (Larson A 2002). Furthermore, agriculturalists represent a fraction of this small rural population, such the cohort of people responsible for producing over $15 billion worth of goods, and 35% of Victoria’s exports is very small (Department of Primary Industries 2004). This creates a paradox, whereby the economic significance of this sector is recognized among departments of agriculture, but their small numbers arguably relegates their specific health needs, with respect the major health risk of AgVet exposure, to a low priority among health departments.

Although some communication must obviously occur, with regard to policy making, government departments appear to operate autonomously from each other. Therefore the importance to the state of this small agricultural workforce, recognized by agricultural portfolios, does not automatically transfer to equally high recognition of state significance within health portfolio. This helps explain why farmers’ risk of exposure to agricultural chemicals appears not to have gained high significance within the health portfolio. Farmers in the pilot study reported being acutely aware of the discrepancy between their substantial economic contribution to the state, and low profile in terms of political voice and subsequent bureaucratic attention to rural infrastructure needs, especially in the realms of education and health services. The words repeatedly used by farmers in the pilot study to express their feelings were “abandoned, abused, and aggrieved”. The negativity expressed was almost uniformly reported, and the language reflected intensity, and associated frustration.

**Agriculture in the regions studied**

This study was conducted across central and north-eastern Victoria, entirely within the Hume Region of the DHS. Located in the North-East and Goulburn areas of rural Victoria, the Hume Region covers an area of approximately 40,430 square kilometres, 18% of Victoria in area (Butler K 2003). The region is defined by the Great Dividing Range in the east, the Murray River in the north and undulating to flat agricultural land to the west.
Two localities were selected, to provide contrast and diversity in agricultural pursuits, and therefore associated farming practices, whilst representing ‘typical’ Victorian agriculture. These were the Ovens and King Valleys, referred to as the North East region, and to the west, the Shepparton environs lie within the Goulburn Valley region. The eastern and western sections of the Hume region are divided by the Hume Freeway, and railway line connecting Melbourne and Sydney, as shown in figures 6.1 and 6.2 below.

**Figure 6.1 DHS Regions of Victoria**

**Fig 6.2 Hume Region:**

Goulburn Valley (GV) & North East (NE)

---

**Ovens & King Valleys – The North East**

The Ovens and King Rivers form picturesque valleys nestled amongst the western slopes of the Great Dividing Range. The two rivers course through narrow valleys of rich flood plains and fertile soils, and converge outside the regional centre of Wangaratta. The valleys are principally serviced by the small townships of Myrtleford, Bright, Porepunkah and Mt Beauty, all of which harbour a strong sense of local community identity. Mild temperatures suit the production of forestry timber, wine grapes, nuts, hops, tobacco, and downstream the valleys broaden out to include sheep and beef cattle properties. Gold was discovered along the Ovens River in 1853-54 (Talbot D 2002). Tobacco growing in the district immediately followed, and the industry began to boom after the 1931 Scullen Government introduced 100% tariff on imported tobacco. Tobacco farms soon spread to cover large sections of these valleys.

The rationale for investigating this district relates principally to the past tobacco farming activities.

Talbot’s *History of the Tobacco Industry in Ovens Valley* documents that in the early 1900s, arsenate of lead (Paris Green) was used to kill grubs on tobacco. In the late 1950’s and throughout the 1960’s, aerial spraying of organochlorine pesticides was a common spectacle whereby spectators stopping to watch would be sprayed. Talbot states that her investigation revealed that nearly all tobacco farmers remembered walking home at the end of each day soaking wet with chemical spray, after acting as
human markers at the end of each row to peg out aerial spray runs (Talbot D 2002). Dogs and chickens were tethered to reduce their chemical exposure, yet this paradoxical disregard for human health was based on a perceived economic necessity to ensure a viable crop.

By the 1960s and 1970s, up to 40,000ha, a high proportion of the arable land, were under cultivation to tobacco. Intensive applications of the organochlorines; DDT, endrin, dieldrin and Zineb, occurred during that twenty year period, until becoming prohibited from use in the State in 1987 (McKenzie Smith F, Tiller D et al. 1994). Several interviewees from this study reported that these agents were continually applied for many years after the official ban, as farmers continued to use residual supplies, and illegal replenishments could still be sourced. The highly persistent nature of these organochlorine pesticides means they can remain active for up to 30 years (Melville J 1989). The study by McKenzie Smith found high levels of these agents still persist in the Ovens and King river systems (McKenzie Smith F, Tiller D et al. 1994), and Sinclair et al. found bores in the region were also contaminated with dieldrin, DDT, DDE and DDD (Sinclair, Knight et al. 1997).

Myrtleford is the largest town in the valleys, and for over two decades, the issue of health effects associated with the vast acreage of tobacco farms has been the subject of widespread community concern. Residents believed the incidence of cancer was significantly greater than elsewhere, such that it is common practice for residents of Myrtleford to call the Ovens Valley (their home), “Cancer Valley”.

Sheep properties invariably have sheep dips, as do many farms which produced wool or lamb in the past, but have since been transformed to produce other crops. The purpose of sheep dips is to fully saturate the wool, through to the skin, with a chemical mixture to provide protection from lice. The chemicals used in sheep dips include arsenic and organophosphates (Stephens R, Spurgeon A et al. 1995), and farmers reported that they have been repeatedly covered with the chemical spray, and as children, were encouraged by their fathers to jump into the dip to move the sheep along. After dipping, the sheep invariably attempt to shake themselves dry, effectively spraying all those working nearby. Hundreds, or thousands of sheep are treated on each farm annually, so all those engaged in the activity spent many hours saturated by the dip mixture. At the end of the procedure, hundreds of litres of the residual dip mixture is then drained out onto the nearby land, flowing downstream, seeping into the soil, and contaminating the area. Sheep yards are customarily located relatively near to the homestead, so the contaminants can drain near the farmhouse, or through to vegetable gardens, play areas, and eventually enter neighbouring waterways.
The United Kingdom lists sheep dip chemicals on the priority list of hazardous substances due their capacity to contaminate the surrounding soil and groundwater. In an effort to reduce harm, the UK EPA requires farmers to contact the EPA prior to disposal. No such requirement exists in Australia. Arsenic is hepatotoxic, and causes a range of skin conditions (ATSDR 2004), and organophosphates produce a range of significant neurotoxic (Stephens R, Spurgeon A et al. 1995) and other health problems as outlined in Chapter 2.

**Goulburn Valley**

Shepparton, the second area studied, is situated in the Goulburn Valley, 150 kms to the west of Myrtleford. This region, covering an area of 2,400 square kilometres, is widely recognized as the 'Fruit Bowl' of Victoria, if not Australia (Cameron B The Hon Victorian Minister for Agriculture 2004). Geographically, the district is flat with warmer temperatures and a lower rainfall than the North East, and is dependent on irrigation from the Goulburn and Broken Rivers to support its intensive fruit and dairy production. Agriculture is seen as critical to the long-term financial future of Shepparton, contributing more than $1billion to the regional economy each year and supporting about 200,000 people across Victoria (Cameron B The Hon Victorian Minister for Agriculture 2004). Intensive dairying and orcharding occurs on the rich irrigated soils in this vicinity, which generates 25% of the total value Victoria's agricultural production (Greater Shepparton City Council 2003).

Greater Shepparton, with its population of 59,000, of whom 67% reside in the twin cities of Shepparton-Mooroorupna, acts as a major service centre for the regional population of 160,000 (Victorian Government 2004). It also has a strong retail and manufacturing base, such that only 15.5% of the 26,200 workforce are employed in agriculture. The study surveyed districts housing orchards and dairies, situated to the north, west and east of the joint cities. Inclusion of this region was based on the concentration of orchards, and associated history of heavy applications of AgVets. Two studies have previously demonstrated organochlorinated pesticides DDT and dieldrin, and the organophosphorus pesticides, chlorpyrifos, s-triazine, simazine and amitrole were found in groundwater prevalent in the Shepparton region resulting directly from AgVet applications in the orchard industry (Bauld J, Evans WR et al. 1993; Wenig D and Lawrence CR 1998). A significant cattle industry exists in this region, predominantly dairy, which also involves the use of hazardous AgVets, although the principle community concerns revolve around chemical agents used in the orchards, so emphasis in this thesis is given to these.
A high proportion of the fruit growers are of Italian descent, with strong family connections. Shepparton based community health nurses reported that wives of Italian fruit growers were establishing a mutual support group in light of significant family health problems and child disabilities observed. However direct access to this group to canvass their input to the study was difficult to achieve. It remains unknown whether this group ever formed, but it strongly suggests a community awareness of ill health among this sub-sector, plus an attempt to deal with their concerns internally and self manage. It may also indicate a lack of external support, or lack of awareness of where to find this support. Although this is conjecture, it brings into focus a starting point for further research, and highlights the need to use culturally appropriate techniques to gain access to this sector.

The warm climate of Shepparton hampers the willingness of farm workers to wear personal protective equipment (PPE), which are reportedly hot and stifling to wear, as consecutive weeks of daily temperatures above 40 degrees centigrade have occurred over the past years (National Climate Centre 2004). The wearing of full suits and gloves also restrict dexterity. This reluctance serves to exacerbate exposure risks. The fruit ripens at the end of summer, and creates an explosion in workforce demands for fruit pickers, which exceeds the available local supply. The conditions are hot and harsh, and reportedly poorly remunerated, so shortfalls are experienced every year, requiring the annual creation of a special employment agency to recruit sufficient itinerant workers to meet the need. Targeted interviews were held with itinerant fruit pickers, mostly backpackers who would not otherwise be accessible to the CATI survey.

**Contextual Factors**

**Drought and Fire**

The community survey was conducted March – April 2003. This period fell during the worst drought in 100 years, which culminated after a severe 7 year long drought. Pilot study participants described a ‘widespread financial despair’ for rural areas across all of southern Australia. Reservoirs such as the Hume Weir were down to six percent capacity, and there no water available in the Menindee Lakes system for the irrigation scheme foreboding an alarming year for irrigators (Truss W Minister For Agriculture Fisheries and Forestry 2003). The full impact of such an event on the local psyche on top of consecutive years of negative income and rising debts may be comprehensible only to other rural dwellers.
The interdependence of the agricultural sectors with all other sectors within these communities meant that all people were acutely affected, and many township businesses became insolvent. Perseverance of farmers to remain on the land is based on two major factors. The first is certain financial ruin with huge accumulated debts should they walk off their farms, which would only serve to create a domino affect for their neighbours. Residual property and stock prices would plummet. The second feature is that Australia has historically been subject to droughts, all of which have broken in time, and eventually been followed by “good' years. The hope that the drought will soon break drives an optimism unparalleled in urban based industries. However, this optimism is now tempered by the gloomy predictions of rising frequencies and greater intensities of droughts associated with climate change. These climatic perturbances help drive the demand for intervention to maximize crop yield, such as the application of AgVets

Between January and March 2003, 108 fires ignited by lightning strikes, burnt through 1.4 million hectares (ha) of tinder dry national parks in North-East Victoria, and a further 1.6 million ha burnt in South East NSW, and the ACT (Strahan Research 2003). The magnitude and intensity of these fires meant that fire-fighters were only able to focus on protecting nearby farms, and directly threatened townships. All residents of north-east region involved in the study had either family members or neighbours leaving in rotating shifts to battle the blazes. Environmental health issues which might cause considerable concern under normal circumstances paled to relative insignificance in comparison to the immediate life-threatening experiences faced by the fire fighters, the local towns, which were broadcast hourly on the news and fire radios². The impact these events had on the survey responses remains unknown.

The effect of the fires on community members was especially acute in the Ovens and King Valley regions. The fires burnt out large sections of the Ovens Valley one month prior to the commencement of the survey. In addition to the direct risk of fire, the persistent thick smoke forced many to evacuate, and those who stayed could not see their front fence for most of that time. This situation lasted for over 7 weeks in January and February. The CATI survey commenced in March. Many people participating in the survey had the fire burn within 20 metres of their homes. In addition to the immediate threat of loss of life and property, environmental concerns were refocussed towards maintenance of a secure water supply. Ash and debris clogged the water filtration units suppling Wangaratta to the point of failure.

² Fire radios are managed by the Country Fire Authority (CFA) to broadcast detailed local area weather forecasts twice daily, which includes the probability of lightening strike, fire risk, and the predicted rate of spread of grass fires. Fire lookout towers broadcast directly on this channel when smoke is spotted. All local CFA units report in twice daily, declaring their availability to assist in sending a manned fire unit should a fire occur. Farmers stay tuned to their portable receivers throughout the summer months to receive early notification of a fire in their district.
leaving the town of 16,000 people without water. Although this situation was quickly resolved by transporting water from neighbouring towns, concerns about water quality remained high.

**Other contextual factors**

The drought and fires were not the only events unfolding at the time of the survey. Australia was reeling from massive insurance premium hikes following a devastating series of events, including the collapse of HIH Insurance and Ansett Airlines, and the aftermath of the “September 11” disaster in New York. Social cohesion in rural communities is largely based on involvement with local groups, and clubs. Many fairs, markets and sporting clubs, and businesses, such as eco-tour operators and horse riding, were facing cancellation or closure due to the inability of finding adequate legal liability cover. Community fairs and markets have long standing traditions, sometimes in excess of 100 years. The sudden wave of cancellations had a devastating impact, described as “ripping the core out of our already collapsing communities” by one farmer. The insurance crisis was therefore threatening to collapse much of the social fabric, which would otherwise provide respite from the mental anguish resulting from the drought and fires. Effects of the insurance fiasco intensified the threat of loosing rural medical services (especially maternity services) as medical practitioners were publicly declaring their inability to find or afford insurance cover. The compounded impacts of these major events played heavily upon the minds of these rural communities.

In such a climate, the spectre of loosing their insurance cover or attracting litigation and rising WorkCover premium was perceived as a very real threat. The survey questioned farming practices, and resultant chemical exposure risks. Several respondents expressed caution stating that completely honest confessions could imply a neglect of duty of care on the part of the farmers, and provide impetus for further increasing insurance premiums. This perception was also detectable when attempting to schedule interviews with office bearers of regional fruit growers associations, where pronouncements of uniformly adopted sound work safety practices, by all in the industry, were cited as reasons not to answer questions.

Additional factors may have affected willingness to participate in a study of this nature. Foremost among these was the potential that the focus of the study could be misinterpreted. The aim of the survey was to capture a snapshot of community exposure and their beliefs with regard to links between environmental exposures to AgVet chemical and ill-health, plus their health seeking behaviour. The survey directly sought cooperation, and time to divulge personal information about their farming practices, and family
health. The famed trust and mateship existing among rural Australians is directed toward helping another person in need of help, a fellow “battler”. This camaraderie does not necessarily extend to bureaucratic organisations. A proportion of rural populations harbour an inherent distrust of bureaucracy and academic institutions (Gray I and Lawrence G 2001; Stafford Smith M 2003). Those refusing to participate were asked their reason for refusal, but not ancestry, or industry. Several people who refused to participate in the study nominated their principle rationale was distrust of bureaucracies. Again the words ‘abused’, ‘abandoned’ and ‘aggrieved’ were used. The motives of a government body (the Department of Human Services) in collaboration with a university, investigating the sensitive issue of AgVet exposure might be misconstrued in a climate where these attitudes prevail. External interference in farming practices is unwelcome, and investigating health problems resulting from the use, or perhaps misuse, of farm chemicals were described by a small number, as an “infringement into the autonomy of farmers to operate their own land as they so chose”.

The timing of a community wide survey, against such contemporaneous events was less than optimal, and sponsorship by a university and government health department into agricultural chemical usage, mis-usage and subsequent health consequences, was perceived by some agriculturalists with overt suspicion. The response rate achieved of 66.5% was somewhat less than anticipated based on the literature.

**Demographics of Study Regions**

The Hume Region comprises a relatively homogenous population, of mostly Anglo-Saxon ethnicity compared to urban regions, where eighty five per cent of the region’s population are Australian-born (compared with 71 per cent for the State) (Butler K 2003). The Hume Region’s population is approximately 246,000 persons (Australian Bureau of Statistics 2001), which represents 5.3 per cent of Victoria’s population, living in 12 local government areas (LGAs). Residents from four of these LGAs were surveyed during the study, three in the North East: Alpine Shire Council, Indigo Shire, and Wangaratta Rural City, and the Greater Shepparton City Council in the Goulburn Valley.

Greater Shepparton has a population of nearly 55,000, however the Ovens and King Valley regions are more sparsely populated, and cross the Shires of Wangaratta Rural City (population 25,600, which includes the city of Wangaratta, home to 16,000 people), Indigo (population 3,390) and Alpine (population 18,000), making exact population estimates more difficult. Both study areas have a strong
agricultural base. Industry and services are situated in the larger towns, where the health sector is also a significant employer.

In 2000, the North Eastern Division of General Practice (NEVDGP) published a report outlining the health profile of the region. English was spoken at home by 86% of residents, compared to a figure of 71% for the rest of Victoria (North East Division of General Practice 2000). Table 6.1 below, and table 6.2 give the ancestry nominated by survey respondents per region in this profile.

**Table 6.1 Selected demographic features of localities studied.**

<table>
<thead>
<tr>
<th>Region</th>
<th>North East Region</th>
<th>Porepunkah</th>
<th>Bright</th>
<th>Myrtleford</th>
<th>Greater Shepparton</th>
<th>Shepparton East</th>
<th>Hume Region</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persons over 65yrs</td>
<td>15.4</td>
<td>12.8</td>
<td>19.2</td>
<td>20.1</td>
<td>12.1</td>
<td>9.3</td>
<td><strong>13.0</strong></td>
<td>12.6</td>
</tr>
<tr>
<td>Non-English Speakers</td>
<td>3.8</td>
<td>3.7</td>
<td>6.7</td>
<td>14.8</td>
<td>11.0</td>
<td>1.9</td>
<td><strong>5.6</strong></td>
<td>19.8</td>
</tr>
<tr>
<td>Indigenous</td>
<td>0.6</td>
<td>0.6</td>
<td>0.4</td>
<td>0.7</td>
<td>3.4</td>
<td>3.7</td>
<td><strong>1.2</strong></td>
<td>0.5</td>
</tr>
<tr>
<td>Professional / Managers</td>
<td>29.7</td>
<td>14.0</td>
<td>21.0</td>
<td>14.6</td>
<td>23.5</td>
<td>42.6</td>
<td><strong>17.6</strong></td>
<td>28.7</td>
</tr>
<tr>
<td>Trades / Labourers</td>
<td>32.1</td>
<td>39.4</td>
<td>31.1</td>
<td>48.9</td>
<td>34.6</td>
<td>27.5</td>
<td><strong>34.2</strong></td>
<td>28.5</td>
</tr>
<tr>
<td>Degree/ Diploma</td>
<td>16.3</td>
<td>11.7</td>
<td>17.3</td>
<td>7.8</td>
<td>12.5</td>
<td>13.5</td>
<td><strong>14.0</strong></td>
<td>20.2</td>
</tr>
<tr>
<td>Unemployed</td>
<td>5.5</td>
<td>8.7</td>
<td>5.3</td>
<td>8.0</td>
<td>8.1</td>
<td>3.7</td>
<td><strong>6.4</strong></td>
<td>6.8</td>
</tr>
</tbody>
</table>

Figures given in percentages. **Source: Monash University Echidna demographics**

Although Shepparton has the largest non-urban indigenous population in Victoria, indigenous numbers are relatively low and only 0.6% of survey respondents reported having Aboriginal or Torres Strait ancestry. At the last Australian Bureau of Statistics (ABS) census in 2001, the Hume Region had approximately 3,170 Aboriginal and Torres Strait Islander people living in the region, and over 1,450 of those resided in greater Shepparton, although it is generally acknowledged that these figures significantly undercount actual numbers (Hume Region DHS 2004).

**Demographics of the Study Sample Population**

This section describes the demographics of the communities studied, and demonstrates the study sample was representative of the broader Hume Region given above.

For the study population (Table 6.2), the proportion of people born in Australia was high, 91.5% in the North East (NE), and 85.5% in the Goulburn Valley (GV). Similar to the entire Hume Region, major
cultural groups in this study were Anglo Saxon, 76% had ancestry from the UK, 18% from Northern Europe, and 10% has Italian ancestry. Representation from other countries was very low, and only 0.5% reported having Aboriginal or Torres Strait Island ancestry. Having Italian ancestry was reported by 12.0% of NE, and 8.4% of GV survey respondents.

Table 6.2 Percentage of study participants by country of birth

<table>
<thead>
<tr>
<th></th>
<th>Australian Born</th>
<th>UK</th>
<th>Italy</th>
<th>Other Mediterranean</th>
<th>Northern Europe</th>
<th>Asia</th>
<th>ATSI</th>
<th>Middle East</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>91.5</td>
<td>79.1</td>
<td>8.4</td>
<td>2.5</td>
<td>19.3</td>
<td>0.9</td>
<td>0.4</td>
<td>0.7</td>
<td>4.2</td>
</tr>
<tr>
<td>GV</td>
<td>85.5</td>
<td>72.8</td>
<td>12.0</td>
<td>1.2</td>
<td>16.6</td>
<td>1.2</td>
<td>0.6</td>
<td>0.4</td>
<td>5.8</td>
</tr>
<tr>
<td>Total</td>
<td>88.5</td>
<td>76.1</td>
<td>10.1</td>
<td>1.9</td>
<td>18.0</td>
<td>1.0</td>
<td>0.5</td>
<td>0.6</td>
<td>5.0</td>
</tr>
</tbody>
</table>

It can be seen from Table 6.2 above that demographic similarities existed between the two surveyed communities across many variables, although differences were observed in some parameters. Residents in the north-eastern households were generally older, having more retirees, and smaller household sizes \( \chi^2 = 42.961, P = 0.000 \). This differential exacerbated the split of numbers across the two regions. A total of 1050 households were surveyed, with 550 or 52% of the households surveyed were in the GV region\(^3\). The combination of these two factors resulted in data being collected from more people from the Goulburn Valley region, 57% of the total sample population.

The telephone sample included screening questions to select households where members lived (present or past) within 2 kilometres of farms, or worked on farms. Almost all (99%) of the sample had lived on or within 2 kilometres of farms, although differences existed between the two groups in the number of years, with Goulburn Valley residents living significantly longer in farm environments \( \chi^2 = 36.9, P = 0.000 \). Significant differences were also observed in the number of years household members had worked on farms \( \chi^2 = 39.1, p = 0.000 \), and where 67% of the North East and 78% of the Goulburn Valley household members had worked on farms. Only 3.5% of the GV households no longer lived on farms, whereas 12.8 % of households from the NE region reported no longer living on farms. This was attributable to sample telephone numbers including the townships of Myrtleford, Bright, Porepunkah and Mount Beauty.

Household proximity to farms, and length of time working on farms was used as a proxy measure for exposure to AgVets. Some differences existed between the two sample populations in number of years living and working in the agricultural areas. As seen in Table 6.3 below, a higher proportion of

---

\(^3\) The additional 50 households surveyed in the GV region resulted from an error on the part of the survey company programming the CATI computer. It was decided to include this additional data.
respondents from the GV region reported household members had worked in the agricultural setting, and had done so for longer. Forty-five percent of GV have worked for over 30 years, compared to only 31% of NE households, and at the other end of the spectrum, working less than five years, was reported nearly twice as often by NE (11.2%) households than GV (6.7%).

**Table 6.3 Length of time household members have worked in agriculture**

<table>
<thead>
<tr>
<th></th>
<th>Percent NE N=500</th>
<th>Percent GV N=550</th>
<th>Total N=1050</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work in Agriculture - present</td>
<td>41.2</td>
<td>57.6</td>
<td>49.8</td>
<td>49.8</td>
</tr>
<tr>
<td>Worked in Agriculture - past</td>
<td>25.6</td>
<td>20.5</td>
<td>23.0</td>
<td>72.8</td>
</tr>
<tr>
<td>Ever worked in Agriculture</td>
<td>66.8</td>
<td>71.1</td>
<td>72.8</td>
<td></td>
</tr>
<tr>
<td>Worked Less than 5 years</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-10 years</td>
<td>11.2</td>
<td>6.7</td>
<td>8.9</td>
<td>8.9</td>
</tr>
<tr>
<td>11 - 20 years</td>
<td>12.2</td>
<td>9.3</td>
<td>10.7</td>
<td>19.5</td>
</tr>
<tr>
<td>21 - 30 years</td>
<td>12.4</td>
<td>17.1</td>
<td>14.9</td>
<td>34.4</td>
</tr>
<tr>
<td>31 - 40 years</td>
<td>10.8</td>
<td>14.7</td>
<td>12.9</td>
<td>47.2</td>
</tr>
<tr>
<td>More than 40 years</td>
<td>9.6</td>
<td>12.4</td>
<td>11.0</td>
<td>58.3</td>
</tr>
<tr>
<td>Never worked in agriculture</td>
<td>33.2</td>
<td>21.8</td>
<td>27.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

The tendency of rural populations having lower education levels than metropolitan regions was not reflected in this study. This finding should be treated with caution as the discrepancy may result from differences in phraseology of the question, where the survey respondents were answering for the entire household (Table 6.4). The proportion of households members having post secondary qualifications was slightly higher in the NE, 48.4% compared to 42.8% in the GV. However income was significantly lower in the NE, \( \chi^2 = 18.812, P = 0.000 \). This anomaly may reflect the older population, as education levels showed positive correlation with income.

**Table 6.4 Education level of household for sample communities, compared to ABS statistics for Victoria and Australia**

<table>
<thead>
<tr>
<th></th>
<th>NE</th>
<th>GV</th>
<th>Vic</th>
<th>Aust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher degree</td>
<td>5.8</td>
<td>6.7</td>
<td>3.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Bachelor degree</td>
<td>22.2</td>
<td>17.3</td>
<td>8.4</td>
<td>7.7</td>
</tr>
<tr>
<td>Diploma</td>
<td>9.4</td>
<td>8.5</td>
<td>6.1</td>
<td>6.1</td>
</tr>
<tr>
<td>Vocational qualification</td>
<td>11.0</td>
<td>8.9</td>
<td>12.4</td>
<td>13.4</td>
</tr>
<tr>
<td>No qualifications (primary / secondary school only)</td>
<td>51.4</td>
<td>58.4</td>
<td>58.3</td>
<td>58.4</td>
</tr>
<tr>
<td>Inadequately described or not stated</td>
<td>0.2</td>
<td>0.2</td>
<td>11.7</td>
<td>11.8</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Health of Hume Region Residents

The NEVDGP 2000 Health Profile results confirm data reported by the Victorian Burden of Disease Study suggesting that the health of North East residents is worse than the state average across a range of indicators, although no previous studies have investigated environmental health of Hume residents. Diabetes complications within the North East (Central Hume Primary Care Partnership 2003) created the highest number of admissions, at 9.27 per 1,000 admissions, yet this rate is similar to the Victorian average. All other of the top 10 admissions for ambulatory care sensitive conditions were significantly above the Victorian averages in 2001-02 (Rural and Regional and Aged Care Services 2004).

In the North East there were more male deaths than female (53% compared to 47%). In particular there is an overwhelmingly higher representation of male suicides deaths (82% and 18% respectively). Overall cancer rates within the region are also more prevalent than the state rates (7.5% compared to 6.9%). North east children in 0-14 age group experience more liver cancers, and more unspecified cancers than the rest of the state. Cancer of the pancreas is more common in men than women (61% versus 39%), and men also have higher incidences of respiratory diseases, including lung cancer. In the 25-34 year ages group the Hume region has more cancers of the stomach and female genital organs, more mental disorders, and acute respiratory infections than the state average. In the 35-44 age group there were also more cancers of the brain, and endocrine disorders, which also remained higher for all older age groups. Diseases of the skin are higher for all age groups from 45-54. Chapter 2 outlines that many of these conditions are induced by exposure to AgVets. Morbidity relating to the toxic effects of non-medical substances is higher in children, however more detailed drill down of agents involved was not provided by the report.

Regional Primary Health Care Services

Medical

Both regions studied have access to major acute referrals centres via category B Hospitals. Goulburn Valley Health provides medical, surgical, maternity services, oncology, intensive care, haemodialysis, rehabilitation, palliative care and psychiatric. Outreach services are provided for discharged patients in the community for services such as pharmacy, diabetes education, dietetics, occupational therapy,
physiotherapy, speech pathology, audiology, dentistry, and Aboriginal Liaison. Wangaratta District Base Hospital provides the tertiary referral centre for the north–east region, including medical and surgical, intensive care, dialysis, maternity, and rehabilitation, in addition to similar outreach services. Alpine Health provides limited acute health services, and increasingly primary care from category D and E Hospitals situated in Myrtleford, Bright and Mt Beauty.

Medical care in the north-east is provided by one GP clinic located in Bright (with 5 GPs), two clinics in Mount Beauty (with one, and five GPs), and two clinics in Myrtleford (with two, and four GPs), giving a total of 17, although not all these work fulltime. All are members of the local GP Division. The natural scenic beauty of the area, proximity to mountains, national parks, skiing, and gourmet food areas makes the area relatively attractive to GPs, so the doctor-patient ratios in these valleys is higher than many other rural areas at 1:838 (Rural Workforce Agency Victoria 2000). No clinics in this region bulk-bill.

Doctor shortages are more apparent in the Shepparton region than the North-East. Five clinics service the Greater City of Shepparton and surrounding regions. Three of these are small operations, with two clinics having only one GP, and the third has four. The remaining three clinics are considerably larger, two with eight, and the third has eleven GPs. Similarly, no clinics bulk-bill in Shepparton. The Goulburn Valley Division of General Practice (GVGP) has calculated that the doctor-patient ratio for the Shepparton and Mooroopna area is 1:2000 with an overall Divisional ratio of 1:1815, giving the second highest ratio in the state (General Practice Divisions of Victoria 2004). Seven of the state’s 10 divisions with the worst GP shortages are in rural areas.

**Community Health Centres (CHCs)**

The Ovens & King Community Health Service (O&K CHS) operates from centres in Wangaratta, Moyhu, Myrtleford and Bright. Alpine Health provides health services to Bright, Mount Beauty and surrounding districts. These agencies provide a range of community programs including services in youth, community health, health promotion, drug and alcohol programs, diabetes education, Health and Community Care funded allied health services, transport, friendly visiting, maternal and child health, victims assistance program, Adult Day Activity Support Services, community inclusion program, district nursing, palliative care, Aged Care Assessment Service, and sexual health. Other regional services include school nurses, specialist children’s services, early childhood intervention and public health. Alpine Health provides occupational therapy, speech therapy, physiotherapy, dentistry, diabetes education and podiatry, services also provided by the O&K CHS.
Goulburn Valley Community Health Service (GVCHS) offers dietetics, drug and alcohol counselling, family violence outreach, gambler’s health, drug safety, victim’s assistance, youth support services, counselling, supported women’s services, and community health nursing. The major areas the Community Health Nurses concentrate on are: cardiovascular health; cancer control (smoking, skin, and screening for bowel, breast and prostate cancer); asthma; diabetes; injury prevention (mostly via a syringe program); and mental health (Goulburn Valley Community Health Centre 2004). The Shepparton based population supports multiple private practitioners providing physiotherapy, osteopathy, podiatry, chiropractic, and acupuncture.

**Complementary and Alternative Medicine (CAM)**

Although CAM use in Australia has been increasing (Brooks PM 2004), the causes of this rise in demand are largely unknown and little researched. Suggested explanations include the ageing population, and a growing emphasis on chronic illness and lifestyle-related morbidity rather than acute illness, especially where conventional medicine has been perceived to be less successful (Siahpush M 1998; Siahpush M 1999; Expert Committee on Complementary Medicines in the Health System 2003).

No Chinese Medicine Practitioners, or Natural Therapists practice in the Ovens and King Valleys, however two Natural Therapists practice in Wangaratta, 60 kilometres away. Three naturopathic clinics based in the township of Shepparton offer CAM services. Two of these are operated by sole practitioners, and one clinic employs five providers offering a range of natural therapy services. This clinic has particular interest in environmental health, and reported viewing view environmental health assessments as a core function of their work.

**Environmental health service**

State and federally operated health services fund acute health, and primary health care provided by general practitioners, and community health services provided largely via community health centre staff. All these providers were asked to describe their level of environmental health skills and training. The unanimous response was nil, no providers had ever received specific training, and hence do not attempt to provide any environmental health services to their patients groups.

The only environmental health service is provided by Environmental Health Officers (EHOs) employed by the local governments, and the activities are therefore limited to the skills of this practitioners group.
The Ovens and King region is serviced by two environmental health officers employed by the Alpine Shire Council. Their roles involve:

- Assessing septic tank applications;
- Inspecting premises to ensure the health of the community;
- Managing Council’s immunisation clinics; and
- Following up health and environmental complaints.

The City of Shepparton Council’s Health Services department employs four EHOs who provide advice and assistance on a range of health-related issues, including immunisation, food safety and pest control throughout the council’s region (City of Shepparton Council 2004). EHOs do not have a client base, receive little pathophysiology education, and are not trained to perform environmental health assessments on people; EHOs assess physical environments for potential human health hazards. It is not customary for community members to seek personal health advice from EHOs.

**Primary Care Partnerships**

The Victorian Government introduced Primary Care Partnerships (PCPs) in an effort to integrate services and improve coordination, and responsiveness to community needs (Central Hume Primary Care Partnership 2003). However success in meeting these objectives by the PCPs servicing the study regions have been limited. One barrier is lack of local health data; data available is drawn largely from national or state-wide sources, morbidity, mortality, hospital separations and disease events. These statistics do not provide the level of interpretation required for the services, nor do they disaggregate sufficiently for developing and delivering local primary health care services. The Central Hume Primary Care Partnership notes ‘utilisation of community needs analysis tools is at best patchy by that regional health agencies, and that the few analyses conducted are nascent, and have been driven by operational imperatives, not by a regional focus aimed at streamlining and improving access to services’ (Central Hume Primary Care Partnership 2003). The partnership called for information about the size and nature of client caseloads, referrals and workforce development issues, client capture, that is, data on those not accessing local services but rather seeking services elsewhere, and utilisation of complementary health services.
Health Advice

Stevens et al. examined the perspectives of specialists, community based practitioners (general practitioners, practice and specialist nurses), and community members on the importance of air pollution as a causative or exacerbating agent in asthma in the UK (Stevens E, Cullinan P et al. 2004). Consistent certainty in lay perceptions that resulted from easily identifiable exposures, where personal observations were clear, and where control of exposure was considered achievable in theory. Uncertainty in community assessments stemmed from situations where defining exposures was difficult, and directly observed evidence was lacking or vague, and expert opinion was unavailable. When parents felt that exposure was beyond their control, widespread assumptions about links between exposure to pollution and asthma were reported as “common sense”. In this study, advice from health professionals was rated the most useful source of information about environmental issues concerning general health, yet when this information was not forthcoming, the majority of information was drawn from public media (Stevens E, Cullinan P et al. 2004).

The Health Risk Perception in Australia study conducted for the enHealth Council revealed the Australian population regarded health advice from doctors the most authoritative (Starr Langley 2000). The summer bushfires of 2002-2003 provided an opportunity to measure the level of environmental health information rural residents sourced from health providers, and to also measure the credibility North East Victorian residents afforded to the health information provided by various agencies during a local ‘environmental crisis’. The Victorian Department of Human Services contracted Strahan Research to conduct an independent investigation into the health effects on NE residents of the 2003 Bushfires. A telephone survey of 603 NE residents was conducted 3 months after the fires. (The Strahan survey covered a wide area, which included the NE localities studied in this project.) Respondents listed doctors, nurses and hospitals as the most credible source of information about health issues. They specifically sought information about health risks caused by bushfire smoke and water contamination, whereas only 2% received information about risks associated with rainwater contamination from their GP, and 4.6% reported being informed by the local nurse. Only 35% of those who rely on rainwater tanks for domestic supplies reported receiving information on how to protect the tanks from contamination, and of this group, only 34% received the information in time for the information to be effective (Strahan Research 2003).
The Strahan survey asked:

*Who are you likely to listen to and believe about health issues and risks caused by bushfire smoke and water contamination?* Responses are given below in Table 6.5.

**Table 6.5 NE residents – rating of credibility as source of health and risk information a from 2003 NE bushfires**

<table>
<thead>
<tr>
<th>Advice Communicator</th>
<th>Credibility ranking % (n= 603)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctors, nurses, hospitals</td>
<td>39.8</td>
</tr>
<tr>
<td>ABC radio, TV, Newspapers</td>
<td>34.4</td>
</tr>
<tr>
<td>County Fire Authority</td>
<td>25.5</td>
</tr>
<tr>
<td>Local Shire, local authorities, local meetings</td>
<td>23.4</td>
</tr>
<tr>
<td>Water authority</td>
<td>17.8</td>
</tr>
<tr>
<td>Health Department, health authorities</td>
<td>16.8</td>
</tr>
<tr>
<td>Government authorities</td>
<td>14.0</td>
</tr>
<tr>
<td>Local media</td>
<td>4.3</td>
</tr>
<tr>
<td>Department of Sustainability &amp; Environment</td>
<td>4.1</td>
</tr>
<tr>
<td>Environmental Protection Authority</td>
<td>3.4</td>
</tr>
<tr>
<td>Don’t know</td>
<td>3.2</td>
</tr>
</tbody>
</table>

These data confirm Stevens’ findings, that health information, and health advice provided by health providers is given the highest level of credibility. The imminent human health effects of this environmental crisis were apparent to a range of other organisations, so in the absence of a health care sector lead response, this vital health promotion activity was performed by agencies outside the health sector. A rapid well organised response was garnered by the Department of Sustainability and Environment (DSE), the EPA, water authorities, and the Country Fire Authority (CFA), yet the health industry was ill equipped to respond to the health needs in the time of emergency, other than providing ‘business as usual’ – individually focussed health care. That the community reported greater respect for the health advice from health professionals suggests that health information provided by health providers stands the greatest chance of being adopted, and being adhered to. This factor becomes significant when information is aimed at altering human behaviours, such as chemical handling.
Conclusion

Agricultural production's financial contribution towards the states' economic wealth is well recognized by agricultural departments, which in turn support their industry, and production needs. However due to the small workforce involved, their specific health needs, which arise directly from agricultural activity, appear not to receive similar support from health departments. That organic production comprises a very small fraction of the current agricultural industry, suggests that the trend towards long-term use of AgVets can be expected, and the problem of human exposure will persist for some time. The Hume Region exemplifies the worse health status experienced by rural populations than their urban counterparts on almost all parameters. Exposure to AgVets may contribute to this health differential.

Demographics of the region typify rural regions, where higher proportions of the populations were born in Australia, from Anglo- European heritage, and who speak English at home, than in urban regions. Education and income levels are also lower. The sample population contributing to the study was representative of the Hume Region, and the two communities were similar although North East residents were slightly older, and had worked for fewer years in agriculture.

The communities studied are serviced by a range of primary health care services, but none are trained to provide environmental health services that focus on human health service delivery. The Strahan report, which evaluated health effects of the 2002-2003 summer bushfires in the North East of Victoria, presented timely evidence of the contrast between the community's need for expert health advice in times of local environmental crisis, and that which health providers were actually skilled and sufficiently knowledgeable to provide. This report confirmed previous research demonstrating that health advice emanating from health professionals was regarded as the most credible source (Petts J and Niemeyer S 2004). The anomaly lies in that this attitude persists even though health providers do not meet the expressed need, which may help explain the dissatisfaction expressed by communities when health advice from providers is not forthcoming.
CHAPTER 7
COMMUNITY PERSPECTIVES

Introduction

An evaluation of how well Australia's primary health care system addresses exposure to AgVets necessitates a determination of whether AgVet exposure levels among rural populations are, or have been, sufficient to produce deleterious health impacts. The CATI survey was devised to collect this information, through which 1050 households (housing 3169 people) completed the survey in March – April 2003. The mean number of people per household was 3.02, and 48% of households has two or less people residing therein. This figure represents almost one quarter of the available households in the regions surveyed. Two rural communities were surveyed about various aspects of their AgVet exposure, and the CATI findings are presented in this chapter.

The CATI survey returned a response rate of 67%. External validity is predicated upon ensuring the sample is representative of the total population. Returning a 100% response rate is ideal, but unrealistic, and all surveys must contend with refusals. Efforts must then be made to determine whether those refusing were representative, or share a similarity which would effectively lead to a skewing of the data. Reasons for the 526 refusals varied, 34% said they were either too busy, they receive too many requests for interviews, or they just do not do them, and a further 31% offered no reason. A small proportion (3%) volunteered that they did not trust bureaucracies and governments, and ‘meal time’ was given by 1%.

The decision to participate is higher among those who support the subject matter. The group of interest here, in terms of assessing validity, are those who gave no reason. It is likely that a proportion of those were not either interested in the topic, or felt antagonistic for the view that AgVets cause ill-health. Two of those expressed the sentiment that “chemicals are harmless, we have worked with them for years, it is all a beat up,” and no doubt others felt the same, but did not articulate the view. The 164 people, who comprised the 31% who refused without reason, form 10% of the eligible people contacted. This figure has the capacity to skew the data towards presenting a higher degree of community concern than actually exists. That achieving targeted interviews with actual current fruit growers was often difficult, although the timing fell during the later stages of harvest, adds support to this possibility.

Presented alongside the CATI findings is the additional data gathered from targeted interviews conducted to explore in greater depth, the sentiments of relevant community sectors. These were held
with fruit growers, tobacco farmers, fruit pickers, and in open community meetings held soon after the survey was completed.

This chapter reports on community views about whether exposure patterns posed a health hazard for rural Victorians, to the extent to which they attribute their ill-health to AgVet exposure, and how their perception about the responsiveness of the primary health care workforce. The first sections deal with exposures, and situations leading to risky exposure, including application frequencies. Then community understanding of the hazardous nature of chemicals, their frequency of wearing personal protective equipment (PPE), and efforts taken to avoid exposure are presented.

Participants were also asked questions relating to their health status, whether AgVets contributed to their health problems, and who they would consider visiting if or when they suspected an exposure related illness. Presentation of findings compares differences between the regions or industry, according to which is most relevant, such that where findings in both localities were comparable, the data for both were pooled.

The data were analysed using SPSS. Descriptive statistical analysis of the results is presented in the following sections. Some manipulation of the data was required for the analysis, responses of “do not know” or “not applicable” were removed from the sample, and the resulting sample size given.

The discussion section looks at the implications of these findings for primary health care workforce planning.

**Reported Exposure to Chemicals**

A determination of AgVet exposure risks facing rural Victorians involves an exploration of exposure pathways encountered. Exposures can be direct and known to the individual, or indirect and not readily detectable. Activities such as mixing, handling, and the application of these AgVet chemicals, plus working among crops during the immediate post-application period are classified as high risk activities (Coronado GD, Thompson B et al. 2004). Additional health hazards emanate from the contamination of mixing areas, sheds, clothing and domestic settings (Ashford N and Miller C 1998). These exposure risks are highest for the farming families (Gladen BC, Sandler DP et al. 1998), and these were explored in detail. Survey respondents reported high risks for exposure via these other pathways. Agricultural
chemicals were stored on the premises in 73% of properties across the NE and GV regions surveyed, and 77% apply chemicals near the house.

Exposure to chemical droplets may occur via spray drift for those in proximity to farms, such as neighbours and those traversing agricultural regions. Exposure pathways take on an insidious nature when they result in contamination of potable water for neighbours, which occurs when spray drift settles on rainwater catchment surfaces such as rooftops, or when run off contaminates rivers and streams, or seeps into underground aquifers contaminating bore water (Steenland K 1996; Burau K and Cooper SP 2004). These pathways create additional exposure risks for farmers and their families, plus they also expose those living in proximity, but who are not actively engaged in agriculture, so the impact can be felt across entire rural communities. Considerable potential therefore exists for chronic AgVets exposures for Australian farmers, their families and neighbours, where chemical application is frequent.

**Exposure through working directly with AgVets**

Exposure was measured in terms of years of working with AgVets, and frequency of application. Exposure to AgVet chemicals was high among the communities surveyed, with some regional differences between the two in terms of numbers of different chemical agents involved, years spent working in agricultural settings, and frequency of chemical applications. Of the 1050 households surveyed, 63% had members who had worked ‘closely’ (defined as ‘potential for skin contact’) with AgVets (660 households housing 2057 people), 36% reported that no one had worked that closely, and 1% reported ‘don’t know’.

Table 7.1 presents the utilisation of various chemical groups for horticulturalists, and stock workers. The most broadly used agents reported in this sample were horticultural chemicals, even for farmers who worked with livestock. Working with a broad array of chemical agents was common; 621 households (59%) worked closely with veterinary chemicals, of these 98% had also worked with a range of horticultural chemicals, whereas 899 (86%) households had members who worked closely with horticultural chemicals, and of these, 66% had also worked with veterinary chemicals. Evidence suggests health risks may be exacerbated when working with multiple chemical agents as two or more compounds can show additive, synergistic, or antagonistic interactions; alternatively chemicals may act on totally different systems and thus not interact (Carpenter DO, Arcaro KF et al. 1998).
Farmers also use industrial chemicals to maintain their heavy machinery and equipment, which further expands the range of chemicals to which rural people are exposed. Additionally, it is common practice for farmers and their families living on smaller acreages to supplement their income through off-farm income. Invariably some instances will involve industrial settings. Chemical exposure through non-agricultural settings was reported, yet this was not investigated in depth.

**Table 7.1 Proportion using chemical groups**

<table>
<thead>
<tr>
<th></th>
<th>Livestock N = 961 (91.5% of total sample)</th>
<th>Commercial Horticulture N = 825 (58.6% of total sample)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinary chemicals</td>
<td>63.3</td>
<td>54.7</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>40</td>
<td>33.1</td>
</tr>
<tr>
<td>Hormone Growth</td>
<td>8.5</td>
<td>8.2</td>
</tr>
<tr>
<td>Promotants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drenches</td>
<td>57.8</td>
<td>48.8</td>
</tr>
<tr>
<td>Lice control agents</td>
<td>43.1</td>
<td>35.5</td>
</tr>
<tr>
<td>Fly strike chemicals</td>
<td>37.1</td>
<td>31.0</td>
</tr>
<tr>
<td>Sheep dips</td>
<td>23.8</td>
<td>20.5</td>
</tr>
<tr>
<td>Testosterone</td>
<td>6.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Horticultural Chemicals</td>
<td>86.1</td>
<td>84.8</td>
</tr>
<tr>
<td>Herbicides</td>
<td>61.2</td>
<td>62.5</td>
</tr>
<tr>
<td>Pesticides</td>
<td>58.7</td>
<td>60.6</td>
</tr>
<tr>
<td>Fungicides</td>
<td>41.3</td>
<td>45.5</td>
</tr>
<tr>
<td>Insecticides</td>
<td>51.9</td>
<td>54.1</td>
</tr>
<tr>
<td>Roundup</td>
<td>81.7</td>
<td>79.6</td>
</tr>
</tbody>
</table>

Explanation: 961 of the 1050 households surveyed had members who worked with livestock, and 63.3 per cent of these reported having members who worked (or had worked) with veterinary chemicals.

Duration of exposure is associated with total chemical burden and hence determines risk. Forty-five percent of GV participants reported working in agricultural settings for over 30 years, compared to 31% of NE households. Exposure for these people has therefore been longstanding, which carries the dual impact of exposure occurring over many years, with the resulting cumulative chemical burden, but also suggests that many residents were exposed to commonly used agents (DDT, Dieldrin, Paris Green and others) which were subsequently banned from sale when their extremely toxic properties became evident. Tobacco emerged as the dominant industry in the North East region in 1931 (Talbot D 2002), and was accompanied by heavy usage of these organochlorines, and arsenic. Seventy percent of NE households surveyed reported that family members had worked with tobacco, compared to only 1% of GV residents. Orchardists also used chemicals now withdrawn from sale due to unacceptable health risks. Of the entire sample, 36% reported having family members who had worked closely with dieldrin and DDT, and this figure rose to 49% in households where members had worked in agricultural settings.
AgVet usage was reported by 63% of the GV region, compared to 56% of NE residents, although the frequency of utilization was significantly higher in the NE (Figure 7.1). Periods of intense activity increase the exposure load. Frequency of application of AgVets varies throughout the year, and usage is often seasonally dependent. Those working with AgVets reported doing so regularly, 47% use AgVets daily, and a further 35% reported weekly use, such that at certain times of the year, chemical usage occurred weekly or more often for members of over 82% of these households. For the entire sample, 29% used chemicals daily, 52% used them weekly or more often, and the remainder all said the used AgVet occasionally – which included domestic usage.

Figure 7.1 Frequency of AgVet use by region (Base: Users of AgVets n = 629 households)

Being placed at risk of exposure as an employee was reported by 51% of households. Targeted interviews in the NE region revealed that spraying continued whilst they were working amongst the plants during activities such as pruning. These people claimed this direct exposure resulted in a variety of health symptoms. This practice was especially prevalent among selected vineyards, whereas workers from other vineyards reported vigorous adherence to occupation health and safety criteria.

**Exposure via spray drift**

Exposure to chemical via spray drift presents several dangers to human health (Public Health Division 1998; APVMA 2003). The APVMA has published guidelines regarding the application of chemicals via spray equipment specify nozzle characteristics and climatic conditions, yet despite this, high incidences of exposure to spray drift were identified. In contrast to the reports documented in Diann Talbot’s history
of tobacco production in Ovens Valley, little reference was made by North East respondents in this survey to exposure events resulting from current aerial spraying applications. Table 7.2 shows that exposure to spray drift was more commonly reported in the Goulburn valley region where only 14% of respondents reported ‘never being exposed’, compared to 26% for those living in the North East. The proportion of Goulburn valley residents who reported being exposed ‘many times’ was 36%, in contrast to 23% in the North East. Spray drift therefore presents a hazard in both regions, but this is intensified in the GV region.

Table 7.2 Frequency of exposure to spray drift

<table>
<thead>
<tr>
<th></th>
<th>North East</th>
<th></th>
<th>Goulburn Valley</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>Cumulative percent</td>
<td>Percent</td>
<td>Cumulative percent</td>
</tr>
<tr>
<td>Yes - Many Times</td>
<td>22.6</td>
<td>22.6</td>
<td>35.8</td>
<td>35.8</td>
</tr>
<tr>
<td>Sometimes</td>
<td>30.4</td>
<td>53.0</td>
<td>31.5</td>
<td>67.3</td>
</tr>
<tr>
<td>Rarely</td>
<td>21.0</td>
<td>74.0</td>
<td>19.1</td>
<td>86.4</td>
</tr>
<tr>
<td>Never</td>
<td>26.0</td>
<td>100.0</td>
<td>13.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These safety breaches are reportedly not minor incidences, several respondents commented that windscreen wipers were needed to clear the windscreen after driving through spray drift crossing public roads in the Goulburn Valley. Such thick spray coverage indicates a serious breach in regard for public safety. The differential between regions may not necessarily reflect variance between the two regions in compliance with regulations, but rather a function of the differing crops and farming techniques. However, farmer education is indicated as further investigation of this issue revealed that much of this exposure risk emanated from poor practice rather than accidental events. The following quote from a farmer in the NE was typical of the incidences described.

“Oh those blokes over at Shepparton! I used to work on the railways, and one day, I was in my truck, near where a farmer was spraying his trees, spraying right up high to get to the tree tops, he came down one aisle – where I was, he came out, turned and went back up the next aisle – but he didn’t turn his gear off. My whole truck was covered in spray, I couldn’t see through the windscreen. It is not as if he couldn’t see me – I was in a truck! And worse still, he continued and did the same up the next row, which is right next to his own house, I could see it going onto his own roof.”

( NE Farmer)
*Exposure through water supply*

Water contamination emerged as a significant concern to the community. The survey was conducted during a protracted drought, and the source of drinking water given in Table 7.3 demonstrates the differing topography, of the two neighbouring regions. NE residents relied on above and underground water supplies, whereas rainwater tanks supplied the majority of households in the Goulburn Valley.

<table>
<thead>
<tr>
<th>Potable water sources</th>
<th>North East</th>
<th>Goulburn Valley</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainwater tank</td>
<td>24.4</td>
<td>77.6</td>
<td>52.5</td>
</tr>
<tr>
<td>Buy in (tanker)</td>
<td>1.2</td>
<td>12.5</td>
<td>7.1</td>
</tr>
<tr>
<td>Town water supply</td>
<td>33.8</td>
<td>28.4</td>
<td>31.0</td>
</tr>
<tr>
<td>Spring / bore / well</td>
<td>33.0</td>
<td>3.6</td>
<td>7.6</td>
</tr>
<tr>
<td>River / creek / dam</td>
<td>25.2</td>
<td>2.5</td>
<td>13.3</td>
</tr>
<tr>
<td>Irrigation channel</td>
<td>0</td>
<td>8</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Spray drift is a major concern in the Goulburn Valley region, and the possibility of chemical sprays drifting onto rooftops and flushing into rainwater tanks places the 78% of the residents who draw their potable water from rainwater tanks at significant risk of chronic exposure to chemicals.

Sourcing household drinking water from irrigation channels presents major health risks, and 82% of these people were aware of a possible risk. Sourcing household drinking water from irrigation channels was limited to the GV region, where 8% of all households surveyed reported sourcing channel water as their sole potable water supply. (During the pilot phase, this unlikely issue was raised by a community health nurse in the GV region, based on her personal experience in a rental property, hence the question was included). During post-survey interviews, farmers described a common practice was to empty their dairy sludge into the channels. Several farmers also stated it was widely regarded as the responsibility of the landowner to control weed growth along the channel banks on their property. Herbicides were routinely used to achieve this goal, and these would invariably wash down into the channel water.

The percentage of the total sample who reported believing their household drinking water is contaminated by AgVet chemicals, via spray drift or other means is presented below in Table 7.4. These data demonstrate low levels of confidence across the entire sample, in the perceived safety of their household water supplies. This varies according to their source of drinking water.
### Table 7.4 Proportion believing AgVets contaminate domestic water supply

<table>
<thead>
<tr>
<th>Possibility of contamination</th>
<th>Dam / river n= 140</th>
<th>Buy In n = 75</th>
<th>Irrigation Channel n = 39</th>
<th>Rainwater tank n= 549</th>
<th>Town supply n = 325</th>
<th>Spring, bore n = 34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>46</td>
<td>45</td>
<td>50</td>
<td>39</td>
<td>42</td>
<td>26</td>
</tr>
<tr>
<td>Possibly</td>
<td>24</td>
<td>19</td>
<td>32</td>
<td>23</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>No</td>
<td>26</td>
<td>34</td>
<td>15</td>
<td>36</td>
<td>33</td>
<td>58</td>
</tr>
<tr>
<td>Don't know</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total %</td>
<td>99</td>
<td>99</td>
<td>100</td>
<td>101</td>
<td>101</td>
<td>101</td>
</tr>
</tbody>
</table>

It can be seen from Table 7.4 that residents have greatest faith in the purity of their drinking water if sourced from bores or wells on their own property, however numerous studies have found that underground aquifers in the Ovens and King Valleys, and Shepparton region are contaminated with DDT, dieldrin, plus the metabolites of these, atrazine and others (McKenzie Smith F 1990; Bauld J, Evans WR et al. 1993; Sinclair, Knight et al. 1997; Wenig D and Lawrence CR 1998). Contamination of bore water in the NE is of significant concern as 33% of NE residents reported sourcing their drinking water from underground sources. The fires in the North East just prior to the survey heightened community concern about the quality of drinking water, as ash and debris accumulated in the rivers, clogged the filtration system which supplied Wangaratta. However the GV participants expressed greater suspicion that their potable water was contaminated that those form the NE, where 42% compared to 32% thought their water was contaminated, and a further 21% in each region thought contamination was possible.

### Knowledge of Exposure Health Risks

Information regarding the inherent health hazards associated with AgVet exposure has been in the public domain for several decades. It is vital that all community members are aware of the risks, as use of AgVets is widespread. Households where members only lived in close proximity farms, yet did not house members who actually worked in agriculture also reported high usage of these agents, predominantly herbicides, pesticides, and fungicides. Of the 381 households where no-one worked ‘closely’ with AgVets, 66% reported that household members had worked with horticultural chemicals, 36% had worked with veterinary chemicals, mainly drenches, antibiotics, and sheep dips, and 61% had repeatedly used Roundup.
In order to purchase ‘restricted’ chemicals, farmers are required to undertake one of the chemical handling education courses offered by a range of nationally registered training organisations (Department of Primary Industries 2005). Chemical handling courses are not required to purchase, or apply other chemicals. The principal provider in Victoria is ChemCert. The Course coordinator asserts that 40% of Victorian farmers have undertaken their course, which is high by national standards (Brimson A Victorian ChemCert Coordinator 2004). For farmers in this survey who reported working ‘closely’ with chemicals, 45% in each region had taken the ChemCert Course or similar. The thinking behind these programs is that knowledge of correct chemical handling techniques, and an understanding of health risks inherent in exposure will translate into adherence to safety measures, a central component of which involves the wearing of personal protective equipment (PPE). Frequency of wearing PPE was used as a proxy measure for awareness of risks associated with AgVet exposure, and attempts to limit self-harm.

Perceptions of risk are highly subjective, and the value people place on preventive behaviours depends in part upon the way a particular risk is presented and the type of risk it is. People are willing to accept greater voluntary risks than involuntary (Plous S 1993). Plous ascribes chemical risks as ‘unknown’ which he describes as “judged to be unobservable, unknown, new and delayed in their manifestation of harm”. Yet AgVet chemicals are feared. Risk researchers plot exposure to pesticides second only to nuclear weapons fallout in terms of ‘unknown’ and dread factor among the general population (Kammen DM and Hassenzahl DM 1999). The level of control that farmers have over their personal exposure makes their risk voluntary, which may help explain their higher willingness to forego personal protection, whereas those who feel they are involuntarily exposed to spray drift, or water contamination, express a sense of outrage through their lack of personal control over their exposure.

Wearing of PPE can significantly reduce exposure risks for those working with AgVets (Keifer MC 2000). Questions relating to the wearing of PPE were analysed for the entire sample, as evidence presented in Chapter 2 established that exposure timing is a critical factor in eliciting deleterious health effects, hence single doses can be damaging. Therefore even infrequent users can be affected. Although the proportion of the entire sample surveyed reporting ‘close’ contact with AgVets was 63%, a total of 86% reported ‘sometimes’ using horticultural chemicals, such as pesticides. Only 24.4% reported using PPE always when mixing, handling or applying chemicals, and a further 11.3% reported ‘mostly wearing PPE’. This

---

4 This “requirement” is not enforced. It was widely reported that restricted agents were able to be purchased without the necessity to show evidence of having undertaken a course.

5 Restricted chemicals are: dangerous poisons (Schedule 7 poisons) that are agricultural chemicals, products containing atrazine, products containing metham sodium, Pindone concentrate (products containing 2.5% or more of pindone), products containing ester formulations of 2,4-D, 2,4-DB, MCPA and triclopyr.
leaves 64% of household members reportedly only sometimes, rarely, or never wearing protective equipment when mixing, handling or applying chemicals. No difference in this practice was observed between the two study regions.

Of the households reporting that the principal chemical handler had completed a chemical users course, 58% responded that they ‘mostly’ endeavoured to wear protective gear, compared to 36% of those who had not taken such a course. Several studies have demonstrated that failure to take personal precautions when in contact with chemicals is associated with higher rates of ill health of the farmers (Acquavella 2004), and their families (Flower KB, Hoppin JA et al. 2004). Reasons cited for reluctance to self protect are given in Table 7.5 below. The results reveal little variation in the rationale for not wearing PPE between those who had received chemical training, and those who had not. The unexpected finding is that little difference existed between these two groups in regarding whether chemical exposure has the potential to cause harm.

**Table 7.5 Reasons for not wearing PPE when handling AgVets**

<table>
<thead>
<tr>
<th>Reasons for not wearing PPE</th>
<th>% of all respondents N= 1050</th>
<th>% of those who work closely with AgVets N =629</th>
<th>% of those who have completed Chemical users course N = 283</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too inconvenient / time consuming</td>
<td>13.3</td>
<td>20.5</td>
<td>28.0</td>
</tr>
<tr>
<td>Uncomfortable / too hot</td>
<td>7.1</td>
<td>11.6</td>
<td>15.9</td>
</tr>
<tr>
<td>Focus more on the job – not myself</td>
<td>8.4</td>
<td>13.2</td>
<td>14.1</td>
</tr>
<tr>
<td>Do not read the instructions</td>
<td>1.7</td>
<td>2.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Don’t think chemicals will cause any harm</td>
<td>14.7</td>
<td>23.5</td>
<td>23.8</td>
</tr>
<tr>
<td>Did not know we should when I was farming</td>
<td>12.8</td>
<td>20.2</td>
<td>13.4</td>
</tr>
<tr>
<td>Don’t know</td>
<td>2.6</td>
<td>4.1</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Further analysis was performed on these data to investigate comparisons of the practice of ignoring personal protection between those who have, and have not received specific training in chemical handling. It was found that of those who “do not read the label instructions”, 38% have taken a chemical users’ course, and 39% of those who “think the agents will not cause any real harm” had also undergone chemical handling education course. Whilst these figures leave scope for further improvement, their reported rate of wearing PPE was significantly greater than AgVet users who have not completed a course ($\chi^2 = 61.13$, p<0.001).
This result confirms findings of previous studies, where six-month post-intervention analyses showed that an educational intervention had significant improvement in the use of gloves and gear during the most recent application, but had limited success in achieving full PPE compliance (Perry MJ 2003).

The general message that all chemicals can be hazardous appears not to have been internalized by the group who had received chemical handling training courses, as their chemical avoidance behaviour did not extend beyond the wearing of PPE. These households consistently reported adopting fewer strategies to avoid general chemical exposure ($\chi^2 = 7.23, p < 0.01$). Table 7.6 presents the comparison in domestic chemical usage between households where the principal household chemical user has received education on safe application of AgVets and their risks of exposure, with households without such education. Households without such a course, encompass those who reported not working ‘closely’ with AgVets, that is, includes non-farming households. It can be interpreted from these data that non-farming households adopt more chemical avoidance practices than farming households. It is possible that farmers’ willingness to voluntarily adopt risk of exposure to other chemicals is based on a lessening of fear after gaining familiarity with working with AgVet chemicals. Cognitive attitudes determine behaviour, so understanding the rationale for this lack of caution is significant for health promotion attempts to improve chemical handling, however this cannot be determined from this study however, and requires further research.

**Table 7.6 Domestic chemical usage**

<table>
<thead>
<tr>
<th>Chemical utilisation</th>
<th>All (%)</th>
<th>Chem Users Course (%)</th>
<th>No Chem course (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply chemicals near the house – eg round up on the vegetable garden</td>
<td>75</td>
<td>78</td>
<td>69</td>
</tr>
<tr>
<td>Treat the house for white ants</td>
<td>62</td>
<td>66</td>
<td>57</td>
</tr>
<tr>
<td>Use domestic chemicals readily (without restrictions) eg. Insect sprays, weedkillers.</td>
<td>27</td>
<td>29</td>
<td>23</td>
</tr>
<tr>
<td>Use domestic chemicals only in extreme conditions</td>
<td>22</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Wash vegetables to remove residual chemicals (rate of home vegetable growing was equal)</td>
<td>85</td>
<td>83</td>
<td>91</td>
</tr>
<tr>
<td>Buy organic where possible</td>
<td>30</td>
<td>26</td>
<td>36</td>
</tr>
<tr>
<td>Take nil action to reduce personal chemical exposure</td>
<td>7</td>
<td>9</td>
<td>4</td>
</tr>
</tbody>
</table>

Application of risk minimisation falls into two categories, protection of self (and family), and occupational health and safety adherence in employer / employee situations. In an unregulated industry, such as agricultural labour, the responsibility for personal protection such as wearing personal protective
equipment (PPE), such as gloves, masks, ear muffs, splash protective overalls or similar, and rubber boots for the purpose of avoiding personal injury often falls with the individual.

Australian farms are 95% family owned and operated, therefore the majority of agricultural workers in Australia are family members. The exception to this occurs in the major horticultural areas across Australia, especially during harvest season, where intense activity occurs simultaneously throughout the region. Operational pressures to pick the fruit at its optimum ripeness necessitate employment of additional fruit pickers to boost the locally available labour force. Employers have a responsibility to provide equipment, and ensure that staff are trained, and comply with safety measures. Labour shortages in these regions present an annual challenge, as it is argued that the working conditions are difficult, and salaries for labour regarded as unskilled, are low.

Interviews with itinerant fruit pickers based at a hostel in Shepparton/Mooroopna revealed that over 83% said that personal protective equipment was offered to them. Only 48% stated that wearing of safety equipment was ever enforced. Fruit picking in this region falls in late summer where the temperature in the shade is frequently in excess of 40°C for up to 10 consecutive days. The work is physically hard, and demands dexterity and agility, which can be hampered by the wearing of gloves and overalls. Fruit pickers are reimbursed per volume of fruit picked. The pressure to increase income may affect the personal choice to don PPE if pickers believe that PPE reduces their picking speed. Stringent chemical residue limits restrict application of chemicals on foods soon to be harvested for the export market, which may help explain that GV pickers reported little direct exposure to chemical sprays occurred during picking season.

**Health Conditions Reported**

Little research has been published in Australia exploring chemical exposure attributed to specific agricultural pursuits and associated health problems. This CATI study surveyed two rural communities where intensive agriculture occurs. All respondents had either lived in close proximity to farms (within 3 kilometres), or had household members who had worked in agricultural settings. Given the high use of chemicals, and frequent reporting of exposure to spray drift, plus the possibilities of potable water contamination, it can be assumed that all respondents carry some exposure burden. Gradients of exposure exist, so it can also be assumed that those who have long histories of close contact with AgVets carry a higher chemical burden.
The survey did not include a specific control group which was not exposed to AgVets. AgVets include insect sprays and skin repellents; therefore all households reported using some agents. Practical problems prevented establishing a control group where nil-exposure had occurred, and the study took a more generic approach, and focussed on total exposure risk. There were low exposure households, and high exposure households. Analysis of the following sections of self reported health problems was preformed using cross tabulations. Comparisons were made with the 39% of households who reported that no member had worked “closely” (defined as close enough to have skin contact) with AgVets, and those reporting that they had either not used the agents in question, nor had been actively involved in the type of agricultural production. That is, comparisons given in the analysis are between rural people engaged in different agricultural practices, and exposed to differing chemical groups.

The effect of having no ‘unexposed’ group serves to diminish the differential between groups in levels of reported health complaints, which would result in an underreporting of exposure effect. As outlined in the methodology chapter, the purpose of the study was not designed to demonstrate causal effect between exposure and ill-health. The aim was to determine whether existing exposure patterns to AgVets places Victorian agricultural communities at risk, their self-reported health status, and their level of concern about causation from environmental exposure, contrasted against environmental services available within the primary health care sector.

Evidence in the literature links AgVet exposure with a range of conditions, including neurobehavioural changes and suicidal ideation (Sanborn M, Cole D et al. 2004). Comparisons with groups who either used different chemicals, or did not work in agriculture, revealed associations of significant health impacts with specific crop or stock production, and with exposure to broad chemical groupings. Tables 7.7 to 7.9 presented in the following pages links the range of reported exposures, categorized by industry, with systemic health problems reported by survey respondents. Several other identified health impacts fell marginally short of statistical significance, although comparisons with non-exposed groups, such as urban populations, may reveal significantly valid results for these conditions. Analysis was performed across both regions as the primary issue is the chemical groupings, which determines exposure, rather than location. The statistical package, SPSS was used to compare results between rural households who engaged in different agricultural industries or activities. Comparative data for all Victorians across this range of general health conditions are not available.

Eliciting information about health problems experienced by household members was achieved by asking “Does the primary worker with AgVets suffer problems with ….?” Where appropriate, qualifying phrases
were added to eliminate common conditions, such as for eyes “other than eyesight”, and for ears “other than hearing”, and nose and lungs “other than colds and chest infections”. Participants were also asked whether household members had been diagnosed with specific disorders such as Chronic Fatigue Syndrome (CFS), or Multiple Chemical Sensitivity (MCS).

The broad range of health impacts demonstrated in the following tables suggests exposure to chemical agents used in each of the industries presents serious health risks. Whilst the community survey was not designed to show causality, these findings provide strong associations with poor health, and indicate a need to further explore these links by appropriately designed epidemiological studies.

The literature review of exposure effects of AgVets indicated the symptoms were wide and varied. The size of the sample and time limitations prevented the questioning of individual conditions. Instead health questions were mostly very broad, such as “Has anyone in your household suffered health problems with the nose or lungs other than colds? Who is that person?”6 Questions also related to reproductive history, such as difficulties falling pregnant, miscarriages, birth of children with disabilities, and other questions sought information about specific symptomatology. These included;

- other unexplained ailments
- unexplained bruising
- unusual taste in the mouth
- changes in behaviour
- inappropriate anger/short temper
- loss of appetite
- vague feelings of unwellness
- confusion, difficulty concentrating
- general or specific aches or pains
- stomach pain

The data in the following tables were analysed using SPSS cross tabulations, comparing for example, those who worked closely with AgVets against those who did not, those who reported working with drenches, against those who reported not. Reports of “Don’t know” in response to health conditions were few in number, and removed from the sample prior to analysis. Similarly, few responses were received regarding the usage of chemical groups, this is thought to be a function of the nature of farm business being conducted “at home”, and often involves family members assisting.

---

6 Household members were listed numerically in chronological order, listing the gender, age group, and general health status. AgVet exposure was also tracked to specific household member.
These data suggest that past exposures to DDT, and dieldrin continue to impact on the health of those exposed. The high frequency of allergy and sensitivity related conditions reported suggests immune dysfunction. Chapter 2 presented evidence linking immune problems with exposure to chlorpyrifos, chlordane and other agents which are used commonly in Australia.

Table 7.7 Self-reported health problems among chemical users

<table>
<thead>
<tr>
<th>Industry Exposure</th>
<th>Health Problem</th>
<th>$\chi^2$</th>
<th>Odds Ratio</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work with AgVets</td>
<td>Allergies / sensitivities</td>
<td>5.11</td>
<td>1.34</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>MCS</td>
<td>3.06</td>
<td>1.95</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Dieldrin, dioxin, DDT</td>
<td>Allergies / sensitivities</td>
<td>7.30</td>
<td>1.44</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>MCS</td>
<td>4.56</td>
<td>2.00</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>2.93</td>
<td>1.28</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Ears</td>
<td>11.94</td>
<td>1.59</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Nose / lungs</td>
<td>2.89</td>
<td>1.13</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Cancer</td>
<td>5.06</td>
<td></td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Drenches</td>
<td>Immune</td>
<td>4.25</td>
<td>1.50</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>CFS</td>
<td>4.71</td>
<td>1.90</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Flystrike chemicals</td>
<td>Chem sensitivity</td>
<td>5.75</td>
<td>2.18</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>HGPs</td>
<td>Allergies / sensitivities</td>
<td>5.32</td>
<td>1.80</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Chem sensitivity</td>
<td>5.82</td>
<td>2.74</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Sheep Dip</td>
<td>Allergies / sensitivities</td>
<td>7.27</td>
<td>1.54</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Testosterone</td>
<td>Chem sensitivity</td>
<td>7.96</td>
<td>3.46</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Veterinary chemicals</td>
<td>Allergies / sensitivities</td>
<td>3.47</td>
<td>1.27</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Immune</td>
<td>4.30</td>
<td>1.52</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>CFS</td>
<td>3.64</td>
<td>1.80</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>MCS</td>
<td>4.81</td>
<td>2.29</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

No significant associations were identified with reproductive problems for those who worked closely with AgVets. The general question of working closely with AgVets also return nil significant association for cancer, however working with Dieldrin and DDT showed positive correlation, $\chi^2 = 4.87$, $OR = 1.36$, $p < 0.05$.

Some differentiation was observable between the regions, ovarian cancer was more prevalent in the NE than GV, $\chi^2 = 4.24$, $OR = 4.45$, $p < 0.05$, as was prostate cancer, $\chi^2 = 3.66$, $OR = 2.68$, $p < 0.05$. Breast cancer was also higher in the NE, but this just fell outside the level of significance at the 95% confidence
limit. The communities living in the Ovens and King Valleys have expressed great concern about the cancer in the region.

**Table 7.8** Self-reported health problems among horticultural workers

<table>
<thead>
<tr>
<th>Industry Exposure</th>
<th>Health Problem</th>
<th>$\chi^2$</th>
<th>Odds Ratio</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut Flowers</td>
<td>CFS</td>
<td>6.63</td>
<td>2.43</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Skin</td>
<td>2.97</td>
<td>1.42</td>
<td>= 0.05</td>
</tr>
<tr>
<td></td>
<td>Nose / lungs</td>
<td>4.25</td>
<td>1.52</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Nerves</td>
<td>7.63</td>
<td>1.76</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Broadacre cropping / Hay</td>
<td>Skin</td>
<td>2.73</td>
<td>1.26</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Fruit or nuts</td>
<td>Difficulties concentrating</td>
<td>6.83</td>
<td>1.43</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Mouth / throat</td>
<td>2.83</td>
<td>1.39</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Nerves</td>
<td>6.50</td>
<td>1.41</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>“Other” problems</td>
<td>3.91</td>
<td>2.17</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Stomach / bowel</td>
<td>4.07</td>
<td>1.32</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Stomach pain</td>
<td>8.14</td>
<td>1.82</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Grapes</td>
<td>Eyes</td>
<td>12.58</td>
<td>1.58</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Muscle</td>
<td>15.48</td>
<td>1.78</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Skin</td>
<td>3.28</td>
<td>1.26</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Stomach / bowel</td>
<td>6.11</td>
<td>1.41</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Hops</td>
<td>Allergies / sensitivities</td>
<td>5.10</td>
<td>1.38</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Stomach / bowel</td>
<td>6.02</td>
<td>1.56</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Tobacco</td>
<td>Allergies / sensitivities</td>
<td>4.59</td>
<td>1.34</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Immune</td>
<td>4.05</td>
<td>1.48</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Mouth / throat</td>
<td>8.87</td>
<td>1.78</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Nerves</td>
<td>13.25</td>
<td>1.65</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Other unexplained unwellness</td>
<td>8.67</td>
<td>1.50</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Stomach / bowel</td>
<td>7.87</td>
<td>1.49</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Vague unwellness</td>
<td>12.06</td>
<td>1.82</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Allergies / sensitivities</td>
<td>5.09</td>
<td>1.45</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Eyes</td>
<td>6.28</td>
<td>1.48</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Giddiness / tingling</td>
<td>4.88</td>
<td>1.52</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>5.19</td>
<td>1.47</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Muscle</td>
<td>14.30</td>
<td>1.88</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Nerves</td>
<td>7.45</td>
<td>1.55</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Nose / lungs</td>
<td>6.17</td>
<td>1.48</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>“other problems”</td>
<td>13.25</td>
<td>3.55</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td></td>
<td>Skin</td>
<td>7.84</td>
<td>1.55</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Stomach / bowel</td>
<td>6.14</td>
<td>1.50</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

Workers engaging with chemicals in the course of fruit, vegetable and tobacco production reported an extensive range of health complaints. Data from this study also revealed that respondents from houses involved in tobacco production reported significantly higher rates of ovarian cancer, $\chi^2 = 5.87$, $p < 0.001$.  

191
Table 7.9  Self-reported health problems of livestock workers

<table>
<thead>
<tr>
<th>Industry Exposure</th>
<th>Health Problem</th>
<th>$\chi^2$</th>
<th>Odds Ratio</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Cattle</td>
<td>Eyes</td>
<td>4.95</td>
<td>1.35</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Mouth throat</td>
<td>3.88</td>
<td>1.52</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Chickens</td>
<td>Ears</td>
<td>3.13</td>
<td>1.55</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Eyes</td>
<td>5.25</td>
<td>1.76</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Giddy nerves</td>
<td>9.20</td>
<td>2.10</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Muscle</td>
<td>5.75</td>
<td>1.85</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Nose / lungs</td>
<td>4.50</td>
<td>1.69</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Stomach / bowel</td>
<td>18.00</td>
<td>2.78</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Dairy Cattle</td>
<td>Heart</td>
<td>6.04</td>
<td>1.42</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Nose / lungs</td>
<td>7.59</td>
<td>1.43</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Skin</td>
<td>5.12</td>
<td>1.33</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Livestock</td>
<td>Muscle</td>
<td>3.57</td>
<td>1.75</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Skin</td>
<td>6.98</td>
<td>1.82</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Pigs</td>
<td>Ears</td>
<td>4.28</td>
<td>1.59</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>3.44</td>
<td>1.55</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Giddy nerves</td>
<td>6.72</td>
<td>1.79</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Muscle</td>
<td>11.46</td>
<td>2.16</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Nose / lungs</td>
<td>8.19</td>
<td>1.88</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Skin</td>
<td>5.55</td>
<td>1.71</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Stomach / bowel</td>
<td>5.39</td>
<td>1.70</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Sheep</td>
<td>Heart</td>
<td>5.64</td>
<td>1.42</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Hodgkin’s</td>
<td>2.6</td>
<td>1.36</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Immune</td>
<td>2.99</td>
<td>1.41</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td></td>
<td>Nose / lungs</td>
<td>3.39</td>
<td>1.29</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td></td>
<td>Stomach / bowel</td>
<td>10.13</td>
<td>1.58</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

Those working in the chicken, sheep and pig industries reported a broad range of health problems. Sheep producing households also reported an increase in cancers of the lymph or blood, $\chi^2 = 4.17$, $p < 0.05$. This confirms the findings of Spurgeon’s study, and Sanborn’s systematic review of Pesticides (Spurgeon A 2002; Sanborn M, Cole D et al. 2004).

High levels of a range of sensitivities were reported. Respondents could nominate pollens and grasses, foods and food additives, and chemical groupings which elicited sensitivities. These included AgVets, industrial chemicals, everyday chemicals, with examples of household cleaning agents, paints, soaps, perfumes, detergents or garden sprays. In total, 22% of households reported housing family members with sensitivities, and sensitivity to AgVet chemicals was reported by 12% of families’ principal chemical users. Exposure to horticultural chemicals showed the strongest link with chemicals sensitivities, 12.7% compared to 9.2% in non-horticultural users. For herbicides the comparison was 14.7% to 7.3% ($\chi^2 = 12.88$, $p \leq 0.01$), and for fungicides, the comparison was 17.1% compared to 8.1% ($\chi^2 = 19.93$, $p \leq 0.01$).
In general, pesticides usage was associated with sensitivities 4.8% compared to a figure of 1.9% among those who did not use pesticides ($\chi^2 = 6.34$, OR 2.66, $p \leq 0.05$). Ninety seven percent of cases of diagnosed chemical sensitivity occurred in people who have worked with horticultural chemicals ($\chi^2 = 4.42$, $p \leq 0.05$).

It was common for the eldest person in the household to be the principal user of chemicals. Table 7.10 below provides a comparison of reported sensitivities between those persons exposed to AgVets and dieldrin, with those who had not been exposed. Exposure was associated with significant increases in sensitivities. Although over 25% were sensitive to pollens and grasses, this was not significantly higher than for the eldest person in households who had not worked with these agents.

### Table 7.10 Chemical sensitivities experienced by the eldest members of household, and exposure to AgVets, or Dieldrin

<table>
<thead>
<tr>
<th>Sensitivity to ...</th>
<th>Eldest worked with AgVets</th>
<th>Eldest worked with Dieldrin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\chi^2$</td>
<td>OR</td>
</tr>
<tr>
<td>Everyday chemicals</td>
<td>4.19</td>
<td>1.54</td>
</tr>
<tr>
<td>Ag Chemicals</td>
<td>24.05</td>
<td>3.55</td>
</tr>
<tr>
<td>Industrial chemicals</td>
<td>7.19</td>
<td>2.26</td>
</tr>
</tbody>
</table>

Allergies and sensitivities are indicative of immune impairment. Chapter Two provided substantial evidence linking subtle widespread immunological impairments with chronic exposure to environmental chemicals via a decreased cell mediated immunity and 70% decrease in antibody formation (US National Research Council 2000; Bilrha H, Roy R et al. 2004). The observed rise in allergenicity witnessed in many countries is attributed chemical exposure, and these findings suggest rural Victorians are also being affected by chemical exposure.

Miscarriages were reported by 27.3% of households. Workers involved in fruit and nuts production reported a rate of child physical disability of 10.1% compared to 5.9% for non fruit growers ($\chi^2 = 6.44$, $p \leq 0.05$), and a rate of a pregnancy resulting in a child with an intellectual disability of 4.1% compared to 2.0% ($\chi^2 = 5.34$, $p \leq 0.05$). No increase in known rate of miscarriage was reported by this group. Use of horticultural chemicals was reported by 85% of fruit and nut producers. Epidemiological studies have demonstrated an increase in the frequency of a congenital abnormality as exposures rise (Longnecker
MP, Klebanoff MA et al. 2001). The reproductive data must be treated with caution as the numbers involved were small, additionally, the impact of higher exposures can be diminished because affected foetuses with severe problems results in death in utero, and these miscarriages may or may not be identified by the parents (Bailer and Bailer 2001).

**Perceived Link: AgVet Exposure and Family Ill-health**

The North East segment of the Hume Region the orchard growing regions of the Goulburn Valley near Shepparton have also been the subject of ongoing health concerns for the local community. Preliminary investigations before commencing this study revealed that those living within the orchard regions had repeatedly been exposed to spray drift, either when moving through or near the orchards (unavoidable as neighbours), or by having the spray drift across to their houses, clothes liens, gardens, and roof tops where their drinking water is collected. The following examples indicate the nature of these incidences, and perceptions of ill health resulting from exposure:

“I could tell when the spraying season was on, you could always smell it in the air. Our entire family came down with headaches, rashes, the children were sick. The neighbours all said they were crook too, but our GPs don’t say anything, they are not interested. What can we do?”

(Shepparton Nurse)

“I couldn’t go outside. The washing on the clothes’ line came in smelling of chemicals. It wasn’t only the farmers near us, half my friends at play group, living all around this area, we all had lots of stories of being sprayed nearly every time we went out. Sometimes we would have to put the windscreen wipers on after being sprayed, so we could see to drive. They are not supposed to spray so it goes towards your house, but how do you stop them?”

(Shepparton East Nurse)

“My daughter got chronic fatigue syndrome during year 10, and the specialist in Melbourne said she was one of the worst cases they had seen. My husband stayed home to look after her, after a year and a half at home with her, he got it. Then my son did. We moved house.

(Shepparton La Trobe Staff Member)

“I have worked as a nurse for over twenty years, and I thought I could navigate my way through the health system. But do you think I could find someone who would take me seriously? They think you’re loonie if you mention that you think it is the sprays that keeps you bringing your family in. Sure they are all vague symptoms – but it happens every year at this time. I’m not the only one. And I know the orchards are what keeps Shepparton alive. But we’re selling up, we have to, it will cost us – but our health is more important”

(Shepparton Nurse)

The CATI survey revealed the communities studied are highly concerned about their exposure to environmental hazards, confirming the Starr study, and given during the preliminary investigation carried out prior to the study. Survey respondents were asked if they believed that existing health problems in their family resulted from exposure to environmental factors, and the responses were divergent - ‘yes
definitely’ (16%), ‘yes probably’ (7%), ‘possibly’ (15%) ‘no unlikely’ (24%), ‘no definitely’ (32%), and ‘do not know’ (6%). The 38% who responded they believed the link possible ‘or more likely’, were further probed as to which specific factors within the environment were believed principally responsible.

For households where a family member had immune system health problems, this figure rose to 61.3%, and 57.1% in households with a member who had contracted cancer of the blood or lymphatic system. Households with a member who currently suffers, or has suffered major illness tended to associate the illness with exposure to AgVets. For example households with cancer believed the disease was related to AgVets exposure ($\chi^2 = 15.58, OR = 1.71, p <0.001$). Those with a child born with a physical disability believed it was likely that exposure to AgVets played a causative role, $\chi^2 = 6.91, OR = 2.07, p<0.01$), as did parents of a child with an intellectual disability ($\chi^2 = 12.89, OR = 2.72, p < 0.001$).

Of households in which someone has worked ‘closely’ with AgVets (n= 660), 29% reported they believed that exposure to AgVets had already caused direct health problems in their families. The majority of the households who reported nobody working ‘closely’ nevertheless worked with AgVets, 65% with horticultural, and 36% with veterinary chemicals. Those working closely with AgVets were significantly more likely to believe that health had suffered as a consequence than those who worked with AgVets, but not closely, ($\chi^2 = 11.57, p = 0.001$). The proportion of people believing AgVets had caused illness in the family varied from 25% to 34% between different groups within the sample population. Table 7.11 demonstrates the strengths of the beliefs that AgVets were responsible for various industries, chemical use, and selected disorders. (The data for this analysis was recoded where Yes encompasses responses of ‘Yes definitely’ and ‘Probably,’ and No covered ‘Unlikely’ and ‘No definitely’).

Table 7.11  Reported belief that family health problems relate to AgVet exposure

<table>
<thead>
<tr>
<th>Population group</th>
<th>% Yes</th>
<th>$\chi^2$</th>
<th>OR 95% CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco growers</td>
<td>25.3</td>
<td>8.67</td>
<td>1.50</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Vegetable growers</td>
<td>33.5</td>
<td>12.06</td>
<td>1.61</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Fruit Growers</td>
<td>29.4</td>
<td>14.38</td>
<td>1.55</td>
<td>= 0.01</td>
</tr>
<tr>
<td>Worked with AgVets</td>
<td>29.2</td>
<td>11.57</td>
<td>1.43</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Exposed to Dieldrin</td>
<td>30.4</td>
<td>10.73</td>
<td>1.49</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Chemical users</td>
<td>29.3</td>
<td>7.35</td>
<td>1.49</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>High chemical users</td>
<td>29.5</td>
<td>17.08</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>People with sensitivities or allergies</td>
<td>33.0</td>
<td>47.48</td>
<td>3.06</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Households experiencing cancer</td>
<td>33.7</td>
<td>21.41</td>
<td></td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>
Respondents were also invited to provide text responses to articulate their views on a perceived link. Several respondents from the North Eastern section referred to community attempts to encourage the DHS to initiate a study into cancer rates in the Myrtleford region over a decade ago, and viewed the findings of no increase with deep suspicion. The term “cancer valley” was used by many residents to describe their home district near Myrtleford. One respondent reported “My husband died of cancer, and then my son, and two of our close neighbours got cancer, and one of their dogs too. And they try to tell you it is not the chemicals. No there has been way too much here, but years ago it was worse, they were dropping like flies.” They also spoke of an unusually high rate of learning difficulties, for example “My son cannot read or write. I thought I was alone, but I know of 12 other children here with problems, there is probably more, and that is only in this small area, and the parents aren’t stupid. There is something going on here.” Goulburn Valley residents also referred to broad array of ailments, ranging from cancer to depression (particularly among farming males), learning difficulties and birth defects.

Table 7.11 above shows that between 25% and 34% of respondents believe that exposure to AgVets is ‘definitely’, or ‘likely’ to have caused their existing health problems. However, despite this, only 12% of the sample reported ever being asked by their GP about their usage of AgVet chemicals, this was 14% for high users of chemicals, and 9% of non-users. Divergence in perceived involvement in environmental factors causing ill-health between lay people and health professionals has been commonly reported (Stevens E, Cullinan P et al. 2004). Recent studies have found community perceptions that their health problems result from exposure to environmental health hazards have been validated by epidemiological findings (Moffatt S and Pless-Mulloli T 2003).

The Starr study on perceptions of environmental risk in Australia, noted that the degree exposure regarded as involuntary or imposed heightened perceptions of risk (Starr G, Langley A et al. 2000). With respect to AgVet exposure, a high degree of personal control generally exists for farmers. AgVets are regarded as vital to agricultural production, and economic viability of the farmers and therefore also of the town, according to the phrase often reported that “chemicals are a necessary evil, and must be applied to achieve high yields/maintain productivity”. However not all can determine their personal level of exposure. Lack of personal control exists for some family members, neighbours, and those whose drinking water is contaminated.

Accessing fruit growers groups for interview was problematic. Of the seven people contacted, telephone interviews were achieved with only two, and these were brief. The dialogue used by these suggested an element of defensiveness, as both refused to concede that any element of risk could exist, whilst they
listed the benefits afforded by AgVet application. One argued that all was being done to ensure safety, and that best practice was uniformly adopted throughout the industry such that exposures were not attributing to the ill-health of the region. The second interviewee argued similarly, and stressed that the industry would not exist without AgVets, so that the nation’s food supplies, Australia’s exports and the region’s economy would suffer if moves were introduced to limit their use, and added as a final statement that AgVets were not very harmful, and that community hysteria was unjustified. That these views were expressed by representatives of grower’s groups would indicate that other producers would agree with this analysis of the issue. Some farmers holding these views would have refused to participate in the survey, and an unknown percentage would have participated and argued that AgVet exposure bore no risk. The community is divided, however the findings suggest that the majority accept that exposure can damage their health, and 25% said yes they were willing to discuss further.

A feature of AgVet exposure related causation is lack of certainty in the minds of the community, given the broad understanding of time lag between exposure and onset of health symptoms, plus the confounding effects of having contact with multiple chemical agents. This confusion drives the desire for expert advice. Another relevant feature in interpreting the community assessment of risk through their AgVet exposure rests on human motivation to make sense out of one’s surroundings and involvement, where making sense is determined primarily by coherence (the amount of information presently available), and plausibility (Garling T and Evans GW (eds) 1991).

The low level of GP enquiry about chemical exposure contrasts the respondents desire to gain information from their GPs, regarding them as their preferred source of health information. Advice from health professionals has frequently been rated the most useful source of information about environmental issues concerning general health, and when this information is not forthcoming, the majority of information is drawn from public media (Smith BJ, Eakin EG et al. 2003; Strahan Research 2003; Stevens E, Cullinan P et al. 2004). The Starr study demonstrated that Australians also rate the information given by health professionals as the most useful source of information about environmental issues concerning general health. North East Victorian residents confirmed this view during the Research on the Health Effects of Bushfires in North East Victoria conducted on behalf of the Department of Human Services (Strahan Research 2003). Hume residents reported valuing health advice provided by health practitioners most highly from a list of available sources, despite the fact that during the 2002-2003 summer bushfire crisis little relevant health information was forthcoming from health providers, as 4% reported receiving useful information from their providers.
Satisfaction with Health Providers

Community members were asked to describe their level of satisfaction with primary health care providers they had seen for health care. The question was asked in the context of what strategies are undertaken to alleviate symptoms and learn more about their ill health, and how to best manage it. Participants were offered a range of options for information sources, including the internet, friends, literature, TV and magazines. The following question asked if they had visited a range of health care providers, and were they satisfied with the service provided. Findings are depicted in table 7.12 below. All participants had visited a doctor at some stage, whereas fewer had seen other providers, reflecting both their relative scarcity in rural areas, and limited services offered by nurses in community health care centres.

Satisfaction levels were 84% or higher for nurses, pharmacists, naturopaths and Traditional Chinese Medicine Practitioners, but less than 30% for doctors. No significant differences existed in satisfaction levels with providers between users or non-users of AgVets, nor between the two regions, except that satisfaction with GPs in the NE region was marginally higher in the NE 32% compared to 27.5% in GV.

Table 7.12 Satisfaction with health provider services used

<table>
<thead>
<tr>
<th>Provider</th>
<th>Very satisfied</th>
<th>Fairly satisfied</th>
<th>Combined ‘satisfied’</th>
<th>Not satisfied</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor (n = 1050)</td>
<td>21.2</td>
<td>8.4</td>
<td>29.6</td>
<td>70.4</td>
<td>0</td>
</tr>
<tr>
<td>Nurse (n = 50)</td>
<td>76.0</td>
<td>8.0</td>
<td>84.0</td>
<td>6.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Pharmacist (n = 247)</td>
<td>72.9</td>
<td>17.0</td>
<td>89.9</td>
<td>10.1</td>
<td>0</td>
</tr>
<tr>
<td>Naturopath (n = 125)</td>
<td>69.6</td>
<td>20.0</td>
<td>89.6</td>
<td>8.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Chinese Medicine Practitioners</td>
<td>73.5</td>
<td>14.7</td>
<td>88.2</td>
<td>8.8</td>
<td>2.9</td>
</tr>
<tr>
<td>(n = 34)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The contrast between GPs and other primary health care providers in levels of service satisfaction in stark. Free text responses were collected to further explore the basis of dissatisfaction where apparent. Sources of dissatisfaction with medical services included issues related to difficulties in making appointments on the day (or following day) when symptoms exacerbate sufficiently to motivate them to seek health advice. Shortness of appointment duration and the lack of bulk-billing were also frequently cited. Respondents elaborated on the specific aspect of the health care service they found unsatisfactory, the following examples typify the comments made by community members from both regions.

“My doctor blatantly ignores my suggestions that our family health problems came from the chemicals. He just doesn’t want to hear it. Just orders creams, or tablets, or whatever and gives us certificates. I’d go to another but they are all full, especially the good ones, and we can’t get in.”
“Years ago I was told I was being silly – so I haven’t brought it up again”

“If I raise the possibility of a connection, they just change the subject and move on. I guess they are in a rush, and feel they cannot do anything about it, but I wish they could take more interest and at least listen to me. Who else can we go to?”

“It was a waste of time, couldn’t do anything to help me, so gave me pills, I think just to keep me happy, but they did no good”

“Someone should look at it, the sprays settle in the valleys, there is a lot of sickness in all the homes along here. Too much, I think, even the boysenberries were all deformed this year. But no one takes any interest.”

“I have asked what to look for, you know, direct questions, but I got the short shrift. I seriously doubt they know much about these chemicals.”

“When I raised the chemical connection with the doctor at the clinic, he told me he was in a hurry, had a lot of patients to see, and if I thought it was chemicals, then I shouldn’t go near them. He then just wrote me script and got rid of me.”

“No, they won’t talk about the chemicals, but they do all they can, they are busy. I think they do a good job, and I try not to take up their time”

In contrast, there was little interest shown in elaborating on aspects of dissatisfaction with service provided by other professionals, who attracted less than 5 comments per specialty.

Despite only 14% of AgVet users reporting ever been asked by their doctor about exposure to AgVets, 81.5% stated they would like to receive more information from their health providers, and 71% of the entire sample agreed with the statement that “health services providers overlook the impact that environmental exposure can have on our health”. Lack of consideration that environmental factors could underpin their health problems was a major source of dissatisfaction with GPs. Dissatisfaction with medical care serves can serve as a prompt for those suffering chemical induced injury to seek the services of other providers (Sherwood P 2000), and this study revealed very high levels of dissatisfaction with GPs in the Hume region, and a corresponding willingness to seek health advice from other providers was widespread. Consideration of these features must be taken into account for environmental health workforce planning.

Health Professional Preference

The study sought to determine which health practitioner specialties community members viewed as being able to provide appropriative health advice, and manage environmental health problems. The question was posed “If you thought that you or a family member developed a health condition related to environmental exposures, would you see any of the following professionals?” A list of suggestions was
offered with rotating ordering of the list. Caution must be applied in the interpretation of these findings, as accessing primary health services in rural areas is limited by shortage of providers, and specialty services. Unfamiliarity with the services offered may have impacted upon the responses. Little variation existed between the two communities in which practitioner types were deemed capable of providing sound advice, other than for Community or Public Health Nurses, whereby NE residents reported a higher likelihood of visiting these nurses for advice and management, 40% compared to 31% for GV residents.

Despite the reported dissatisfaction, nearly all respondents (90%) reported they would visit a GP. Several Hume region medical clinics state that “their books are full”, meaning they will accept no new patients, therefore limiting the ability of patients to switch clinics, and chose a doctor, however there were no reports of inability to make appointments with medical practitioners.

Traditional Chinese Medicine Practitioners do not practice in these regions, and very limited numbers of Natural Therapists practice in the Hume Region. With this in mind, the question included the qualifying phrase “- if these professions practiced locally”. Responses indicted 49% of the sample would see a Natural Therapist, and 24% nominated a Chinese Medicine Practitioner.

Through their work as Diabetes Educators, wound and continence specialists, the role of Advanced Practice Nurse is now familiar to some rural people. Asthma Management Nurses are now appearing; however the role of Environmental Health Nurse Practitioner does not presently exist in Victoria. This role was offered as a potential service, and 52% of the sample said they would access their services. Forty per cent nominated an EHO. The question was then asked of these people whether they knew the role of EHO existed, and 64% reported they did not, and therefore knew little of their expertise, skills, or limitations.

Community members access a range of service providers, so it was anticipated that respondents would consider a range of professional groups in such a scenario. The decision to establish practice in small communities for private practice is based on (among other personal factors), perceived client demand and economic viability, similar considerations apply for funding bodies in determining the value or cost benefit of providing the service. For purposes of workforce planning, it is useful to know which professionals are viewed as preferred by the community. The responses to the question “Who would you see?” were analysed to learn which other professionals were also deemed also appropriate to provide environmental health advice and management.
Presented in Table 7.13 are the percentages of the sample who had nominated a specific provider group, and reported they would also visit other specialty. For example, of those who answered they would attend a GP, 52% also said they would visit a Nurse Practitioner who specialized in Environmental Health, and 36% said they would also consider seeing a Community Public Health Nurse. Respondents could also select “other health provider”. The last row in Table 7.13 gives the percentages responding they were familiar with the role of EHO, according to who they would visit (health professional listed at the head of the column).

**Table 7.13 Proportion of who would also visit other professionals: Base = those who would visit**

<table>
<thead>
<tr>
<th>Health Profession would see</th>
<th>GP</th>
<th>NseP w EH</th>
<th>NT</th>
<th>EHO</th>
<th>CHN or PHN</th>
<th>TCMP</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Practitioner</td>
<td>100</td>
<td>90</td>
<td>85</td>
<td>89</td>
<td>91</td>
<td>86</td>
<td>90</td>
</tr>
<tr>
<td>Nurse Practitioner</td>
<td>52</td>
<td>100</td>
<td>69</td>
<td>82</td>
<td>86</td>
<td>77</td>
<td>52</td>
</tr>
<tr>
<td>Environmental Health Officer</td>
<td>46</td>
<td>66</td>
<td>100</td>
<td>67</td>
<td>65</td>
<td>88</td>
<td>49</td>
</tr>
<tr>
<td>Community or Public Health Nurse</td>
<td>40</td>
<td>64</td>
<td>55</td>
<td>100</td>
<td>67</td>
<td>63</td>
<td>40</td>
</tr>
<tr>
<td>Natural Therapist</td>
<td>36</td>
<td>59</td>
<td>47</td>
<td>59</td>
<td>100</td>
<td>60</td>
<td>36</td>
</tr>
<tr>
<td>Chinese Medicine Practitioner</td>
<td>23</td>
<td>37</td>
<td>44</td>
<td>39</td>
<td>41</td>
<td>100</td>
<td>24</td>
</tr>
<tr>
<td>‘Other’ health professional</td>
<td>7</td>
<td>11</td>
<td>9</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Knew EHO role existed</td>
<td>31</td>
<td>32</td>
<td>30</td>
<td>36</td>
<td>34</td>
<td>31</td>
<td>31</td>
</tr>
</tbody>
</table>

Figures given in percentages. GP = General Practitioner, NseP w EH = Nurse Practitioner with specialized skills in Environmental Health, CHN or PHN = Community or Public Health Nurse, NT = Natural Therapist, TCMP = Traditional Chinese Medicine Practitioner, EHO = Environmental Health Officer.

Ninety nine percent nominated they would consider seeing at least one health specialty. Most people (90%) stated they would visit a GP, however considerable variation exits for those who would visit other professions. People fell broadly into two camps; either they would restrict their health seeking behaviours to only seeing a doctor, alternatively they would consider visiting a range of other professions. Table 7.13 shows that of those who would see a GP, less than 50% would also see a Natural Therapist, or EHO, or Community or PHN, or CMP, whereas of those who indicated they would see a TCMP, more than 60% would be also willing to seek help from all other professional groups.

The highest level of education in the household was associated with greater diversity in choice of health care provider. Households with lower education levels were more likely to only visit a doctor, and not other professions ($\chi^2 = 25.26 \ p \leq 0.001$). Conversely, those with higher education levels reported being more inclined to visit a boarder range of health professionals. For example 68% of those with a higher
degree would see a Nurse Practitioner with speciality training in Environmental heath, as compared to only 27% of those educated to primary level, and 53% for those educated at some secondary level. This trend was true for environmental health trained Nurse Practitioners, \(X^2 = 23.38, p<0.001\); Community or Public Health Nurses \(X^2 = 14.66, p<0.01\); Environmental Health Officers \(X^2 = 14.06, p<0.05\); and ‘Other’ (non-specified) Health Professional \(X^2 = 21.05, p<0.001\).

The findings for Natural Therapists or TCM Practitioners contradict previous research findings, as these had broad appeal across all education levels. In other studies in Australia (Sherwood P 2000) and America (Eisenberg DM, Davis RB et al. 1998), education emerges as the primary socio-demographic variable that predicts use of alternative medicine, whereby people with higher educational attainment were more likely to use alternative forms of health care.

**Survey of the CATI Interviewers**

The interviewers conducting the CATI survey were asked to complete a short questionnaire two weeks after its completion. All eight responded. The intent was to capture their sense of the community responses, and asked them to state what issues they believed were primary in the minds of the respondents, this was intended to capture material that may not have been included in the survey. All reported that compared to other surveys they had previously conducted, the community enthusiasm to participate in this survey was significantly higher, which they interpreted to result from broad concern about health problems resulting from their exposure to AgVet chemicals, and ‘relief’ that the problem was being investigated. Interviewers stated they were stunned to receive thanks from many residents who stated they were pleased that “someone was finally addressing this problem”. Being repeatedly and enthusiastically thanked for telephoning for an interview, they reported, was a novelty. Interviewers felt they developed a strong sense of understanding of the respondents’ despair as the survey progressed and they learnt of the range and severity of health impacts, plus the widespread sense of futility in a) feeling powerless to reduce chemical dependence in agriculture, and b) community frustration when taking their health concerns to their health providers.

All interviewers reported high levels of concern expressed about possible health impacts of the recent fires on the north east residents, and noted this was rarely raised by those living in the GV region, which was 100 kilometres to the west of the fires. The 2003 summer bush fires swept through the Victorian Alpine regions 6 weeks prior to interviews being conducted, forcing many North Eastern residents to evacuate their homes for several weeks. This was impacting on the minds of those living in this region.
Interviewers reported issues of water quality, the potential for soil erosion, and run off, the content and damage caused by extended exposure to smoke and gases, and long-term effects of defoliation of the surrounding forests were frequently raised. The survey contained no questions specifically relating to the recent bush fires, so no relevant data were collated from the survey. Impacts of the bushfire on survey responses cannot be quantified.

**Discussion**

The survey returned some important data. As with any survey, potential exists for positive bias, as those willing to participate are more likely to believe that chemical exposure can cause harm. However this is expected to be less than 10%, if all those who refused to participate without stating a reason, did so on the grounds of holding the view that AgVet chemicals do not pose a health threat. Only 2 surveys were abandoned midstream. As 17% (n=182) of participants reported not receiving the introductory letter, it would be expected that if 10% shared that view, then 18 surveys would be abandoned once the topic became apparent. The survey revealed that those who worked more closely with chemicals were likely to believe that this had contributed to their current ill-health, however some growers were adamant that the agents bore no ill effect. It is possible therefore that those refusing held mixed opinions about the hazardous nature of AgVet exposure. Impact on the findings could therefore be little, in terms of exposure levels, but differences in attitudes may exist.

The community survey was designed to determine whether exposure rates were sufficient to cause ill-health, and this was established. Some households had no-one who worked closely with AgVets, yet most of these did use the agents. The analysis presented here compared behaviour patterns, attitudes and health effects between groups engaged in differing agricultural practices, and working with different chemicals groups, or working less frequently with AgVets. The widespread usage of these agents makes finding an effective control group of rural people a challenge. The effect of having no control group, serves to diminish the observed exposure effect of this current study. This potentially reduces the differential between reported health complaints, which would result in an underreporting of exposure effect. As outlined in the methodology chapter, the purpose of the study was not designed to demonstrate causal effect between exposure and ill-health. These comparisons were presented as, despite this caveat, and resulting diminishing of observed effect, differences that were statistically significant were nonetheless demonstrated. This suggests that AgVet exposure is impacting on the health of these rural populations, so further study is indicated. Determination of the attributable risk
associated with exposure could be achieved by employing a large epidemiological study, although accessing large numbers of rural people who have not been exposed remains a challenge.

The rural communities in the Ovens and King Valleys, and Goulburn Valley have been chronically exposed to a broad cocktail of AgVet chemicals, and for many this exposure has continued for several decades. This entails that exposure has occurred for many years, and therefore, also to the highly toxic chemicals, many of which have now been withdrawn. Exposure to these agents often occurred prior to the knowledge of the need for wearing PPE. Skin contact, to the point of being saturated for the entire day, was commonly reported. Chemical exposure has occurred through multiple pathways of spray drift, potable water contamination, and direct skin contact. Although the question was not asked directly, it is possible that inhalation is also problematic.

Respondents self reported a range of specific and general health problems among themselves and for their family members. Cross tabulation analysis of these reports was performed, which compared growers of certain products against other growers and non-farmers, and also compared health complaints among those using specific chemical groups against those who had not. That the comparative groups used other chemicals, or possibly grew other produce entails that they were exposed to other agents. They cannot be truly classified as free from contamination; hence no attempt has been made to classify these as an effective control group. Serious challenges confront any search to find rural people free from possible exposure given the ubiquitous nature of chemical in the rural environment.

The study was not designed to provide epidemiological evidence of links between AgVet usage and ill-health. The findings however, suggest worse health among higher AgVet users, and users of certain chemical groups. Specific health complaints dominated in certain industries, as could be predicted by the literature review of harmful health impacts presented in Chapter 2. These include certain cancers, immune deficiencies, such as allergies and asthma, skin disorders, stomach and bowel problems, neurological impairment and psychological disorders, especially depression and giddiness. Chronic Fatigue Syndrome and Multiple Chemical Sensitivity were also reported among certain groups.

The belief that ill-health experienced by family members directly attributed to AgVet exposure was held by 23% of all households, and a further 15% thought this link was ‘possible’. This view was significantly more pronounced among families who have experienced serious health complaints, such as cancer and developmental disabilities. Whilst not always being accurate, the strength of community wisdom in their
own health matters was demonstrated by Ilder and Benyamani’s review of 27 community studies. It follows then that a proportion of respondents’ assessment of their health link to AgVet exposure is accurate, and although exact figures cannot be determined from these data, the belief that a real link exists may be accurate for a significant proportion of the sample population. Further research is necessary to fully determine the strength of association.

Data provided by the community members presents strong case for introduction of environmental health expertise amongst primary health care providers. The findings specifically indicate that for a significant proportion, current chemical handling remains unsafe. To prevent ongoing harm, a need exists for a deepening of community understanding of the risks associated with chemical exposure. Education programs must be supported by the introduction of health promotion strategies to maximize safe practice. Multiple exposure pathways have been identified. It is likely then that effective multiple strategies will be required to raise awareness, and modify behaviours.

Community members expressed a keen interest to learn more about how these against could affect their health, and to know whether this has already occurred. Chemicals screening is offered to professional applicators, but not agricultural workers, or their families or neighbours. The sample demonstrated they were highly dissatisfied with medical care provided in relation to environmental exposures. These findings match the findings of the Kimberley study, where exposed workers suffered a range of non-specific and often serious health complaints, but felt these were largely ignored by the attending physicians.

Sandall et al measured Australian farmers’ perceptions of farm health and safety hazards, finding that chemicals are ranked alongside tractors and machinery as the most serious (Sandall J, Cooksey R et al. 1999). However translation of this knowledge into safe practice remains problematic. This survey found some farmers handle these agents with due care for the safety of themselves, their families, and neighbours. However, further work is indicated in this area, as 65 % report routinely adopting unsafe practices. Existing chemical handling courses are regarded highly (van der Jagt K, Tielemans E et al. 2004), and adherence to safe practices was reportedly more frequent among the group who had received this education, suggesting efforts to increase uptake of education could result in improvements in chemical handling and application.

Findings of this study indicate that a broader education program is required than existing chemical handling courses, as although efforts to adopt personal protection against AgVets was higher, it
remained far from ideal, and exposure avoidance behaviours did not extend beyond AgVets. This group also reported that despite understanding the risks associated, a series of practical and time saving pressures prevented their strict adherence to chemical application instructions, thereby increasing exposure risks for themselves, and their families. The high levels of reported exposure to spray drift also indicated that unsafe practice is relatively common, adding further AgVet exposure risks for neighbours and families of farmers.

Sustainability of safe practice therefore presents an ongoing challenge. Unsafe practice is a behavioural issue demonstrating a need for enhanced farmer education. The community expect that if a product is readily available to the public, it is widely assumed it has been fully tested and is safe to use (NSW Environment Protection Authority 2001). Although knowledge is necessary, it is not a sufficient condition to guarantee sustained safe practice. A substantial proportion of chemical users across Australia have received no formal training in safe handling of AgVets, nor of the associated health consequences. Scope also exists to increase the proportion of regular AgVet users receiving education, and more-intensive programs could stress the health consequences of failure to take precautions. Education programs must also encapsulate infrequent users. Follow-up health promotion, reaffirmed by advice from health practitioners is broadly canvassed as a strategy to increase personal protection (LaMontagne AD, Youngstrom RA et al. 2003; Perry MJ 2003). Respondents demonstrated a preference to receive health advice and management from their health providers, primarily doctors.

Shakeshaft and Frankish argue that the rate of adoption of health promotion messages depends upon five elements, which link with the precede-proceed model of health promotion (Shakeshaft A and Frankish CJ 2003). The first element, knowledge, asserts that awareness of information creates an uncertainty in the minds of the potential adopters that needs to be reduced to a tolerable level before a change of behaviours will be adopted. Knowledge entails a broad scope of attitudes, beliefs and values. For AgVets, health symptoms associated with acute toxicity is available on labels of all products purchased, and some of this information is reinforced by chemical handling courses. However, health problems associated with chronic exposure is not printed on labels.

The second element, persuasion, highlights that positive features need to be emphasized to encourage behaviour modification. This must outweigh the perceived prospect of forgoing beneficial alternatives. Survey respondents indicated that inconvenience, perceived insignificance of risk, and haste ranked the highest disincentives for adopting of safe practices, and that these were considered powerful enough to overshadow the associated risks. The lack of immediate harmful effect – or as one farmer articulated,
“Chemicals don’t have teeth”, means that the harmful properties of these agents are not immediately perceived. These first two elements, knowledge and persuasion, are predisposing factors within the precede-proceed model.

The third element, the decision to adopt modified practice, may be expedited by an option to adopt the innovation on a trial basis. However, when handling toxic substances, sustained safe behaviour is required, rather than purely on a trial basis. Here again, benefits incurred from taking the cautionary approach to self-protecting from exposure are not immediately apparent to users of AgVets, as chronic harm has a cumulative, long-term effect.

Implementation is the fourth element, in which the change agent provides technical assistance and tailoring of the innovation to ensure its suitability to a particular setting or to meet some particular need. Chemical handling courses provide farmers with the necessary technical assistance. The decision to implement behaviour change, and subsequent implementation are the enabling factors in the precede-proceed model. The fifth element, confirmation, involves feedback and support for those who have adopted the behaviour to ensure continued satisfaction with their decision, and hence sustainability of behaviour modification. This last element is the reinforcing factor of the precede-proceed model (Shakeshaft A and Frankish CJ 2003).

Achieving voluntary sustained behaviour modification, according to this model, is difficult when a significant proportion of the decision-making analysis of whether to alter behaviours is based on a cost–benefit judgement, and the impacts of negative consequences are delayed, perhaps for decades. The farmer can immediately identify the immediate time costs in returning to the shed to fetch and don the PPE. The benefits of not falling ill until five, ten or perhaps 30 years later are more difficult to factor into the equation, and hence the benefits of precautionary behaviour are discounted.

Workers exposed during the course of employment reported not knowing to whom they should report these exposure events, and expressed feelings of powerlessness to demand employers pay greater attention to occupational safety, given their need for employment, and lack of union organisation or consolidated representation for their labour entitlements. This confirms that significant scope exists for improvements in occupational health and safety standards in rural settings, as identified by the Australian Centre for Agricultural Health and Safety and others (Sandall J, Cooksey R et al. 1999; Franklin RC, Brown P et al. 2001).
Enforcing occupational health and safety in agricultural setting confronts practical problems as most farmers operate independently. By comparison, the industrial setting employs foremen and occupational health nurses, to act as external authoritative agents applying pressure to ensure safety standards accord with occupational health and safety legislation. In this way, safety is enforced. In the absence of an external watchdog, strategies to heighten personal motivation take a higher priority. In the case of AgVet exposure harm, this needs be in the form of stressing the high probability of personal health harm in the long term, in addition to having a duty of care for others. Targeted chemical training, and health promotion programs emphasising the health aspects are therefore indicated.

Hence primary health care has a significant role to play and strategies to encourage involvement of PHC providers should be employed. Many studies have demonstrated that advice given by health practitioners is regarded as credible, and indeed the preferred and expected source of health information (Infante FA, Proudfoot JG et al. 2004; Petts J and Niemeyer S 2004). Seventy-nine percent of the entire sample thought that health providers currently overlook the impact of the environment has on their health, and a similar proportion indicted they wanted to learn more about the impact of the environment upon their health, which suggests that these communities are seeking more environmental health information from their health care providers. A consistency emerged in community dissatisfaction with the current primary health care workforce, due their lack of interest in chemical-health link and environmental health expertise. This dissatisfaction principally targeted GPs.

**Conclusion**

The CATI survey and subsequent interviews conducted in the Goulburn Valley and Ovens and King regions revealed high risk levels of AgVet exposure, and demonstrated that exposure is occurring through multiple pathways. Findings indicate that exposure levels are largely a function of unsafe practices in the past, and despite a rising awareness, unsafe practices are continuing, placing these rural agriculturalists, their families and communities at considerable ongoing health risk, and the subsequent community concern is widespread. People working with AgVets, and those suffering serious health problems believe their current ill health is a function of this exposure. Despite this, translation of knowledge into safe chemical handling remains limited.

Community sentiments however, are polarised on the potential of AgVet exposure to cause direct harm to health. Contrasting with the belief that these agents have caused health problems, is an ongoing ambivalence of some growers towards exposure hazards, notwithstanding that these people are working
closely with AgVet chemicals, and therefore at increased personal risk. The contribution of these industries to regional wealth is substantial and fruit production forms a significant component the regional cultural identity. The growers and the local community subscribe to the belief that commercial competitiveness drives the need to use chemicals in the production of these crops. The knowledge that these agents are deleterious to human health and the environment has been widely reported, yet many respondents stated they regarded chemicals as a ‘necessary evil’; hence an element of complacency also exists. Scope exists therefore to reverse this apparent complacency and improve chemical handling safety. Further farmer and community education about the risks associated with AgVet use and exposure, plus health advice and management of health consequences are indicated.

The health of rural Australians is significantly poorer than those living in metropolitan regions, and a substantial body of international evidence now links ill-health with AgVet exposure. Data presented here suggest Victorian communities are affected by exposure. Many of the illnesses that affect these rural communities are known to be associated with AgVet exposure. It is therefore biologically plausible that some (possibly many) of the community concerns are justified. The lack of interest and expertise in environmental health was broadly identified, and significant dissatisfaction in GP services was demonstrated. The communities studied expressed a willingness to seek a range of practitioners who could offer environmental health services, with preference given to GPs, Environmental Health Nurses and Natural Therapists.

Further research is required to determine the full extent of chemical exposure, and identify specific health risks emanating from chronic exposure to AgVets. Increasing agriculturalists’ understanding of the long-term health risks and necessity to adopt safe practices is indicated. Emphasizing the health risks is critical; hence intensifying motivation could be achieved by developing environmental health expertise within the health care sector.
CHAPTER 8
PRIMARY HEALTH CARE DELIVERY RESPONDING TO COMMUNITY CONCERNS

Introduction

Chapter 7 presented community members’ concerns about exposure to AgVet chemicals impacting upon the health of themselves, their families, and neighbours, and their statements describing a lack of attention shown by their health care providers to these emerging environmental hazards. This chapter now turns to examine the perspectives of health professionals delivering primary health care (PHC) services to the two regions under study. In this chapter, the subsidiary research question addressed asks ‘How well prepared is the primary health care workforce to identify and manage environmentally induced ill-health?’

All PHC providers servicing the region were invited to contribute to the study. In addition to determining the expertise and engagement in managing environmentally related ill-health, a key feature of this part of the study was to determine the level of interest in environmental health among the PHC workforce, therefore initial segments of this chapter discusses participation trends, and factors influencing their willingness and availability.

Data on the provider perspectives were gathered by a variety of methods, including face to face and telephone interviews, focus groups, and where these could not be achieved, via self-completed paper surveys. All methods were offered in an attempt to maximise participation. Providers were asked to comment on environmentally related ill-health affecting their patient community, frequency of environmentally related presentations, what environmental health concerns had been raised by their patients or clients, and which environmental health practice or activities formed part of their clinical routine. Questions also related to strategies adopted for referring patients to others for specialist management, and for self-education in environmental health. Lastly, providers were invited to nominate their preferred workforce model for dealing with emerging environmental health issues. These data were then analysed thematically, drawing comparisons between the various provider groups, and between the two regions under study. The second section of this chapter presents these findings followed by a discussion of the implications. The following section then examines the differential between the community and provider perspectives on the issue of AgVet exposure.
Health Provider Participation

All non-medical health providers invited to contribute willingly participated in the study. Interviews were achieved with 11 of the 17 GPs invited from the North East Region, and despite multiple attempts to arrange interviews from the GV region, none were achieved, and only two of the invited 33 GPs contributed by returning written questionnaires left at the clinics. The striking disparity in the ability of each region to attract health professionals is most pronounced in GP penetration. Shepparton has the second highest doctor: patient ratio in Victoria, at 1: 1800, compared to the North East, which approximates Melbourne’s levels with a ratio of only 1: 900. The range of clinical services offered by the GP clinics across the two regions remained similar.

Attitudinal differences towards the environment and provider-client relationships were apparent between provider groups across the two regions. These may relate to workload differentials, or they may reflect individual predispositions of those who elect to live and work in the two regions. This was not tested. However willingness to consider the environment as a potential health determinant, and subsequently, to contribute to the study was significantly more pronounced in the North East than in the Shepparton region.

In total, 25 non-medical health providers, plus two EHOs, servicing the Goulburn Valley and North East contributed to the study. The majority of non-medical providers interviewed were Community Health Centre staff, most of whom who received their initial health training as Registered Nurses. CHC program funding is received to deliver district nursing, mental health, men’s health, drug and alcohol counselling, diabetes education, palliative care and rehabilitation. Social workers provide advice on gambling problems and perform case work such as financial management.

Complementary and Alternative Medicine services are extremely limited in the areas studied. A search revealed no practicing Traditional Chinese Medicine Practitioners servicing the areas under study. Several CAM practices offered services limited to counselling, aromatherapy, massage and chiropractics, but it was viewed unlikely that people experiencing health conditions resulting from AgVet exposure would seek these services, so interviews were not sought with this group. Shepparton has a large multidisciplinary natural therapy clinic which attracts clients from across both regions, plus two sole practitioners. In depth interviews were held with all staff at the clinic.
Similarly to GPs, natural medicine practitioners are private business operators. In contrast to the GPs, all those approached willingly participated, and furthermore, freely offered additional cooperation in terms of materials, demonstrations of their clinical practice and environmental health assessments, and suggested links to others interested in this area. This high level of enthusiasm for the project was motivated by their belief that local environmental conditions impacting on human health pose a significant regional health issue, which they argued, has not attracted sufficient strategic health policy attention to date.

Four EHOs service the greater Shepparton Region, and two are employed in the Ovens Valley. They operate within a legislative framework. They do not have a client base, and therefore have minimal contact with community members affected by health complaints. Community members who report local nuisance complaints or issues relating to alleged negligent spray techniques to the Local Shire Offices are referred to the EHO on duty. EHOs are usually employed by Local Governments; they operate outside the health care sector, and are therefore not classified as providers of health care.

**Provider Perspectives**

Responses given by professional groups to specific questions are summarized in table 8.1.
<table>
<thead>
<tr>
<th>Table 8.1  Provider Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Practitioners</strong> N = 13</td>
</tr>
<tr>
<td><strong>Perception of regional environmentally related ill-health issues</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Understanding of regional agricultural activities, and associated chemical usage</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>AgVet exposure clinical outcomes / presenting features</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Conduct environmental health assessments</strong></td>
</tr>
</tbody>
</table>
Table 8.1 Provider Responses (Continued)

<table>
<thead>
<tr>
<th></th>
<th>General Practitioners N = 11</th>
<th>Community Health Nurses N = 14</th>
<th>Allied Health N = 6</th>
<th>CAM – Natural Therapists N = 5</th>
<th>EHOs N = 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referral practices</td>
<td>Refer to specialists when required as per standard practice based on clinical symptoms.</td>
<td>Refer all to GP</td>
<td>Refer all to GP</td>
<td>Refer to GP under special circumstances only</td>
<td>Refer all to GP</td>
</tr>
<tr>
<td>Self education</td>
<td>Poisons Centre Royal Melbourne Hospital</td>
<td>Poisons Centre Royal Melbourne Hospital</td>
<td>Nil reported</td>
<td>Refer to CAM field literature</td>
<td>Reported limited reason to update knowledge on health complaints</td>
</tr>
<tr>
<td>Best solution to environmental health care service delivery</td>
<td>Variable responses. Nil additional requirements, GPs, Medical specialty, Environmental Health Nurse, Public Health with toxicology</td>
<td>Environmental Health Nurse, GP specialist or CME course</td>
<td>GP specialist or CME course, Environmental Health Nurse</td>
<td>GP specialist or CME course</td>
<td>GP specialist or CME course</td>
</tr>
<tr>
<td>Concerns raised by patient / client groups - seeking professional health advice</td>
<td>Infrequently raised by patients</td>
<td>Identified exposure to AgVets as very commonly reported by clients. Reported had no evidence to confirm or deny.</td>
<td>Identified exposure to AgVets as very commonly reported by clients. Reported had no evidence to confirm or deny.</td>
<td>Regular feature of presenting complaints.</td>
<td>Limited contact with people seeking advice on personal health matters. Frequent contact with people concerned about potential harm re environmental hazards</td>
</tr>
</tbody>
</table>

Environmentally related ill-health within the region

Primary health care providers were asked what conditions they encountered through their routine client load, which they, the provider, believed were induced by environmental factors, and the second field asked providers to nominate environmental health hazards existing in their local catchment area.

All professional groups found the first part of this question difficult to answer, mulling it around before responding. The initial response from most GPs was “None”, then after further contemplation some
modified their answers to “Very little”, and then some offered “Asthma and skin conditions”. Further probing drew mention of exposure to agricultural chemicals, but no one initially volunteered AgVet exposure as a significant environmental health issue. Other issues raised were road trauma, industrial working environments, injuries and respiratory problems relating to dusts. Injury risks associated with agricultural working environments were not mentioned. When asked how frequently (per week, month or year), they treated environmentally caused health conditions, GPs responded “Asthma is very common, and seasonal, but other complaints - only a few per year”.

One GP stated that he also worked in an Accident and Emergency department, and referred to one farmer as a “frequent flyer” who presented annually with neurological symptoms indicative of acute toxicity. It was believed this patient still mixed chemicals with his bare hands, and was resistant to advice regarding the inherent hazards of this activity. No other reference was made to cases of acute toxicity diagnosed by GPs, or illness resulting from chronic exposure.

The Victorian State Government does not allocate specific funding to CHC’s for the provision of environmental health services, hence there were no staff employed to deliver environmental health care at centres servicing the study regions. Accordingly, no one interviewed had received any formal environmental health training. CHC staff advised that their clients seek their services for the designated purpose of their specialty role, such as treating or advising on gambling problems or personal financial management, counselling, diabetes, asthma, continence, wound care, or help with activities of daily living. Responses volunteered by these health providers therefore were based on impressions gained from discussions occurring whilst engaging with clients for other purposes, when clients raised their concerns about AgVet exposure during the course of consultation.

Almost all the community health staff and school nurses nominated exposure to AgVets as the most significant environmental health problem in the regions, then followed by asthma, road trauma, and water quality, although water was mentioned by north-east practitioners only. Two responded, “No idea, I only deal with ..... (eg. drug and alcohol issues) ... so I don’t talk about clinical health, so I wouldn’t have a clue and I have never asked.” Other health conditions identified by non-medical providers as prevalent environmentally induced health conditions were allergies, food intolerances or other gastric complaints, birth defects and the rise in autism.

Five CHC staff stressed the high prevalence of depression existing locally, especially among men. This, they felt was exacerbated by attempts to adhere to the tough farmer image, whereby demonstrations
indicative of being unable to cope with life pressures are viewed by many as a sign of weakness (Wainer J 2004). They reported this often served as a barrier for men to seek professional help, or indeed mutual support from their friends and colleagues. The potential link between neurological, mood, affect and behavioural problems being directly associated with chemical exposure, was made by only two community health providers, as the following quotation demonstrates.\footnote{Note: Providers are notated simply by professional group due the small numbers of health professionals interviewed, and potential for identification as their comments relate to their practice location. RN = Registered Nurse, AH = Allied Health, NT = Natural Therapist}

“I read the sprays can affect your nervous system, maybe that can explain the depression, and suicide rates. I see mainly men, and they are beginning to come out of the woodwork to our men’s groups, and lots have worked in the orchards and dairies. But not many of them would think that it was the chemicals causing that.”

CHN 1

Principal environmental health risks facing communities depend upon local environmental conditions. The two communities studies varied in their topography, population densities, principal agricultural industries, recreational and agricultural pursuits, potable water supplies and human behaviours, among many other factors. Accordingly, the primary health care provider perspectives on environmental health risks showed an element of consistency within each community, and some differences between the two regions. Despite this, the overarching concern identified by most non-medical providers, across both districts was exposure to agricultural sprays. The quotes below illustrate the issue of AgVet concern, in the context of how it is perceived as a broad community health issue.

“Oh the biggest issue here has been the tobacco. I do have people who think the sprays have made them sick, and some have died. They all call this ‘cancer valley’, but that is not why patients come to me.”

CHN 2

“Everyone knows the sprays on the orchards are bad. They talk about it, but we need the orchards, the town would die without them, so we all put up with it. But it isn’t relevant to my line of work, so it is not part of my case load. I can’t really help them.”

CHN 3

“The water is shot up here, and the fires got people excited, and the tobacco – well most people hate that, and the wineries too. Yeah most do care, but what can they do? They can’t stop the farmers using chemicals if they want to use them. We tried to fix the water; well that was a joke. I know that some have been laughed at when they tried to raise it with their doctor. But we have people into crystals and junk up here, so I guess the docs think they’re all the same.”

CHN 4

“The farm chemicals - I’ve had my car sprayed so thickly I have had to put the windscreen wipers on, and that is not just once. So we are all exposed to them. What else? Asthma, road trauma, child disabilities, autism seems to be rising, so are mental health problems. I deal with ….. so I can only answer because I live here, not really through my professional role.”

AH 1
Natural therapists uniformly reported that their case load indicated exposure to AgVets was a major environmentally related health issue in the region, and was often the primary reason their services were sought. EHOs initially cited sanitation, water quality, insects, food borne illness, and after further probing, added exposure to AgVets.

Perspectives were also sought from providers regarding which specific activities (occupational, domestic or recreational); they believed placed community members most at risk. To this question, a general consensus (90% of respondents) nominated farming, and primarily the application of agricultural chemicals as posing the greatest health risk. Even those that did not nominate AgVet exposure as a primary environmental health concern in the region, listed agricultural chemical application as the riskiest local occupational activity. Tobacco farms in the north-east and orchards in the Goulburn Valley ranked as most hazardous settings. Notably this concern rated higher than the risk of occupational injury, and road trauma was raised by over 50% of respondents. Other exposure risks mentioned were factory workers exposed to milk dusts, industrial chemicals, and noise. The only recreational activity nominated as a significant regional health risk was drug and alcohol dependence, especially among the young, and farming males, but this was not usually linked to an environmental risk factor. Domestic activities were not nominated as presenting any risks.

**Estimation of community environmental health concern**

Providers were asked whether their patients or clients had verbalised an opinion, or a suspicion, that environmental factors had played a causative role in their health problems, and were questioned about their response to these instances.

Nurses working in the north-east reported a widespread community held belief that cancer rates were “higher than they should be”, especially non-Hodgkin’s lymphoma. Nurses frequently cited the term ‘common knowledge’ to describe the community awareness drawn from personal knowledge of multiple cases of illness and death among neighbouring agricultural workers. Those who worked primarily with the aged described a complacency among their clients, despite their conviction of the presence of a link between agricultural chemical exposure to the premature deaths of their friends, family members and neighbours. Nurses reported that these clients had justified their acceptance of chemical exposure by describing chemicals as a ‘necessary evil’ vital to the agricultural industry, which they viewed as crucial to the economic prosperity of their region – so exposure, among this cohort, was perceived as inevitable.
This fatalistic acceptance among the aged contrasted with sentiments of community outrage reported from middle-aged and younger clients.

Several themes emerged during the interviews and focus groups. Appreciation that a deep concern permeating throughout the community regarding AgVet exposure was a major theme. Recognition of the intensity of this concern varied starkly between professional groups, as did the recognition that health professional concern did not match community concern. This trend was apparent in both regions studied. GPs believed community concern regarding environmental impact on their health was low, existing at depth only among a very small minority (5% - 10%). When asked how frequently their patients raised environmental issues, GPs responded this occurred very rarely.

In contrast, more than 80% of the non-medical community based health workers articulated they perceived widespread (60% or more), high–level community concern about the direct impact of environmental factors on their health. They noted concern was principally focussed towards direct exposure to agricultural chemicals, and indirectly via spay drift contamination of household drinking water, and local recreational waterways. The following quotes are indicative of the comments provided.

“Oh lots are concerned - I see a lot of skin problems, and then they start talking, asking whether it is from the chemicals, or cancer, they are very worried about cancer. You know they call it ‘cancer valley’ here, but maybe all those have already died. We’ll never know really. We were never taught anything about what those chemicals can do, so how would I know what caused what?”

CHN 5

“I think people do know now – but think it is all too late, but they still won’t follow the labels, you know, about wearing the gloves. . . . . I know that my neighbours – from when I was a kid, too many of them got sick, more than you would expect. There is a lot of it around here. But we can’t really help, except give advice. I’d say most now know it was wrong, and that they are dangerous.”

CHN 6

“Oh wow, Ag chemicals are a major issue around here. I have people who think it has made many people sick – and die! They call it ‘cancer valley’, and some people have tried to ferret out information, but they were all blocked years ago, it was put under wraps. I think the DHS was supposed to test it, but no-one had any faith. Because it was all going to be too hard. People are very suspicious of bureaucracies.”

CHN 7

“I think they fall into 3 distinct camps. The ‘very aware’, the ‘half hearteds’, and the ‘I don’t cares’, and I don’t think their respect for chemicals necessarily matches their exposure risk. Some who don’t go near chemicals are paranoid, and others virtually swim in the stuff, and don’t care. But I think most people now realize they are dangerous, as they have all seen so many people fall ill.”

CHN 3

“I think there is a support group starting of Italian orchard farmers’ wives, to help each other, as so many have had serious sicknesses in their families, but I think it is a closed group.”

CHN 8
“Lots, people know nowadays they’re bad, even some of the little oldies, ‘cause they’ve seen too many get sick. And I know that they get short shrift from the GPs. All they care about is money. “Next please, here’s a pill”. They wouldn’t even ask them. Some of my patients and friends even, have tried to get information from the local doctors, some docs are OK, but others treat them as loonies, so they shut up about it eventually. Then they go off to see natural therapists.”

CHN 9

No, I don’t think they really think about the environment. I don’t think they care. I’d know if they were worried, because they would ask, but that doesn’t really happen. GP 1

Several providers made the point that their clients had questioned them about the health impacts of chemical exposure, specifically if their health problem could be a function of exposure. Clients had informed community health workers that they felt it futile to suggest, or ask about a link to exposure to their general practitioners. Natural therapists reported many of their clients sought alternative therapies for the specific purpose of seeking alleviation of conditions such as allergies, general malaise and fatigue, which they directly attributed to exposure to an array of environmental factors.

**Understanding of regional agricultural activities, and associated chemical usage**

The background and residential circumstances of the practitioner played a greater role in the level of understanding about specific agricultural practices than qualification or specialty training. Those who declared a current or past personal involvement in farming demonstrated greater knowledge of the annual cycle of farming practices, awareness of the specific agricultural activities, and hence risks involved. Direct questioning of health providers to seek their level of understanding of agricultural activities, and chemicals used within their communities revealed little knowledge. Less than 30% of GPs interviewed mentioned the chemical group of organochlorines or organophosphates, and less than 10% provided actual names of any products or other active agents, this individual lived on a farm. These figures were even lower for nurses and allied health professionals, including NTs.

The following quotes describe frequently encountered responses.

“I grew up on a farm, and I worked with Ag Chemicals, and they were sloshed around. We wore no protection then. So I have read up on the impact of arsenic in sheep dips, and the chemicals that we used, but I was never taught about them at Uni. My brothers both had kids with problems; I think that was caused by the chemicals we were exposed to.”

CHN 10

“I wouldn’t know. I came from the city. I don’t know what they use. I only see when I drive around that it is spraying season, and it gets on my car, and you can smell it sometimes. You can see when the lambs are born, and the fruit trees are bare in winter, and when they have fruit, and the pickers are around, but other than that I don’t know what the farmers are up to, and certainly not what they use, or what signs and symptoms might be.”

CHN 11
“I live on a farm, and so I’m pretty careful about them (AgVet chemicals), and because of my work, I get people asking me, so I have learnt that way, for my own – and my family’s safety, and to answer their questions. It is part our community role I guess.”

AH 2

“I lived near the orchards, and I could tell when they had been spraying, even when I was not at home during the day, ‘cos I’d get headaches, and so do my children. It was a dead giveaway. We moved house.”

CHN 12

“I run a few acres, we have beef cattle mostly, so we don’t use much, but the organochlorines are pretty nasty, they are used a lot. I try to be vigilant. My big problem is getting my son to wear the protective gear when he works with chemicals. I have told him a thousand times, but he is young, thinks he is impervious. You know I think the problem is that chemicals don’t have teeth.”

GP 2

Health professionals with direct links to the agricultural sector uniformly reported taking a personal interest, motivated primarily by health protection for themselves and their family, but also frequently referred to being viewed as a community resource for information. This role was willingly adopted as valid and reasonable, several nurses, and allied health expressed feelings of dissatisfaction (and guilt) with the limited level of expertise they could offer.

**Knowledge of chemicals usage and side effects**

Questions asking what specific signs and symptoms would the provider associate with exposure to AgVets met with significant discomfiture. Direct questions were restricted to the GP surveys and interviews. GPs left this section blank, or in the interview setting, the conversation was quickly broadened to general skin irritations, cancers, and nervous system effects, all without providing specifics. Questions to nurses asked if would they recognize a case, and those with strong clinical backgrounds were keen to discuss, but reported being unable to make a definitive clinical diagnoses.

Although all groups were only able to provide minimal detail in response to questions about clinical features suggesting AgVet exposure, the language used varied significantly between the professional groups in their answers. Natural therapists and GPs did not use terms such as “I do not know” or “I could not recognize a case”, whereas nurses and allied health staff openly stated their lack of knowledge by using such frank terminology. Recognition of the potential for exposure cases being undiagnosed, and therefore not being adequately managed was limited to these groups.

The lack of formal training about AgVets was raised by 85% of non-medical participants. No GPs referred to their education, or acknowledged gaps in their knowledge base. This compares starkly to the 65% of non-medical providers, who verbalised their feelings of failing their community responsibilities to
their patients, by not being in a position to identify categorically whether AgVet exposure could be attributing to a health problem. The intensity of this view varied, with clinically based nurses expressing this sentiment more strongly, believing they ought to have clinical expertise, whereas others implied they should carry a higher level of ‘informed’ knowledge, sufficient to make an appropriate referral.

Providers having personal farm experience demonstrated a greater understanding of farming activities, in terms of how the work was performed, financial pressures, and weather constraints, than precise knowledge of chemicals used. Only small numbers of specific chemical agents could be recalled, and these were mostly limited to personal experience only, and listing of side effects was limited to one or two broad symptoms.

**Environmental health practice**

Natural therapists were the sole provider group in the study regions to report that conducting environmental exposure assessments constituted part of their routine professional practice. This group routinely questioned exposure patterns when engaged in taking health histories. The NTs reported conducting an assortment of assessments, which they explained was to determine chemical imbalances, and prescribed treatments to redress these.

A small sample (n=8) of Australian Occupational Health and Safety Nurses (OHNs), not practicing in the study regions, were opportunistically surveyed during their annual conference in Melbourne. This was to ascertain their level of understanding of environmental health issues, and to seek their views on a workforce model to best address these. While small samples cannot be presumed to be representative of the entire OHN workforce, they have specific technical knowledge pertaining to environmental and occupational hazards. Australian OHNs are largely employed in industrial settings, such as petrochemical, energy, and mining industries. They are familiar with working in multi-disciplinary settings as these larger organisations also employ medical practitioners and environmental managers, and have established systems in place for clinical and exposure assessment, treatment, information access on poisons, reporting mechanisms and referrals to medical specialists when appropriate.

OHNs reported their routine practice includes conducting detailed multi-system physiological health assessments, which includes taking exposure histories, assessing the physical environment and human behaviours to identify potential or existing occupational hazards. Their professional role also incorporates provision of screening, health education, and health promotion services, which extends to delivering
clinical management in primary care. Most respondents were well versed in chemical exposure identification, clinical management and chemical legislation frameworks.

Waste-water management issues reportedly occupy about 50% of the efforts of EHOs servicing the Shepparton Region. Other activities comprising the bulk of their workload include reviewing septic tank plans, coordinating immunisation programs and registrations of new businesses, such as food premises. The Shepparton EHOs report that they receive on average 4 reports per season from aggrieved community members regarding safety breaches in the orchards. The adopted protocol requires EHOs to draft an incident report and refer the matter to the Victorian Department of Primary Industry - Chemical Standards Branch for action, and in situations involving worker safety, an additional report is lodged with the Victorian Workcover Authority.

**Referral practices and self-educational strategies adopted.**

Self-education in environmental health amongst the providers surveyed from the study regions was reported as limited. Almost exclusively, it was only providers who either lived in the past, or live currently on farms, who reported engaging in personal research to inform themselves about AgVet exposure health risks. This was motivated by attempts to maximize safety of their immediate family, and secondly to provide advice, when asked by patients and neighbours. Information sources listed were largely limited to on-line sources. No one mentioned purchasing textbooks on environmental health, or toxicology, attending seminars or courses, nor listed reading specific toxicological or environmental health journals, such as Environmental Health Perspectives. All OHNs nominated Material Safety Data Sheets (MSDS), as a source of self-eduction on chemical exposure side-effects and initial management. MSDAs were mentioned only by one community worker surveyed in the rural areas.

When poisoning was suspected, GPs and some nurses stated they would seek information from the state poisons centre. Answers indicated that practitioners were primarily focussing on acute exposures, rather than chronic. Considerations of chronic exposures only occurred when directly questioned by the study interviewer, and providers stated that unless directly prompted by their clients, they were unlikely to initiate questions about chronic exposure.

The non-medical practitioners reported they would refer clients to their local general practitioner whenever an environmental causative link was suspected. GPs stated they would refer to the appropriate medical specialty if they felt that this would benefit the patient, although none of those interviewed
reported ever having done so. GPs reported that they believed their current clinical management was adequate.

**Provider preferred workforce model**

In addition to determining how the Australian primary health care system currently addresses environmental health issues, this study also sought to gather information to inform the development of a primary health care workforce model able to provide effective environmental health care service delivery, and fit with existing Australian infrastructure. Canvassing the views of current health providers provides insight into the inter-professional recognition such a workforce model might encounter. Existing practitioners not only have a vested interest in the health care system in which they operate, and also in its and future planning, but they also carry important knowledge about what needs exist (General Practice Strategy Review Group 1998). Additionally, inviting comment from relevant practitioner groups can also serve to identify strategies which would be poorly received, and hence help prevent the development of strategies doomed to fail.

During the closing section of the interviews, health providers were asked their perspectives on what would be a suitable workforce model, and the best way to achieve this. Options canvassed were developing a new designated health specialty, extending current roles, injecting additional subjects into existing health curricula of undergraduate courses, and making continuing education modules available for existing provider groups. Post-graduate options were also discussed.

As a group, health care providers recognized the need for increasing environmental health expertise among nurses and doctors across a range of workplace settings. They were receptive to a range of model options involving injection of environmental health expertise into the primary health care sector repertoire. Environmental health nurse practitioners, public health officers with speciality training in toxicology and environmental health, natural therapists and specified general practitioners were all viewed as potentially being the most effective. It was also generally viewed that these workforce models would fit well within the current infrastructure. Among these options, a specialist GP and environmental health nurse were the most favoured options.

Natural therapists believed they were able to expand their role further, whereas mainstream providers restricted their preferences largely to fellow mainstream practitioners, reflecting a greater level of comfort with familiar, and similarly trained health professionals. When this professional bias was
suggested, 40% agreed. Doubt was raised by all health provider groups about environmental health officers having sufficient patient contact and physiology knowledge to adequately address exposure related health concerns.

GPs were asked if they were willing to undergo additional training in environmental health in general, and health impacts of AgVet exposure in particular. Suggested formats included Continuing Medical Education modules, and single event education programs, such as seminars. One GP reported interest. The remaining ten affirmed that they regarded other health issues are more important, and that they had little time. GPs expressed limited receptivity to other practitioners, ranking GPs, then nurses, and thirdly a new specialty. Their least favoured option was natural therapy.

Allied health providers thought diagnoses and management of exposure induced ill-health fell outside their professional realm, and believed the role was best suited to nurses, GPs, and some mentioned complementary health practitioners. Nurses were very receptive to the introduction of a new nursing specialty. Four expressed a personal interest but stressed their current lack of expertise, and toxicological knowledge.

Occupational health nurses uniformly stressed that their existing skills facilitated an easy transition to the role. Seven of the eight returned surveys expressed a strong personal interest in the area of environmental health, and a willingness to incorporate more environmental health into their work practice, and spoke of a desire for broader recognition of the skills they currently held. Health providers from the rural areas of the study did not voluntarily suggest OHS nurses; this may reflect their relatively low profile in rural settings where very few are employed, resulting in limited professional contact.

**Discussion: Primary Health Care Provider Perspectives on Environmental Health Delivery**

Health provider willingness to participate in local research studies can be assumed to be a function of several factors. These include the level of general interest in the research topic, perceived benefit to the health of the client base and personal or professional practice advantage resulting from participation, in addition to the ability to donate professional discretionary time. Invariably, prioritisation of these factors will be individualistic. The rural health workforce shortage has attracted considerable political attention (Abbott T 2004), so its influence on willingness to participate is explored first. This influences
discretionary time to attend what has been argued as “non-core” or voluntary activities (van der Weyden MB 2003).

The difficulties experienced by rural regions in attracting and keeping health care practitioners are now widely recognized. The driving forces behind this trend affect the full range a range of allied health, nursing specialties, and complementary therapists as well as GPs (Rural Workforce Agency Victoria 2000). This served to limit the diversity and concentrations of practitioners available for participation in the study. The North East district offers certain lifestyle advantages, being renowned for its spectacular mountainous beauty, gourmet food and wine, wide ranging sporting, and tourist attractions. Accordingly, it suffers workforce shortages to a somewhat lesser degree than the flatter and drier Shepparton region.

Low participation rates among General Practitioners in research is the reported norm (Gunn JM 2002), however willingness to participate bares special relevance to this study. A core concern expressed by the community was an apparent lack of interest demonstrated by GPs in the potential for environmental exposures to explain their symptoms. GP interest in pursuing environmental causation of disease states determines the workability of a proposed environmental health workforce model based on active GP involvement. Consideration of the factors predisposing to this alleged lack of interest is therefore warranted.

One factor is that low participation rates of GPs in research is a generally observed trend. The Divisions of General Practice Program (DGPP) established in 1992, and funded by the Commonwealth Department of Health and Ageing (DoHA), sought to redress low participation rates in activities designed to better coordinate health services, and promote population health. The Commonwealth Government’s Primary Health Care Research, Evaluation and Development Strategy (PHC-RED) also aims to embed a research culture in Australian general practice and primary care, and strengthen GPs’ direct involvement with research (Del Mar BC 2001). Despite over 10 years of Divisional activity, reluctance of GPs to participate in research continues to be evidently widespread as the review of the GP divisions ‘The Future Role of the Divisions Network’ noted in 2003 (Commonwealth of Australia 2003). This report recommended that all Divisions be required to engage in research activities relating to their core roles, focusing in particular on population health research, and the reduction of health inequalities.

Askew et al. tested Australian GP attitudes towards research and found that the GPs interviewed did not have a common understanding of research, and argued that the weak research culture in Australian general practice was a function of “the environment itself is not one where people are encouraged to ask
questions and spend time finding the answers to those” (Askew DA, Clavarino AM et al. 2002). Askew’s study revealed that GPs were more likely to become involved in a research activity:

“... if it (research) was perceived as relevant, and structured to minimise the inherent barriers in the environment and culture of general practice, and relevant to general practice, their patient profile and their business operational interests.”

The significant feature for this study is that low participation rates indicate low levels of interest, based on the belief that environmental contamination is not relevant to their direct patient care or operational aspects of their business enterprise. It must be noted that GPs have argued that the current funding arrangements for GPs renders research, and any activity not involving direct patient contact, a luxury because the time involved is not remunerated (Del Mar CB, Freeman GK et al. 2003). This in effect, argues that the possibility of discovering a cause for health–inequalities does not outweigh personal financial interests in a climate of perceived minimal professional discretionary time. It is plausible that the additional workload endured by the GV GPs, having a patient: doctor ratio almost double that of the NE and Melbourne, would have contributed to their lower interest in this study. By contrast, natural therapists were willing to forgo income to participate, and did not seek financial incentives. The North East Division was prepared to fund GPs to attend sessions, the GV Division did not.

Although some GPs may consider research necessary to improved patient care, Mayer found clinical experience takes preference to research evidence when making clinical decisions (Mayer J 1998). That GPs report relying more on experience than evidence when making clinical decisions is not new (Del Mar CB, Freeman GK et al. 2003). In Mayer’s study, general practitioners spoke of the "GP mindset" that ascribes higher authority to clinical experience of ‘medical experts’, than to research evidence, particularly where divergence exists. Such ‘disciple’ behaviour perpetuates a culture of adherence to disease paradigms and treatment modalities as taught in medical schools.

The corollary of this is that less credence is given to the growing body of literature linking environmental exposures to human ill-health. The recency of this evidence prevented its coverage during medical training of a workforce having an average age of 48 (AIHW 2003). Furthermore, evidence linking AgVet exposure to human ill-health has yet to be fully incorporated into the medical journals. Hence it follows that busy rural GPs with minimal spare time to scan non-medical literature, may be not exposed to this emerging knowledge. Under such conditions, a degree of scepticism in environmental causation of ill-health can be expected. This suggests that scope exists to change this attitude, given the strong evidence now showing the significant health problems emanating from chronic exposure to AgVets, as
presented in Chapter 2, and confirmed by the data provided by the communities in Chapter 7. All other provider groups willingly participated in the study, expressed interest in the topic, and most believed that exposure to AgVets probably played a significant role in the ill-health experienced by farming communities. It must be noted however, that apart from the Natural Therapists, all others were salaried, and therefore did not incur loss of income in participating.

Health providers, of all types, in both regions demonstrated very limited knowledge of agricultural chemicals used locally, and of the health risks associated. When questioned about symptoms which would prompt them to think of chemical exposure GPs moved the questioning to other situations or clinical conditions. It was clear that health providers’ expertise in diagnosing health impacts associated with exposure to AgVets was also limited, raising doubts about accuracy of case identification, and appropriateness of medical management. Early recognition and diagnosis of pesticide toxicity is important to ensure appropriate medical management, otherwise patient outcomes are compromised (Aygun D 2004). Harper’s Kimberley Chemical Review concluded that as a result of lack of medical diagnoses of chemically induced harm, chronic illness persisted, and exacerbated in many cases, and several deaths ensued (Harper AC 2002). In this Victorian study, the issue of chemical exposure was not routinely pursued by health providers other than natural therapists, who reportedly were the only group to conduct environmental health assessments, or routinely ask patients about exposure history. This confirmed the community reports provided in the previous chapter.

There appeared to be a dissociation existing between agricultural annual cycle of activities, and the work of health providers servicing these areas of intensive agriculture. Health issues related to chronic exposure can occur at any time throughout the year, whereas acute toxicity would occur soon after exposure. GPs only spoke of acute toxicity, whereas other providers frequently referred to community concerns about chronic exposure effects.

Responses from the PHC providers indicated a shortfall exists in environmental health expertise throughout both regions. Education on the health impacts of AgVet chemicals has not been available, leaving the current workforce largely unable to respond to community concerns. A competent primary health care workforce capable of managing chronic environmental health effects is required.

Questions relating to a preferred workforce model to provide environmental health care services revealed a range of options were deemed suitable for the Australian context. The complex and fragmented nature of split funding has tended to force services to operate as silos, and the paradigm of competition between
services for government funding has resulted in an erosion of interagency cooperation, and exacerbated ‘turf wars’ as providers cling to maintain sovereignty of their professional roles (Stone N, McNair R et al. 2002; Brooks PM 2003; van der Weyden MB 2003). All provider groups, other than Allied Health practitioners, thought their own specialty could competently pick up the role. The most commonly favoured recommendations were specialised GPs and Environmental Health Nurses.

All existing provider groups would require additional training in the toxicology of AgVets to function effectively. A significant component of environmental health care delivery would require a population health approach. Chapter 7 revealed that efforts are required to alter chemical handling practices on the part of farmers. The role would therefore include health promotion for farmers, in addition to taking exposure histories, conducting physical assessments and biological monitoring, making diagnoses, prescribing treatments, and referring complex cases to appropriate specialists.

Australia could follow the model operating in the United States and introduce occupational and environmental health clinics to provide community needs assessment, environmental health education, clinical evaluations, biomonitoring, and clinical specialty referrals. These would help clarify exposure status and evaluate any associated health concerns, improve access to environmental health services, and strengthen the local public health system to follow up on environmental health concerns. The Agency for Toxic Substances and Disease Registry provides on line education, and these could be accessed. Significant knowledge and expertise exists globally to support local knowledge to meet the educational needs of the existing workforce to prepare them for these roles. These clinics could then provide ongoing, on site training for new graduates.

**Perceived Importance of the Environment: Divergence Between Community and Health Provider Beliefs**

GPs, NTs and OHNs thought their services adequately addressed the environmental health needs of their patients, and clients, whereas other community health providers acknowledged their own profession was not currently providing environmental health services. EHOs also believed their services addressed the community needs, yet their operational paradigm defines environmental health as ensuring a healthy environment, rather than diagnosing, monitoring and treating health conditions relating to environmental exposures. The data presented in Chapter 7 indicated that community members were highly satisfied with the services provided by all PHC groups other than GPs, who had a satisfactory rating of 23%. Only
12% of the community members surveyed reported they had ever been asked by their GP about chemical exposures when seeking health care for ailments.

The founder of the National Medical Advisory Service in the USA, highlighted in 1983, the dilemma facing medical practitioners when patients asked them direct questions about environmental exposures causing or exacerbating health conditions. He acknowledged that in most cases, the physician would not have the expertise to either confirm or deny the link, but suggested the physician would “be tempted to provide answers” (Gotts RE 1992). Gotts highlighted the degree of belief and trust in medical expertise, and stressed that providing ill-informed answers carried risks, as confirmation of causation could be taken as medical expertise and later used in litigation. He argued that juries, insurers, and workers compensation commissions, plus the public believe doctors are the only ones “who know the true answers”. Gotts further warned that a physician’s word is considered by lay reviewers to be the considered statement of an expert, and that the community sought health advice primarily from within the health care sector (Gotts RE 1992).

Non-medical providers reporting self-education about the health impacts of exposure to AgVets, were motivated by awareness of their lack of expertise when questioned by patients or clients. It was also frequently reported that it was these feelings of professional inadequacy, which prompted providers to draw conversations away from the topic towards areas within their “professional comfort zone”.

The community views reported via the CATI survey confirms Gott’s argument, where health advice was preferentially sought from within the health care sector, and that GP provided information was most highly regarded, and therefore most frequently sourced. This translated to frustration when enquiries returned a lack of expertise, or lack of interest in discussing potential causal links between health symptoms and environmental exposure.

Several North East nurses referred to the resident, backed by a group of concerned neighbours, who attempted to prompt a Department of Health investigation into cancer rates in the Ovens and King Valleys a decade ago. (This was raised by several CATI respondents) It was feared that breast milk contamination with DDT was sharply elevated. A spokesperson for the DHS advised that the department responded to this community request by analysing routinely collected cancer statistics, and found no elevation in cancer rates. However, the geography of these narrow valleys restricts the distribution of farms to the river flats, which gives these districts very low population densities. Amalgamation with wider regional data, therefore, may have created a dilutionary effect sufficient to mask evidence of increased
incidence (Beaglehole R, Bonita R et al. 1993). Geographical Information System technology linking specific household location to cases was not widely available at the time residents reported the ‘epidemic’ of cancer.

According to the Myrtleford Community Health Nurses, community members believed that a ‘cover up’ occurred, which has generated a distrust of bureaucracies. A Monash University study released in January 2005, has confirmed elevated dioxin levels in human breast milk within the Myrtleford region, and linked this to the elevated incidence of breast cancer in the region (Khanjani N 2005).

A marked divergence exists between the perspectives of the community members and the PHC workforce, especially GPs, in relation to AgVet exposures contributing to community ill-health.

Discrepancies have been reported between specialists, community based practitioners (general practitioners, practice and specialist nurses), and lay people on the importance of environmental factors as a causative or exacerbating agent in disease (Stevens E, Cullinan P et al. 2004). The issue at stake here is that shortfalls in environmental health expertise, and lack of questioning about exposures can result in conditions remaining undiagnosed. In this scenario discrepancies in perceptions are inevitable. The critical factor is that without a skilled workforce, diagnoses and monitoring is impossible, so the extent of AgVet exposure induced ill-health remains unknown.

The divergence between provider groups’ attitudes towards causation of disease, or receptiveness to the consideration that exposure to environmental factors exerts sufficient impact to induce disease was marked, but retained strong consistency within groups. This would suggest a cultural belief, which may reflect paradigms adopted during professional training. Medical students trained during the 1970’s and 1980’s were exposed to the reductionist school, where clinical evidence held priority over the subjective. Other professions adopted an earlier acknowledgement of the lived experience as valid criteria for determining wellness. Recognition of differences in patient’s pain thresholds, and individualistic responses to diseases featured in undergraduate nursing programs in the 1970’s.

**Conclusion**

Engaging regional general practitioners to participate in the study was problematic in the Goulburn Valley region, less so in the North East. All other primary health care provider groups willingly participated. Community members had argued in the CATI survey that their GPs showed little interest in
environmental health as a potential cause of their ill-health. Community health staff across both regions, and natural therapists confirmed they had often heard these complaints about GPs from their patients.

Evidence of the link between AgVet exposure and ill-health has yet to infuse through to medical journals, which reduces the likelihood of access by the primary health care workforce. Health providers demonstrated at best, confessions of ignorance and skills lack, or at worst, a level of scepticism in causal relationships which fall outside their initial training. Knowledge of the chemical agents used locally and the clinical manifestations of exposure were poor across all groups. Attempts to undertake self-directed learning in the field was largely restricted to service providers who lived on farms.

The result is a shortfall in accurate diagnoses, and therefore management of these health problems, despite the faith held by the community that their health providers are knowledgeable and can expertly address their health needs. The data provided by primary health care providers servicing these at risk communities indicate that undiagnosed cases of AgVet exposure related ill-health is most probably occurring in rural Victoria.

In light of this finding, the question of ‘How to improve environmental health care delivery?’ is raised. Alternatively, the question becomes “What model of environmental health expertise would fit best into Australia’s primary health care workforce?” GPs showed limited interest in expanding their repertoire, although with evidence of need this attitude may be reversed. Other potential models involve training a specialty of nurses to provide the environmental health services required, or development of a new role specifically designed to screen, carry out environmental health assessments, organise monitoring, diagnose and report, and refer cases medical toxicological experts as appropriate.

Occupational health nurses argued a principal benefit of establishing environmental health nurses as the primary health workforce schooled in environmental health, lay in achieving greater penetration throughout communities in need and hence improved access. This is the model operating in the United States. Only nurses and Natural Therapists showed interest in expanding their role to include environmental health care services.

Identification of health events of concern initially arise from clinical encounters with astute providers. They may also be identified through regular reporting in administrative databases or regular surveys. Given the lack of responsiveness on the part of PHC providers, and a lack of other surveillance systems
within the health sector, identification and monitoring of these health risks is not occurring. This leaves the populations exposed to these agents at considerable risk.

Although Australia has several well developed health surveillance systems for clinical diagnostic conditions, intelligence relating to chemical exposure is lacking, and introduction of a surveillance system will remain problematic in the absence of expertise at the local level in recognizing human health impacts of chemical exposure, as reporting cannot occur unless accurate diagnoses are made. A clear need exists for improvements in primary health provider education in health impacts associated with acute and chronic exposure to routinely used chemicals among their client groups. Effective health policy making, and future health planning requires the health intelligence provided by an astute PHC workforce, and for data collation via a well-structured surveillance system.
CHAPTER 9
CONCLUSION: SYNTHESIS and RECOMMENDATIONS

Introduction

This concluding chapter summarizes the major points to emerge from this study, and draws together the lessons to be learned. The material presented in the preceding chapters explored the divergence of environmental health from the public health paradigm, and how a new set of environmental health threats have forced Europe and the U.S. to employ concerted efforts to reconnect the two fields as the best option to protect human health. Comparisons were drawn which demonstrate that Australia’s failure to adopt this strategy has meant the continued disassociation of the health sector from rising environmental concerns. As a result, Australians remain at a heightened vulnerability to undiagnosed, and therefore untreated exposure related ill health. This has led to a lack of health intelligence, which has hampered the ability of health planners to develop appropriate strategies to address these issues. This finding has revealed primary health care workforce needs. Final sections of this chapter present a series of areas for improvement in Australia’s approach to the management of environmental health issues.

Study Findings

At the simplest level, this study explored whether AgVet exposure of rural communities is sufficient to cause health harm. It also explored whether the existing primary health care workforce and infrastructure had the capabilities and expertise to appropriately respond. The study also looked at the existing infrastructure underpinning Australia’s capacity for health sector response to environmental issues.

Environmental health once lay at the core of public health, but with improvements in living standards in the industrialized world; public health attention turned its focus towards the Ottawa Charter principles of social and behavioural determinants of health. The focus of environmental health contracted to health protection, that is, ensuring healthy environments that would avert health hazards. Whilst this serves Australia well in many aspects, it allows for gaps, as identified in the study.
AgVet exposures pose a health risk to Australians

AgVets comprise ten of the UN’s ‘Dirty Dozen’ persistent organic pollutants (POPs) targeted for global removal under the Stockholm Treaty, which came into force May 17th 2004, and to which Australia is a signatory. However, although some (but not all) of these most hazardous agents have already been removed from sale in Australia, their persistence in the environment means they continue to impact on human health. Compounding this problem, chemical users and their neighbours also carry the effects of prolonged past exposures. These are indeed highly dangerous chemicals with abundant evidence linking them with serious health impacts. Currently available AgVets, introduced to replace the older chemicals, also cause a range of serious adverse health effects, as outlined in Chapter 2.

Australia’s participation in the competitive global commodity markets has intensified pressures for farmers to maximize production at minimal costs. The precarious Australian landscape, prone to floods, droughts, and salinity, plus the decline in commodity prices have added additional challenges for primary producers to maintain economic viability (O’Connor M 1998). Under such conditions, Australian farmers believe they have little option but to embrace technologies, which offer increased yields and crop reliability. AgVet chemicals, whilst carrying inherent health risks, have therefore become the principal tool of the farmers’ production repertoire. European governments are encouraging farmers to reduce reliance in AgVet usage, but Australia has not followed this move. Growth in AgVet usage has occurred exponentially from the 1950’s, and evidence suggests this pattern is likely to continue (Radcliffe JC 2002).

A literature search revealed pesticide contamination was evident in the Ovens and King Rivers in North East Victoria, and aquifers in the orcharding regions of the Goulburn Valley. Australian studies have also revealed human contamination with pesticides, and Beard demonstrated poorer health outcomes among people who worked with pesticides compared with other outdoor workers. A search revealed no studies which examined the interrelation between AgVets and human health in the context of matching their health care needs. Without recognition of environmental causes of morbidity, routine surveillance has been impossible, and therefore has not occurred in Australia, hence the extent of the problem of chemical exposure remains unknown. The study was devised to examine AgVet exposure among rural communities in Victoria, and what help was available from the primary health care workforce attending the regions studied. Findings revealed that exposure levels are high, and these emanate from a range of pathways.
Farming is the second most risky industry in Australia. The agricultural industry has called for research into improvements in health and safety, access to skilled OH and S advisors, and for attention to psychological problems, and environmental problems facing farming families (Franklin RC 2002). Contemporary OH&S legislation in all states and territories requires employers / managers to implement a risk management approach to health and safety hazards in the workplace, but this has not translated to the farming sector where 95% of farms are family owned and operated. Many farmers and farm managers have not to date had access to relevant training to develop these skills, nor the appropriate and relevant tools to implement the risk management approach to farm health and safety. Farmers need to be aware of the associated risks, and have support systems in place to encourage, and if necessary, enforce safe application of AgVets.

Adherence to label instructions for mixing, handling and applying AgVets was reportedly low among the study communities. Wearing of personal protective equipment as per instructions most of the time was reported by only 25% of farmers, whereas 64% of users reported rarely or never wearing protective gear. The final responsibility for safe usage of these chemicals lies with the applicators, in this case, the individual users of farm chemicals.

The growth in reliance on AgVet usage over recent decades has been a national phenomenon. Intensive agriculture associated with heavy AgVet reliance occurs in rural settings in all states and territories of Australia. No evidence exists to suggest that adherence to personal protective measures is less common among agriculturalists in Victoria than in other states. Indeed, the ChemCert Coordinator reports that Victorians have a higher rate of undertaking Chemicals Users Courses. Based on this information, the study assumes cautiously, that exposure patterns are broadly similar across the country. This assumption needs to be tested.

If the community responses provided to this study are representative across Australia, then farmers nationwide must accept the challenge and the responsibility of using agricultural and veterinary chemicals safely and judiciously and in a manner which would safeguard other people and the environment. The study identified practical reason for why farmers were reluctant to adopt safety precautions, and it is possible that familiarity has lessened their ‘respect’ for the toxic nature of these agents. Research is need for behaviour change strategies to be affective. ChemCert and Agsafe offer courses in safe handling of AgVets. However, less than 40% of respondents indicated that the primary user of chemicals had undertaken such a course, indicating that scope exists to increase uptake of these courses to achieve greater penetration among rural communities, to modify personal practice, but to also
help change broad community attitudes towards AgVet handling. Broad community understanding can also result in pressure being applied for neighbours to reduce the incidence of spray drift.

The CATI survey revealed that rural exposure to AgVets among rural communities is high, and spray drift presents a serious problem indicating poor application techniques. Many residents have been exposed for several decades, to a cocktail of chemicals, including the highly toxic agents listed in the UN’s ‘Dirty Dozen’ earmarked for phase-out under the Stockholm Treaty. Exposure occurs through a range of direct and indirect pathways. The study also found that self-reported health status of those exposed is worse than for those who have not worked with these chemicals, across a range of health parameters.

**Australia’s policy framework fails to prevent risks**

The global rise in chemicals usage, coupled with a series of chemical related environmental disasters has spurred an international response. A series of United Nations conventions and multilateral agreements have followed, and in Europe and the U.S., a number of environmental laws were enacted, and agencies were established to specifically address the human-chemical interface. These included nation-wide monitoring and surveillance programs, and strategies to educate the primary health care workforce, equipping them with the skills to recognize and manage chemically induced harm to human health. This was made possible through reorganisation of chemical management frameworks to create formal links between health and environment infrastructures.

The 1990 Report of the Australian Senate Select Committee on Agricultural and Veterinary Chemicals contained 45 recommendations relating to the then current chemical legislation and regulatory system. These included the need for a nationally unified approach, the potential place of non-chemical management systems, including integrated pest management and biological control, the social, health and environmental impacts of chemicals, and the need for better training in the management of their use. These recommendations have not been adopted (Radcliffe JC 2002).

Australia is a signatory to some of the multilateral agreements, but has not ratified the Rio Declaration, so is not bound to incorporate the precautionary principle into policy. It also retains a framework split with little interaction between the health and environment sectors. The process currently employed to review Australia’s Chemical Management Framework demonstrates the impact of this. The agency charged with this task is aligned with the Department of Environment and Heritage; accordingly, the focus of
Australia’s Chemicals Management Framework review emphasises environmental impacts (EPHC National Chemicals Taskforce 2003). Excluded from the review was a detailed examination of existing infrastructure to monitor or manage the human-chemical interface. Australia is not currently working towards the establishment of avenues to monitor human health impacts from chemical exposure. This contrasts starkly with international developments, where human health is the primary focus.

The NEHS identified that health per se rarely received high priority in Australian environmental policies and development plans (enHealth Council 1999), and urged that closer links are required between the environment and health. Despite this, enHealth documentation continues to define environmental health in terms of health protection. Departments of health and public health organisations in Australia have also operated within this paradigm, which divorces health from environmental health by maintaining focus on developing environmental parameters rather than human health parameters.

The statutory authority responsible for registering AgVets in Australia, the APVMA, falls under the Department of Agriculture, Fisheries and Forestry. Links with human health are limited to toxicological assessments of new AgVet chemicals proposed for sale in Australia, and of existing chemicals placed under review. These assessments presume prefect compliance with the published guidelines for handling and application of AgVets, whereas it is known that compliance in the field is poor (EPHC National Chemicals Taskforce 2003). Additionally, jurisdiction of the APVMA ceases at the point of sale. Post sale compliance monitoring in Australia is performed by variety of different agencies in the states and territories. Given the practical difficulties of supervising farmer application techniques, compliance monitoring of AgVets is weak, and instead, relies on volunteered reports, a complex process made difficult by the fractured nature of the framework. Intelligence on the usage of AgVets is also lacking. It is limited to sales data, which serve as a proxy. It is therefore not possible to identify the amount or type of chemicals applied, nor in what locations are they used. This negates the community right–to–know, and hampers surveillance efforts.

Contrasting this, is the situation in the U.S., where the authority charged with regulation of AgVets is the EPA. Responsibility of the U.S. EPA far exceeds that of the APVMA, for it also deals with human exposure issues. AgVet regulation was transferred out of the Department of Agriculture in 1970, specifically to incorporate the human health function. The flow on effect in the U.S has been the development of nationwide surveillance and health tracking programs, and considerable efforts to inject environmental health education, and chemical injury expertise into the health care workforce. National inventories on chemical manufacturing sites, storage and application are also publicly available –
allowing for community right-to-know, and facilitating research into health problems associated with exposure.

**Australia lacks skills in environmental health practice**

Environmental health service provision in Australia is largely limited to Environmental Health Officers, yet their role is regulatory, and focused on health protection. EHOs are not health care providers. The Australian primary health care workforce have not received formal education in environmental health, nor are courses broadly available to health care providers on how to diagnose and manage exposure illnesses. Exposures to agricultural and veterinary chemicals are still missing from most – if not all – undergraduate training curricula. Evidence linking AgVet exposure with disease has yet to flow through to the medical literature, and rural GPs have limited time to scan journals external to medicine. Upskilling of the existing and future primary health care workforce is unlikely to occur without the introduction of formal education programs of environmental health designed for health care providers. Patient outcomes are compromised when denied early recognition and diagnosis of pesticide toxicity, for this is vital to ensure appropriate and timely clinical management.

A high degree of conviction exists in these rural communities that their ill-health is directly attributable to their AgVet exposure. Few have been questioned about exposure, or been provided with health advice from their primary health care providers.

Respondents reported that they are willing to seek environmental health care from a range of providers, with a strong preference for GP’s, followed by Nurse Practitioners specialising in Environmental Health, Natural Therapists, Environmental Health Officers and Public Health Nurses, although 70% of the sample reported not knowing of the role of the EHO. Willingness to see a GP persists despite only 30% reported being satisfied with their care, compared to over 80% reporting being satisfied with the health care provided by the other specialties.

Interviews with primary health care providers servicing the region revealed little understanding of regional utilisation of AgVets, which agents are used, nor of the symptoms associated with exposure. Although somewhat better informed, knowledge levels of providers who had lived on farms were also extremely limited. No one had received formal training in recognition or management of AgVet exposure. Among GPs, the concept of AgVet exposure related illness was restricted to acute toxicity.
Non-medical providers were aware of community concerns about their exposure history and possible health impacts, whereas GPs believed community concern was low. Excepting allied health professionals, the providers surveyed believed their own health speciality was well placed to assume the role of providing environmental health services to the community, given additional training. When asked if they had any personal interest in taking on the role, only nurses showed interest. Occupational nurses were especially interested, and believed their role currently encapsulated many of the activities required, including chemical exposure, although their knowledge of AgVets was admittedly poor. (These nurses were currently working in the industrial setting). Natural Therapists also believed they were currently engaging in providing environmental health services, and were the only group within the region to report performing environmental health assessments.

**Community – Provider Perspective Discordance**

The observed divergence between community and provider groups regarding the significance of environmentally related health disorders has been observed internationally, and in other studies reporting chemical exposure in Australia. Concern about health impacts was most ardently expressed by those experiencing significant health problems, especially allergies and cancers. Whereas non-medical health providers expressed discomfiture about their inability to provide practical advice when asked by their clients, medical providers did not rank environmental exposures as a significant contributor regional ill-health, even amongst patients who routinely work with AgVets. Reluctance to participate in the study was also a feature limited to general practitioners.

The study confirmed the findings of Starr and others that health advice given by health professionals, especially GPs, is widely regarded as the most useful source of information about environmental issues concerning general health. When this information is not forthcoming, community views are then developed through personal and anecdotal experience of friends and neighbours, mixed with information accessed through the media. The accuracy of media information on technical details can be questionable. Exposed communities have a right to access accurate information from reliable sources.

Discrepancies in ranking the potential harm resulting from AgVet exposure can also impact on whether farmers treat these agents with appropriate caution. And when treating health practitioners are not alert to exposure related health conditions, diagnoses can be missed, which places patients at risk of absent or delayed health treatment, and perhaps more importantly, at risk of continued hazardous exposure. Lack of GP interest in AgVet exposure was repeatedly expressed throughout this study.
Public Health Infrastructure

Historically, the importance of environmental health has often been recognized during or as a result of major tragedy (Marmagas SW, King LR et al. 2003). The attacks that occurred in the United States in 2001 are no exception. These events raised awareness of inadequacies in the public health infrastructure, and highlighted the need for emergency preparedness, and for infrastructure to be flexible and sustainable, and the demonstrated the importance of identifying and monitoring the linkages between environmental exposures and health outcomes (Lurie N 2002). Evaluations of the public health response to this tragic event, further promoted the findings of the PEW Health Commissions recommendations (Litt J, Tran N et al. 2004; McGeehin MA, Qualters JR et al. 2004).

Australia has not been jolted into reviewing the efficacy of the primary health care workforce and infrastructure to respond to a similar event; however that 9/11 disaster serves as a salient lesson for Australia. Due to previous major environmental contamination events, the U.S. had embarked on the pathway of developing environmental health expertise, and instituting health surveillance systems. This event gave further impetus to this, and the U.S. responded by establishing national environmental health tracking system to improve overall public health capacity and prepare the United States to investigate the critical issues of the day, whether they be emerging infectious diseases, terrorist attacks, or chronic illnesses.

Surveillance can take several forms, such as routinely collected data from GP clinics, and hospital data, or population surveys. Different information can be collected by using these methods (Noah ND 1997). Formal monitoring systems are needed to provide regular collection of information, and an understanding of the changing dynamics of the health risk behaviours of the general population. Monitoring issues allows the setting of targets and measuring of performance against those targets, including measuring the effect of health promotion initiatives or interventions. Surveillance of chronic diseases and the associated behavioural and socio-environmental risk factors have been identified as national priorities in Australia. Several states have introduced routine surveillance and monitoring systems, although environmental health questions have not to date featured in these surveys.
Objective outcome measures such as changes in surveillance data or some measure of pesticide exposure, as determined by biological monitoring or exposure monitoring have been used in several studies, and can be used effectively as biological monitoring for routine surveillance (Keifer MC 2000).

A precondition for effective surveillance is environmental health expertise in the primary health care sector operating in areas where the need exists, to enable identification of confirmed and suspected cases to be fed into the system. The first-level solution is improved surveillance and response capability within the primary health care sector. The second is the integration of health surveillance with environmental health monitoring. The third is incorporating the information gathered into an appropriate response (rapid where necessary), and health planning. Early interventions can save money and lives. Greater disease surveillance and response capability are the first, essential steps for Australia.

The public health approach aims to prevent illness by promoting healthy behaviours, addressing the cause of disease, and attempting to understand the complex web of determinants underlying disease. Through the integrated analysis presented here, this thesis has undertaken a public health approach to AgVet exposures. C.E.A. Winslow’s definition described the preventive focus of public health which still resonates today.

"Public health is the science and art of preventing disease, prolonging life, and promoting physical and mental health, and efficiency through organised community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organisation of medical and nursing services for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community, a standard of living adequate for the maintenance of health"

(Winslow C 1920)

Prevention can occur at three levels. Primary prevention involves intervening in systems to address the risk factors for disease (and reduce or eliminate exposure to harmful agents) before diagnosis. Secondary prevention is early detection, often at the preclinical stage, before disease is evident, and allows for early treatment and prevents further development of disease, and tertiary prevention limits the health damage through treatment and rehabilitation after disease has occurred.

---

8 Pesticide exposure is evaluated using the following methods: AChE levels (cholinesterase (AChE), is an enzyme measurable in blood and whose activity is reduced by exposure to organophosphate and carbamate); alpha cellulose pads or dermal patches placed on and beneath protective clothing; the level of urinary ethion metabolites; fluorescent tracer with or without video imaging techniques; inhalation exposure measurements; and reported ‘toxic’ symptoms. Keifer MC (2000). "Effectiveness of interventions in reducing pesticide overexposure and poisonings." American Journal of Preventive Medicine 18(4 Suppl): 80-89.
Application of these levels of prevention to reducing the effects of harmful AgVet exposure can involve:

- **Primary prevention** - reducing reliance on AgVets, substitution towards safer chemicals, health promotion about the impacts of pesticides on health, and specific protection such as encouraging the wearing of PPE;
- **Secondary prevention** – establishing biomonitoring system to identify the levels of contaminants in human body fluids;
- **Tertiary prevention** – treating farmworkers, and others, for early signs of pesticide poisoning.

A role exists for primary health care practitioners with expertise in environmental health to contribute to and perform at all levels of prevention. Once thought to be saviours, the hazardous nature of chemicals has emerged over recent decades and globally, has prompted a plethora of environmental laws, and established an era of reviews of chemical management frameworks. Human health should take priority in policy development at this level, so experts from the field have a place at these forums, and also in providing advice to the national chemical regulators. Other roles in primary prevention involve providing health promotion on chemical hazard awareness, and contribute to safe chemical handling and personal protection.

Primary prevention also involves risk assessment, risk characterisation, and risk management, which forms part of the public health infrastructure. Local regions, or activities such as fruit growing, should undergo risk assessment to identify specific hazards, their adverse effects, and conditions of exposure. Risk characterisation combines the exposure and dose-response assessments to calculate the estimated health risks, such as the number of people predicted to experience a particular disease, for a particular population. Then follows risk management, the managerial, decision-making and control process to deal with those environmental agents for which risk evaluation has identified that the risk is too high. Performance of these functions requires knowledge of toxicology, epidemiology, physiology, and public health policy, or a team approach.

The ability to submit samples, manage data bases and undertake other administrative tasks are not profession specific, however a surveillance system involving biomonitoring, requires the taking of samples, a fundamental skill specific to the primary health care workforce. Tertiary prevention, limiting further progression by providing treatment modalities within the community setting is also restricted to those with professional health qualifications.
Primary Health Care Skills and Competencies Required

The study identified that rural populations are exposed to hazardous levels of AgVets, with negative health consequences, and the current primary health care workforce model fails to adequately meet these needs.

Europe and the U.S. have identified their gaps in environmental health care infrastructure and instituted responses. Panels of experts across multiple disciplinary fields were convened to examine the public health workforce to determine core competencies, and educational framework required to meet the environmental health needs of the future. The Pew Health Professions Commission (U.S.A.) listed 21 competencies needed by all health professionals to address emerging environmental health care issues (Center for the Health Professions 1998). Five health disciplines were invited to answer the question “What are the skills that currently employed personnel need that they do not have”. A national panel of 25 leading public health education professionals, which included 19 public health educators from local, state, and federal health agencies, three faculty members representing academic professionals training programs, two directors of key professional organisations, and the convenor was a specialist in public health nursing (Allegrante JP, Moon RW et al. 2001).

A scan of international approaches to this problem revealed that the United States has recently reviewed its public health competencies. The Public Health Faculty / Agency Forum identified universal competencies expected of graduates from a school of public health including competencies for the specific disciplines (Gebbie K, Rosenstock L et al. 2002). Environmental health was nominated along with public health administration, epidemiology and biostatistics, and behavioural sciences as a required core competency. The Institute of Medicine Report “Who will keep the public healthy?” prepared by the Committee on Educating Public Health Professionals for the 21st Century, identified a need for enhanced public health training within the health professional curricula. The report argued that all medical students should receive basic public health training in population-based prevention, and up to one-half of these students should be fully trained in the ecological approach to public health at an equivalent to the Master of Public Health level.

The National Strategies for Health Care Providers: Pesticides Initiative has set forth a strategic direction for the nation to improve the recognition, management, and prevention of pesticide-related health conditions. The vision is for all primary health care providers to:
• Possess a basic understanding of the health effects associated with pesticide exposures as well as broader environmental exposures.
• Take action to ameliorate such effects through clinical and prevention activities.

Two documents were published in 2003 to further these goals. The first of these detailed the environmental health care skills and knowledge base that should be mastered by primary care physicians and nurses in the practice arena, and the companion document focused on the knowledge base that should be mastered by students as part of general medical and nursing training.

Public Health Nurses in the United States are also being prepared to respond to emerging environmental health threats (Mondy C, Cardenas D et al. 2003; Veenema TM 2003). International research suggests that one of the critical factors for improving chronic disease management in the primary health care sector, is the effective use of non-GP care providers and patient-care teams (Poulton B and West M 1999; Wagner EH 2000). Oldroyd’s study revealed that Australian GPs were content to have practice nurses assist with their burden of paperwork, conduct patient recalls, fill in as receptionists and provide some patient education. GPs did not however see practice nurses as being potentially able to reduce the clinical management burden of chronic diseases by taking over clinical duties traditionally performed by GPs (Oldroyd J, Proudfoot J et al. 2003). To overcome this potential hurdle of lack of recognition, introduction of a nursing role to conduct environmental health would therefore require sufficient environmental health and toxicology training to earn professional respect from others in the PHC field.

Recent reviews of public health workforce in Australia excluded environmental health. This is deemed the role of the enHealth Council. However the enHealth Council documentation restricts its examination of environmental health to Environmental Health Officer training, and does not explore the issue of environmental health expertise within primary health care workforce.

Based on the study findings, the primary health care practitioner must have specific skills in order to address environmental health problems. These include having the ability to:

• interview and to take an environmental health history;
• understand community and individual pesticide risk factors;
• have a sound knowledge of AgVet toxicology, usage guidelines and regulations;
• conduct environmental health assessments of communities and individuals (including physical health assessments);
- conduct physical environmental health assessments (assessment of environmental hazards);
- take biomedical samples; and interpret and communicate findings;
- provide health advice and deliver health promotion (general and specific) programs;
- diagnose and screen for likely exposure related health impacts;
- institute therapy (clinical management) and refer to appropriate specialists;
- manage client records on database; and contribute to surveillance;
- report pesticide exposure and support surveillance efforts
- engage in risk communication

Educational background required by the primary health care workforce with respect to AgVet chemical exposures must include a solid grounding in AgVet toxicology, based on sound knowledge of physiology and pathology. In addition to having established expertise in developing sound client - provider relationships, an environmental health practitioner must also be trained in epidemiology and research. Skills need to be strengthened through systematic continuing education to meet the challenges ahead and contribute towards the national effort to ensure the improvements in rural health. Achieving this vision means incorporating some changes in educational institutions related to the health professions – medical schools, nursing schools, residency, and practicum programs – to better equip students and the existing workforce to deal with pesticide-related exposures and health conditions.

**Workforce Model**

A subsidiary research question underpinning this study asked “What primary health care workforce model would suit Australia's environmental health issues?”

The study did not attempt to find a single model to address the health needs for those exposed to AgVet chemicals. It was anticipated that a variety of recommendations may emerge which may also serve to inform the development of a model to address broader environmental health issues.

Consideration of workforce models for the primary health care sector is dependant upon the needs of the local community. This study has identified a need for the development of environmental health expertise in the rural primary health care workforce. This could be achieved by the introduction of an environmental health specialty within an existing health profession. An alternative approach is to inject
broad environmental health training across existing professions, via additions to curricula, supported by continuing learning modules for current practitioners. These approaches are not mutually exclusive.

Several major points emerge from the findings which impact upon consideration of workforce models to address this need. Firstly, little interest in environmental health was demonstrated by general partitioners. Factors impacting on this were reportedly heavy workloads for rural GPs, and a resultant reduction in professional discretionary time to maintain currency in emerging literature. Whereas GPs have foundation knowledge of the principles of toxicology, minimal environmental health literature has filtered through to medical journals.

A preference for the health systems model of health as taught in original medical training was evident. The National Health Strategy and the Primary Health Care in Health Promotion reports concluded that GPs concentrated almost entirely on clinical care for individual patients, and engaged in minimal health promotion, citing a lack of population health focus and fee-for-service funding system as drivers (Macklin J 1990; Commonwealth of Australia 2003). The review of the General Practice Strategy concluded that increasing the GP role in public health would require additional training and establishment of working relationships with existing public health networks (Baum F 1999; Commonwealth of Australia 2003).

Creation of an environmental health role for GPs would require establishment of a specified funding source to remunerate time spent conducting health promotion and screening, as the current fee-for-service arrangements would not reimburse GPs sufficiently to motivate them to effectively execute this task. On this basis, it can be anticipated that efforts aimed at reversing this apparent lack of interest in environmental health issues will be needed to confront these challenges, and therefore may meet with limited success.

Health promotion has much to offer environmental health, in tandem with other environment health activities (enHealth Council 1999). Changes in farmers’ handling of chemicals are required, and the need for assiduously wearing of PPE needs to be reinforced. Difficulties in engaging GPs in health promotion have been well documented, and furthermore the Monash Centre for Health Program Evaluation identified that increasing the supply of GPs bears minimal impact upon reducing health inequalities (Richardson J and Peacock S 1997). Several studies have identified that specialized nurse practitioners can achieve equal (and in some cases greater) improvement in health status to GPs for specific primary health care delivery (Mundinger MO and Kane RL 2000).
Nurses interviewed expressed an interest in the area of environmental health, and occupational health and safety nurses are currently engaging in environmental health assessments for their clients, although this is currently largely restricted to the industrial settings. Nurses have a sound understanding of human physiology, and have demonstrated effectiveness at delivering health promotion. They are also competent at performing health assessments, screening, and instituting basic health care delivery. Additionally, nurses are relatively well represented in rural areas, compared to other health professionals. Nurses therefore present a realistic solution to this problem if given the additional training required in toxicology of chemicals.

Other options for consideration must include EHOs, natural therapists, and the creation of a new health professional role with expertise in health assessments, health promotion, and environmental health. The role of EHOs is presently focussed towards enforcing legislative requirements, and maintaining healthy environments. Throughout Australia, they currently have very restricted face to face contact in an established client - practitioner role, limited knowledge in physiology, and are therefore not currently equipped to perform health assessments. Additional training in this regard would be required.

Natural therapists currently perform environmental health assessments, provide health promotion, and health advice, and also engage in patient - provider relationship, but their toxicology training is limited. Their existing practice methodology is congruent with an environmental focus; however services provided by natural therapists are currently regarded as complementary to the mainstream health sector. Broad acceptance of the role to fully integrate with the health sector is required to ensure closer affiliation and intersectoral collaboration.

Introduction of a new specialty, an environmental health practitioner offers benefits of designating the set of required skills and knowledge appropriate for Australian conditions which would align with existing in workforce arrangements. Disadvantages include that this would entail a complex and lengthy process of role creation, educating the new workforce, registering practitioners and regulation of the industry. In light of these issues, it would appear that environmental health nurses present the most viable option in terms of a rapid and cost limited response to the question of introducing environmental health expertise into the Australian primary health care workforce. The United States model of establishing combined occupational and environmental health clinics appears a sound option to address broad needs.
**Strengths and Weaknesses of the Study**

As outlined in Chapter 5, the community survey was not designed as an epidemiological study. Data were not sought about individual AgVets, as farmers routinely use a cocktail of chemicals. Therefore further research is required to accurately determine the association of AgVet exposure with poorer health outcomes in these communities. Sufficient evidence exists in the literature however, to demonstrate that AgVet exposure is associated with a range of health conditions. These communities have experienced chronic AgVet exposure, and although not conclusive, the findings suggest these communities exhibit conditions known to result from exposure.

Survey methodology presents biases of recall, and the sampling methodology involved the use of proxies to provide information. This also places limitations on the community data. Additionally, the impact of the bushfires occurring immediately prior to the community survey on survey findings remains unknown. No data are available on the refusals, which may also introduce distortions to the findings. However, given the relatively small populations of the districts surveys, the survey achieved a high penetration by surveying 1000 (and 1050) households across each region.

Poor representation of Goulburn Valley GPs was achieved, so the findings are skewed towards the views of North East GPs. Further research to determine the level of engagement GV GPs have with the environmental health needs of their patients, and their understanding of AgVet exposures is required.

**Further Research**

Design of any study necessitates the application of limitations regarding breadth and scope. The intent of this study was to fully contextualizing the community experienced AgVet exposure risk (the rationale for reliance on AgVets, levels of self protection adopted, perceived harm attributable to AgVet exposure) and the primary health care capacity to respond (level of education, environmental health framework and interaction between the health care sector and environmental health). This was to allow firstly for an assessment of whether sectors of Australian rural communities are at risk of hazardous AgVet exposure, and these findings suggested strongly that this was indeed the case. Secondly, to allow for the making of recommendations about how a primary health care model can fit within existing environmental health infrastructure, and what (if any) adjustments could be made to facilitate this.
In selecting this approach there were many tradeoffs, questions which could not be explored in detail, but have significant bearing on the issues of chemical injury and chemical management. The research itself also raised a series of questions which should be the subject of ongoing research.

Questions that could be explored further include:

- What is the attributable risk of AgVet exposure to the health status of rural communities?
- What capacity exists for diagnosis of acute and chronic poisoning? and ... What additional training is needed to achieve this – for future and existing practitioners?
- What PHC actions are available to avert and minimize harm from hazardous AgVet exposure?
- What is the link between epidemiological evidence of harm, and implications for taking a precautionary approach, with ability for diagnostic accuracy?
- What impact would having an effective population wide surveillance system which would flag clusters, both occupationally and geographically have on reducing poor health outcomes? How could this be introduced?
Conclusion

This study engaged in a broad examination of one emerging environmental health issue facing the Australian people, and therefore also its policy makers. The rapid rise in AgVet utilisation, coupled with the increasing body of knowledge demonstrating their harmful effects on human health has jettisoned this to become a critical public health issue in need of reparation. There is no doubt that utilisation of AgVets has boosted agricultural production and bought benefits in delivering a stable, plentiful and varied food supply, whilst also reducing the spread of vector borne diseases such as malaria. Their benefits must however, be balanced against their associated risks. The study has demonstrated that Australia needs to adopt a more cautious approach to these agents. Weaknesses have been discovered along the entire pathway of chemical management through to utilisation at the individual level, all of which need addressing to avoid further ill-health of those currently exposed, and those who might be in the future.

Chapter 2 described the broad range of health problems attributable to exposure to AgVets. Rural Australians have higher rates of many of the conditions described, and the survey participants indicated higher diseases rates were associated with certain chemical exposures. Screening of human chemical burdens in international settings have shown that all members of society have chemicals in their systems, and the load is higher for agricultural workers, but these studies have not been conducted in Australia, so we do not know the actual burden. Research has also demonstrated that areas of the Australian landscape are contaminated with AgVets and their degradation products. It is highly probable that Australians are also contaminated; further research in this area is needed to ascertain the full impact on Australians. One example is the high rates of depression and male suicides in rural areas, where exposure to organophosphates are known to be neurotoxic, and produce a range of neurological and behavioural symptoms, difficulties in social adjustment and developmental delays.

Situations of reported inadequate medical practitioner responses when their patients present with chemical injuries have also been reported by two other Australian studies discussed in the thesis (in the Kimberley & within the Defence/ Airforce). Findings of this study in Northeast Victoria support the arguments presented in those two studies, i.e. that a problem of undiagnosed chemical injury does exist, and that affected community members find the medical response/attention lacking. This would suggest that the problem could occur nationwide, particularly in areas of high utilisation of AgVets.
The occupational health physician, Dr. Harper, stressed that when conditions are unrecognised, effective management and appropriate harm reduction strategies cannot be instigated, so it is highly likely that further deterioration of health condition would ensue. As health provider education and their practices are common, this study represents another instance where problem exists elsewhere Australia.

According to these findings, it appears that little progress has been made towards adopting the recommendations made in the 1998 National Profile of Chemicals Management in Australia. The assessment made in this report, that achieving a reduction in hazardous chemical exposure would be difficult for government control, needs re-evaluating. A national effort is required, involving a whole of government approach. There needs to be a reduction in reliance in AgVets, and governments have a range of options available for use as leverage to achieve this, and to drive the move towards safer chemicals. Regulatory authorities need to bear in mind the human factor in their decision to register chemicals for sale in Australia. Compliance monitoring is flawed, and in some cases absent, this process needs addressing, to be effective, and readily accessible, so that aggrieved people have confidence that the agencies responsible for managing compliance are securing their safety.

The current situation in Australia therefore is one in which some of the most dangerous chemicals in usage are continuing to be applied in a dangerous manner. Rural populations have also been chronically exposed to range of toxic chemicals, and the present primary health care system remains unable to effectively monitor or rectify. This places Australians at undue health risks.

The examination, presented in this thesis, of the existing environmental health infrastructure, primary health care workforce and community interface within the in rural Victoria, revealed several key features in need of attention. Of these, three appear most pressing. They are farmer behaviour modification, injection of environmental health skills into the primary health care sector, and thirdly, introduction of a coordinated system of surveillance to monitor for exposure ‘hotspots’.

Without an appropriately trained health workforce, diagnoses and monitoring is unachievable. The current situation is that we simply cannot detect whether or where, exposure related health problems exist, nor to what degree. Health planning and strategic policy development must be evidence based. Community fears may be legitimate, or not, but without effective surveillance systems there can be no appropriate response, nor alleviation of their concerns.
Introduction of several strategies to improve the environmental health expertise of the primary health care workforce show merit, and would fit with the existing infrastructure. The introduction of Environmental Health Nurses offers certain advantages over other solutions. Establishment of this role would involve relatively little lead-time compared to other specialties. Existing education exists for occupational health and safety nurses, and the step to include a rural focus, and AgVet toxicology is achievable in a relatively short timeframe, with relatively limited additional resource requirements. Significant web based resources have been developed in the U.S., these are readily available and would support the additional training requirements. Additionally, and significantly, nurses have demonstrated a willingness to work in rural areas, whereas it has proven more difficult to attract other health providers. This is the model adopted in the United States.

Consideration should also be given to the development of continuing education modules for the existing primary health care workforce, in addition to enhancing environmental health education across the spectrum of health practitioner curricula, at undergraduate and post graduate levels.

The major finding of this study is that the underling problem facing Australia in terms of environmental health is the lack of the health care sector involvement in environmental health. This has been explored in depth at the community – provider interface, however scanning the institutional frameworks through to the responsible Federal Ministers for the Health, the Environment, and Agriculture reveals this separation is institutionalised to the highest level of jurisdictional isolationism. Exposures to AgVets serve as an exemplar of the vulnerability of the Australian population resulting from continued adherence to this outdated arrangement.

For Australia to maintain its clean and green image, vital for trade, tourism, and to ensure the health of the Australian current and future populations and physical environment, it must look to the lessons learned by international governments affected by the series of environmental disasters. Other nations responded to these events by ensuring chemical management frameworks (including AgVets) hold human health as a priority. Europe is working towards reducing chemical reliance, and policy makers in both Europe and the U.S have realised the need to monitor the effects of chemical exposures on humans, and to also introduce environmental health skills among their primary health care workforce. Australian policy makers cannot continue to believe that the protection offered by Australia’s island status and low population densities will persist indefinitely. Chemicals have impacted globally, and evidence presented in this study indicates that Australians are also suffering the effects. Fundamental structural changes are now required to address this in Australia.
Recommendations

Primary health care workforce

- That a new specialty role of environmental health care service provider is introduced. Consideration should be given to modifying the course for occupational health and safety nurses.

- That undergraduate curricula of medical and nursing degrees include training in environmental health.

- That postgraduate courses in environmental health be developed for doctors, nurses, and public health practitioners.

Community health education/promotion

- That chemical handling courses are expanded to increase the uptake by farmers.

- That chemical awareness programs are introduced for non-farmers.

- That user-friendly information on AgVets, and other chemicals, including application techniques, personal protection guidelines, and associated health risks become publicly available, in a variety of languages.

Environmental health surveillance

- That infrastructure to introduce environmental health surveillance systems is established, including establishment of government laboratories to conduct biomonitoring. The U.S. Environmental Public Health Tracking Program serves as a model.

- That existing national and state based health surveys include questions concerning environmental health, and exposure.

- That the National Chemical Inventory be expanded to include small sized industries, and that information on chemicals, manufacture, storage and release into the environment (including AgVets) be made publicly available, according to the principles of community-right to know.
Primary Health Care Model to Incorporate Environmental Health

- That establishment of occupational and environmental health clinics be trialled, similar to the model operating in the United States.

- That alternative models, such as establishment of positions within Community Health Centres for primary health care providers specifically trained environmental health, be trialled.

- That incentives be introduced facilitate interested individuals wishing to establish practice in this realm, and offer training opportunities as required.

Chemical Policy Framework

- That Australia ratify the Rio Declaration and adopt the precautionary principle.

- That a unified national chemical regulatory authority, encompassing the existing four agencies (TGA, NICNAS, APVMA and FSANZ) within the federal health portfolio, be established to streamline the chemical regulatory and assessment functions, with the principle focus of ensuring human health and safety, and protection of the environment.

- That the National Chemical Management Framework (in current development) be expanded to strengthen the focus to limit hazardous human health exposures, and should include the mission to actively promote safer chemicals and reduce chemical reliance. Incentives could be used as a strategy to achieve this goal.

The global rise in chemical reliance has presented an emerging health threat of significance, which requires a coordinated government response. The study identified the strategic importance of Australia having environmental health expertise within its primary healthcare workforce, as has been recognised internationally. The primary health care workforce has a principal role in health promotion, and the ability to identify and manage exposure related health problems is critical to inform a surveillance system to enable effective health planning.
REFERENCES


AIHW (1998). Health in Rural and Remote Australia. Canberra, Australian Institute of Health and Welfare (AIHW) and NPHP.


Arctic Monitoring Assessment Programme (AMAP) (2000). Persistent organic pollutants (POPs) - Fact Sheet. *, AMAP.


Australian Institute of Environmental Health (2005). Australian Institute of Environmental Health Course Accreditation Policy. Version 4.0 Draft Policy, AIEH.

Canberra, AIHW.


Canberra, AIHW - Australian Institute of Health and Welfare.

Australian Medical Council (2000). Undergraduate medical education and unorthodox medical practice. AMC Position Statement, AMC.


Bensoussan A and Myers SP (1996). Towards a safer choice, the practice of Traditional Chinese Medicine in Australia. no. Sydney, Faculty of Health, University of Western Sydney.


CHERE Defining Primary Health Care. Sydney, Centre for Health Equity Training, Research & Evaluation, University of New South Wales.


Dyer O (2003). "Women with breast cancer are more likely to have high blood levels of pesticides." BMJ 326(7396): 952.


General Practice Divison Victoria (2002). Response to Victorian Department of Human Services: GPs in community health services report. Melbourne, GPDV.


Halweil B (2000). “Where have all the farmers gone?” WorldWatch(September/October).


IPCC (2002). *Climate change and biodiversity. IPCC Technical Paper V*. Geneva, Intergovernmental Panel on Climate Change (IPCC), WMO, UNEP.


Keleher H (2000). "Why primary health care offers a more comprehensive approach for tackling health inequalities than primary care." NPHP.


McMichael C and Lin V "Public Health Interventions In Australia."


Parsons WT (1979). The present status of 2,4-D and 2,4,5-T. cited in Harper AC. no, Victorian Vermin and Noxious Weeds Destruction Board.


Rotberg RI (2000). "Health and Disease in Human History."


Shellard D and Searles A (2001). The other person' technique; a methodology to minimize 'volunteer' bias in telephone surveys using random sampling techniques. The 3rd CATI Forum, Sydney, Hunter Valley Research Foundation.


Sidoti C (2000). *Beyond Bush Talks*. Infront Outback, Toowoomba, Qld, Australian Association of Rural Nurses Conferences, and Australian Human Rights & Equal Opportunities Commission.


Truss W Minister For Agriculture Fisheries and Forestry (2003). 'Planning Agriculture's Future - Drought and Beyond' Speech to the Farm Writers' Association of NSW, Commonwealth of Australia.


Wells R (2000). *Underserviced communities - Australia*. 5th International Medical Workforce Conference, Sydney, AMWAC.


APPENDIX  1

Community CATI Survey
Introduction

We are phoning to learn more about the impact that agricultural chemicals have on the health of rural Australians.

The project was described in a letter sent out by Liz Hanna.

Do you recall receiving that letter? Yes, received _____ Not received _________

Screen question 1.
Questions relate to all members of your household. By this we mean people that are currently living, or often reside with you.

1 Have any of your household members ever worked in agriculture? For how many years?

(ACCEPT STOCK AGENTS, SALES, VETS,)

1.1 Yes – still do
1.2 Yes – but no longer
1.3 How many years? <5 years, 5-10, 11 – 20, 21 – 30, 31 – 40, > 40 years
1.4 No
1.5 Don’t know

Screen question 2.

2 Have any of your household members lived on or near farms – within a kilometer or 2? For how many years?

2.1 Yes – still do
2.2 Yes – but no longer
2.3 How many years? <5 years, 5-10, 11 – 20, 21 – 30, 31 – 40, > 40 years
2.4 No
2.5 Don’t know

3 Where you born in Australia?

3.1 Yes
3.2 No

4 Can you tell me what part of the world you or your ancestors came to Australia from??.

4.1 Aboriginal or Torres Strait Islanders
4.2 From the UK or North America
4.3 Italian
4.4 Middle Eastern
4.5 Other
4.6 Don’t Know
MANY QUESTIONS WILL RELATE TO ALL MEMBERS OF YOUR HOUSEHOLD.
BY THIS WE MEAN PEOPLE THAT ARE CURRENTLY LIVING, OR OFTEN RESIDE WITH YOU.

5  What is the highest education level in your household?
   5.1 Primary
   5.2 Secondary
   5.3 Certificate or Trade
   5.4 Diploma
   5.5 Degree or higher / Masters ? PhD
   5.6 Don’t know / refused

The next section asks about each household member in turn, starting from the eldest and working down to the youngest. Please answer for all those either living with you currently and who usually live on the property.

6  Firstly, how many people usually reside in your household? ________________________

7  What age group is the eldest person in the house?
   7.1 70 or older
   7.2 60 to 69
   7.3 50 to 59
   7.4 40 to 49
   7.5 30 to 39
   7.6 20 to 29
   7.7 10 to 19
   7.8 Under 10

8  Is that person Male or Female
   8.1 Male
   8.2 Female

9  And how would you rate their general health
   9.1 Excellent
   9.2 Very good
   9.3 Good
   9.4 Fair
   9.5 Poor
   9.6 Very poor
Now for the second person. What age group is the second eldest? ______________

Is that person Male or Female ______________

And how would you rate their general health ______________

And for the third eldest, what age group are they in? ______________

Is that person Male or Female ______________

And how would you rate their general health ______________

Is there a fourth person in your house? What age group are they in? ______________

Is that person Male or Female ______________

And how would you rate their general health ______________

And for the third eldest, what age group are they in? ______________

Is that person Male or Female ______________

And how would you rate their general health ______________

Is there a fourth person in your house? What age group are they in? ______________

Is that person Male or Female ______________

And how would you rate their general health ______________

Repeat for all people in the house

6th Age ___________ 6th Gender ___________ 6th Health ___________ 22

7th Age ___________ 7th Gender ___________ 7th Health ___________ 23

Which number person are you? __________________? 24

And how would you rate their general health ______________ 25

The next few questions relate to all the farms that your household members have either lived or worked on or near? Can you tell me what commercial livestock were on these farms?

[Explanation - animals for produce or sale - not domestic or pets]

None 26.1
Beef Cattle 26.2
Dairy Cattle 26.3
Sheep 26.4
Alpacas 26.5
Chickens 26.6
Deer 26.7
Goats 26.8
Horses 26.9
Pigs 26.10
Any other livestock??? 26.11
Don’t know 26.12
27 Did any of these farms have any broad acre cropping or hay production for fodder? (include OWN USE)

27.1 Cropping
27.2 Hay
27.3 Neither
27.4 Don’t know / no answer

28 Was there any commercial horticulture?

28.1 None
28.2 Cut flowers or nursery
28.3 Forestry
28.4 Fruit or nuts
28.5 Grapes
28.6 Hops
28.7 Olives
28.8 Tobacco
28.9 Vegetables
28.10 Other
28.11 Don’t Know

29 Now can you tell me, has any one worked with or near any of the following Veterinary chemicals groups? (Explanation – close enough that direct skin contact could occur, either during mixing, handling, administering, or even assisting?)

29.1 Antibiotics
29.2 Drenches
29.3 Fly strike chemicals
29.4 Hormone Growth Promotants (HGP)
29.5 Lice control agents
29.6 Sheep dips
29.7 Testosterone
29.8 Other. Specify ________________ (Q29.B)  Who was that? Person no. ______

30 Have your household members ever worked closely with the following horticultural chemicals groups?

30.1 None
30.2 Herbicides
30.3 Pesticides
30.4 Fungicides
30.5 Insecticides
30.6 Roundup
30.7 Other.
30.8 (Q30.B)  Who was that? Person no. ________________
Can you remember, has any member of your household *ever* work with *dieldrin*, *dioxin*, *arsenic*, *10-80*, *2-4-D* or *DDT*? Who was that?

(Include PCDDs, PCDFs – Furans - PCB's)

31.1 Yes - Specify Who (person #) ___________________
31.2 Possibly Specify Who (person #) ___________________
31.3 No
31.4 Don’t Know

32 Thinking about the person who most uses (or used) Ag chemicals. Have they completed a chemical users course?

32.1.1 Yes
32.1.2 Possibly
32.1.3 No
32.1.4 Don’t Know
32.1.5 No one uses now

33 During peak season how often would you say they *work - or did work* - with agricultural chemicals?

(Explanation - the person who uses chemicals the most)

33.1.1 Often daily
33.1.2 Sometimes daily
33.1.3 Sometimes weekly
33.1.4 Occasionally
33.1.5 Rarely
33.1.6 Don’t Know

34 Consider the statement…. "Whenever chemicals are mixed, transported and/or applied precaution for personal protection is followed, as per instruction. We always wore goggles, gloves, masks and full protective clothing when recommended"

How often would you say this statement is true for your household members?

34.1.1 Always true
34.1.2 Mostly true
34.1.3 Sometimes true
34.1.4 Rarely true
34.1.5 Never true
34.1.6 Don’t Know
34.1.7 Never use chemicals
34.2 Why do you think they find it difficult to comply with the warnings and instructions to always wear goggles, masks, gloves and long sleeve shirts & trousers ??

34.2.1 It is too inconvenient / time consuming
34.2.2 Uncomfortable / too hot
34.2.3 Focus more on the job — not myself
34.2.4 Cannot read the instructions
34.2.5 DO not read the instruction
34.2.6 Don’t think the chemicals will really cause any harm
34.2.7 Did not know we should when I was farming
34.2.8 Don’t Know
34.2.9 Not relevant

35 Do you think it possible that members of your household have ever been exposed to spray drift, either from your own, or neighbouring properties?

35.1.1 Yes – many times
35.1.2 Sometimes
35.1.3 Rarely
35.1.4 Never
35.1.5 Don’t Know

36 The next question asks about your drinking water. Where does that usually come from?

36.1.1 Rainwater tank
36.1.2 ‘Buy In’ water
36.1.3 Town supply / reservoir
36.1.4 Spring, bore or well
36.1.5 River, creek or dam
36.1.6 Irrigation Channel
36.1.7 Don’t Know
36.1.8 Other

37 Do you believe that sprays or chemicals could have ever entered your household water supply - for example by drifting onto rooftops or running in to dams, bores or rivers ?

37.1.1 Yes – definitely
37.1.2 Yes - probably
37.1.3 Possibly
37.1.4 No – unlikely
37.1.5 No - definitely
37.1.6 Don’t Know
38 Would you say that chemicals have been stored on the property – [either now or in the past]?
   38.1.1 Yes – definitely
   38.1.2 Yes - probably
   38.1.3 Possibly
   38.1.4 No – Unlikely
   38.1.5 No - definitely
   38.1.6 Don’t Know

39 Do you apply chemicals near the house - such as round up and pesticides on the garden or lawn?
   39.1.1 Yes
   39.1.2 Possibly
   39.1.3 No
   39.1.4 Don’t know

40 Has your house been treated for white ants or other pest control?
   40.1.1 Yes
   40.1.2 Possibly
   40.1.3 No
   40.1.4 Don’t Know

41 Which of the following best describes your use of common household chemicals; for example mortein, aeroguard, cleaning agents and perfumes?
   41.1.1 We use them readily when ever we need to, without hesitation
   41.1.2 We use them – but try to minimize their use
   41.1.3 We use them only under extreme conditions
   41.1.4 We never use them
   41.1.5 No answer

42 Would you say that members of your household try to avoid chemicals by doing any of the following?
   42.1 Washing all fruits and vegetables before eating / or cooking
   42.2 Buying organic – when this is possible
   42.3 Growing your own food (so you know what has been used)
   42.4 Growing your own - chemical free
   42.5 None of the above
The next segment asks about any allergies or sensitivities your family may have experienced. Please answer about all household members who have any allergies or sensitivities— even occasional or mild ones.

43 Can you tell me, does anyone in your household have any of the following sensitivities or allergies?

43.1.1 Any ‘everyday’ chemicals, like household cleaning agents, paints, soaps, perfumes, detergents or garden sprays? Specify who [Person no.] ___________________

43.1.2 Any agricultural chemicals? Specify who [Person no.] ___________________

43.1.3 Any industrial chemicals? Specify who [Person no.] ___________________

43.1.4 Any foods or food additives? Specify who [Person no.] ___________________

43.1.5 Any pollens, plants or grasses? Specify who [Person no.] ___________________

43.1.6 No

43.1.7 Don’t Know

IF ANSWERED ‘NO’ or ‘Don’t Know’ — TO ALL — GO TO Q 50

44 Can the sufferer usually avoid whatever causes the problems?

44.1.1 Yes – mostly

44.1.2 Sometimes

44.1.3 No

44.1.4 Don’t know

44.1.5 Not relevant

45 What strategies have been tried to get advice or alleviate the symptoms?

45.1.1 Do nothing – it will pass

45.1.2 Self manage – with either creams or vitamins, rest, 

45.1.3 Avoid the problem – chemical or food

45.1.4 Get information from books, magazines, radio or TV

45.1.5 Look up on the web

45.1.6 Visited a doctor

45.1.7 A pharmacist

45.1.8 A nurse

45.1.9 A naturopath

45.1.10 Visited a Chinese Medicine Practitioner

45.1.11 Visited another health professional. Specify ___________________

45.1.12 Don’t know

46 Were they satisfied with treatment form the doctor- Yes ____ Fair ____ No ____ DK_____

47 Were they satisfied with treatment form the nurse- Yes ____ Fair ____ No ____ DK_____

302
48. Were they satisfied with treatment from the naturopath? Yes ___  Fair ___  No ___ DK_____

49. Were they satisfied with treatment from the Chinese Medical P? Yes ___  Fair ___  No ___ DK_____

50. What would you say is the usual period of time they are free of all symptoms

- 50.1 Hours
- 50.2 Weeks
- 50.3 Months
- 50.4 Years
- 50.5 Always present
- 50.6 Don’t know
- 50.7 Not relevant

51. When the symptoms are present, do they usually stop the person from doing any of the following activities that they would normally do?

- 51.1 Hard physical work
- 51.2 Moderate work
- 51.3 Sedentary activities (minimal exertion – eg. reading)
- 51.4 Self care – like washing and getting dressed
- 51.5 Leisure activities
- 51.6 Other
- 51.7 Don’t know
- 51.8 Not relevant

52. Has anyone in your household ever been diagnosed as having any of the following problems with their immune system? [Explanation - been told by a health carer or doctor]

- 52.1.1 Chronic fatigue syndrome - Specify Person # ______________________
- 52.1.2 Fibromyalgia - Specify Person # ______________________
- 52.1.3 Chemical sensitivity - Specify Person # ______________________
- 52.1.4 Hodgkin’s - Specify Person # ______________________
- 52.1.5 Non-Hodgkin’s Lymphoma - Specify Person # ______________________
- 52.1.6 Any others? - Specify _____________________________
- 52.1.7 No
- 52.1.8 Don’t know

The next series of questions again asks about the entire household – please answer even if the conditions are minor and you do not think they are related to chemicals or sensitivities.
53 Has anyone EVER suffered ANY health problems with their SKIN? Such as rashes, dermatitis, sensitive skin?

53.1.1 Yes. Specify who [person No.] ________________________
53.1.2 No
53.1.3 Don’t Know

54 Has anyone EVER suffered ANY health problems with their STOMACH OR BOWEL? Include food intolerance, cramps or bowel problems?

54.1.1 Yes. Specify who [person No.] ________________________
54.1.2 No
54.1.3 Don’t Know

55 Has anyone EVER suffered ANY problems with their HEART - such as palpitations?

55.1.1 Yes. Specify who [person No.] ________________________
55.1.2 No
55.1.3 Don’t Know

56 Has anyone EVER suffered ANY problems with their EARS - such as industrial deafness or ringing?

56.1.1 Yes. Specify who [person No.] ________________________
56.1.2 No
56.1.3 Don’t Know

57 Other than eyesight, has anyone EVER suffered any problems with their EYES, such as itchy or red eyes?

57.1.1 Yes. Specify who [person No.] ________________________
57.1.2 No
57.1.3 Don’t Know

58 Excluding colds - Has anyone EVER suffered any problems with their NOSE OR LUNGS, such as chest tightness, difficulty breathing, coughing or burning?

58.1.1 Yes. Specify who [person No.] ________________________
58.1.2 No
58.1.3 Don’t Know

Again, excluding colds or flu, has anyone EVER suffered ANY problems with their MOUTH OR THROAT? Such as 'burning' lips, sore throats or a swollen tongue?

58.1.4 Yes. Specify who [person No.] ________________________
58.1.5 No
58.1.6 Don’t Know
59 Has anyone **EVER** suffered **giddiness, tingling, dizziness, twitching, or spasms**?

59.1.1 Yes. Specify who [person No.] ________________________
59.1.2 No
59.1.3 Don't Know

60 Has anyone **EVER** experienced an increase in **irritability, or ANY restlessness, headaches, depression, or any other nervous problems**?

60.1.1 Yes. Specify who [person No.] ________________________
60.1.2 No
60.1.3 Don’t Know

61 Has anyone **EVER** suffered **MUSCLE PROBLEMS** - such as weakness, aching, lethargy or excessive fatigue that is **not a result of vigorous exercise**?

61.1.1 Yes. Specify who [person No.] ________________________
61.1.2 No
61.1.3 Don’t Know

62 Has **ANYONE WHO HAS LIVED** in your household ever had a benign **TUMOUR** or any form of **CANCER**? – [ACCEPT PAST MEMBERS]

62.1.1 Yes. A current member of the household Specify who [Person No.] ___________
62.1.2 A past member of the household Specify __________________
62.1.3 No
62.1.4 Don’t Know

IF 'NO' SKIP TO Q 63

63 Can you tell me what type that was?

63.1.1 Blood or lymph
63.1.2 Bowel
63.1.3 Brain
63.1.4 Breast
63.1.5 Kidney or bladder
63.1.6 Lung
63.1.7 Myeloma
63.1.8 Ovarian
63.1.9 Prostate
63.1.10 Skin
63.1.11 Stomach
63.1.12 Don’t know
63.1.13 Other. Specify ______________________________

64 Has any household member experienced a ailments **not readily explained** by their doctor - such as

64.1.1 Unexplained bruising
64.1.2 Unusual taste in the mouth
64.1.3 Changes in behaviour
64.1.4 Inappropriate anger or short temperedness
64.1.5 Loss of appetite
64.1.6 Vague feelings of unwellness
64.1.7 Confusion, difficulty concentrating
64.1.8 General or specific aches or pains
64.1.9 Stomach pain
64.1.10 Others __________________________
64.1.11 No / none
64.1.12 Don’t know
64.1.13 Refused

The next 4 questions ask about children - they are **important** as chemicals have a much greater impact on children than on adults - **even before they are born**.

65 Can you tell me, have you ever had children?

65.1.1 Yes
65.1.2 No

66 Do you mind telling me, have any of your children had a physical disability since birth?

66.1.1 Yes. Specify what type __________________________
66.1.2 No
66.1.3 Refused

67 Have you had a child with an intellectual disability?

67.1.1 Yes . Specify what type __________________________
67.1.2 No
67.1.3 Refused
68 Have you or your partner ever had a miscarriage?

68.1.1 Yes . Specify how many 1, 2, 3, 4, 5
68.1.2 No
68.1.3 No partner
68.1.4 Don’t Know
68.1.5 Refused

69 And the last question about children is: Would you say that you and your partner had difficulties falling pregnant?

69.1.1 Yes
69.1.2 No
69.1.3 Don’t know
69.1.4 Not relevant

70 Do you believe ANY of your family’s health problems COULD BE due to exposure to factors in the environment? Such as pesticides, chemicals, or food additives . . .

70.1.1 Yes – definitely
70.1.2 Yes – probably
70.1.3 Possibly
70.1.4 No – Unlikely
70.1.5 No – definitely
70.1.6 Don’t Know

71 What factors of you think might be the cause?

71.1.1 Agricultural chemicals
71.1.2 Climate
71.1.3 Industrial chemicals
71.1.4 Pollens or grasses
71.1.5 Pollution
71.1.6 Radiation
71.1.7 Other . Specify __________________________
71.1.8 Don’t Know

72 Has your doctor EVER QUESTIONED YOU [or your family] questions about what chemicals you are exposed to?

72.1.1 Yes
72.1.2 No
72.1.3 Don’t Know
73 Do you agree with the statement "Health professionals often overlook the impact that the environment **CAN HAVE** on our health"

73.1.1 Strongly agree
73.1.2 Agree
73.1.3 Neither agree nor disagree
73.1.4 Disagree
73.1.5 Strongly disagree
73.1.6 Don’t Know

74 If you suspected that you, or a family member, had a health problem caused by the environment...or chemicals, who do you think you might visit for information and/or treatment if they practiced locally?

(Note: The order of this list was randomly presented)

74.1.1 A nurse practitioner who specialized in Environmental health
74.1.2 A doctor
74.1.3 A naturopath
74.1.4 An environmental health officer
74.1.5 A community or public health nurse
74.1.6 A Chinese Medicine Practitioner
74.1.7 Another health professional. Specify _____________________
74.1.8 Don’t know, none of these

75 Did you know of the existence of environmental health officers?

75.1.1 Yes
75.1.2 No
75.1.3 Don’t know

76 Would you say it was true that "Members of our household have been exposed to chemicals when working for other people"? Is that true from any members of your household??

76.1.1 True
76.1.2 Not true
76.1.3 Don’t know
76.1.4 Not relevant
77  Would you agree or disagree with the statement "I would like to know more about how our environment impacts on my health"

77.1.1  Strongly agree
77.1.2  Agree
77.1.3  Neither agree nor disagree
77.1.4  Disagree
77.1.5  Strongly disagree
77.1.6  Don't Know

78  And finally, this last question about household income. This helps compare responses for this survey to other surveys. What is your average annual household disposable income?

78.1.1  Under $30,000
78.1.2  Between $30,000 and $60,000
78.1.3  Over $60,000
78.1.4  Don’t know / not sure
78.1.5  Refused

79.  Postcode of resident

80.  Town or locality of resident

Liz Hanna is managing the project. She would like to talk to people who wish to discuss this further. Is there anyone in the household who would be happy to be telephoned to talk further about this for another 10 or 15 minutes at a later date?

On behalf of the Department of Human Services, and La Trobe University, thank you very much for taking part in this survey. This information will help planning health services within the region. As I have explained, the answers you have provided will remain confidential. So thank again for your input today. I know it will help.
APPENDIX 2

Introductory Letters - to the community

Introductory Letters - to the primary health care providers

Advertisements for Community Meetings
Dear .................

The World Health Organisation found that nearly a quarter of global ill-health is due to the factors in the environment. Much of that will be lack of access to clean drinking water in developing countries, so the figure for Australia will not be that high. But the fact remains that we do not know what level of impact we have in Australia. Some effects are easy to measure – but others are more difficult to identify, they can lead to chronic health problems. This project wants to learn what YOU think.

The aim of the study is primarily to learn what issues are important to local communities in rural Victoria in relation to your health. International studies have demonstrated that certain factors in the environment can damage human health. Countries with higher populations and more pollution have experienced substantial health problems. We need to avoid their mistakes.

We say that Australia is ‘cleaner and greener’, but we don’t know what, if any, health problems do exist that are related to factors in the environment. This is where we need your help. During the next weeks, this project will telephone over 1000 households in NE Victoria.

This telephone survey is part of a collaborative study conducted by the Department of Human Services and La Trobe University to examine how we can best manage and minimize the effects of environmental hazards on our health.

Your participation in the survey is entirely voluntary.

Your telephone number has been selected at random as one of 4000 from the white pages telephone directory. From this list another random selection of 1000 numbers will be telephoned in the next week or so. Subject to your agreement to participate, the interviewer will ask questions about the general health of yourself and your family, what exposures you may have had to environmental factors, and what actions you usually take to avoid risk, or seek treatment and advice. Some standard demographic questions must also be asked, such as age and education level. The entire interview should take no longer than 15-16 minutes.

The study will provide information on the general health status of Victorians living in the North East, and highlight regional environmental health risks that warrant attention. The final outcome of the project will be recommendations for an appropriate health service model “tailor-made” to suit rural Victoria. This may involve introduction of a new environmental health professional / advisor, or it may show that we need to change the way our current health workforce practice, or introduce educational packages for the health workforce or community sectors, or all of these. It depends on the information you and your community provide. So your opinion is important.
All answers providers to the interviewer will remain confidential – the responses will not be linked to your name or address. Personal details which could identify you, such as your name, address & telephone number are not connected to your answers. All that will be left will be postcode, age group and gender. The final report generated will only report community responses to the questions.

Again, I wish to stress that participation in the survey is entirely voluntary, but we earnestly seek your assistance to help us gather a community-wide perspective on this important issue. Your answers are important – even if you and your family are in perfect health, which we hope is the case. To get the complete picture of the situation, we need to know the exact proportions of the well and unwell people, and of those who are and are not exposed to any environmental risks.

This study has no commercial interests, and is funded by the Department of Human Services, La Trobe University, and the National Health and Medical Research Council.

Ethics approval to conduct this study has been received from the La Trobe University Human Ethics Committee (Ref 02-92). This survey forms part of a larger project, undertaken by Ms Liz Hanna, for her PhD, investigating how we can improve your health, by improving regional health care service. The complete project, including this survey, is under the full supervision of Professor Vivian Lin, Professor of Public Health and Public Policy & Head of School of Public Health, La Trobe University, Bundoora. Co-supervisor is Dr Tom Keating, Regional Director, Hume Region Department of Human Services.

Please forward initial queries to the Project Manager, Liz Hanna on telephone 03 5761 1248, or email Liz.Hanna@dhs.vic.gov.au. Any further questions regarding this project may be directed to the Senior Investigator, Professor Vivian Lin, of the School of Public Health, on telephone number 03 9479 1743.

If you have any complaints or queries that the researchers have not been able to answer to your satisfaction, you may contact the Ethics Liaison Officer, Human Ethics Committee, La Trobe University, Victoria, 3086 (Ph: 03 9479 1443, email: humanethics@latrobe.edu.au).

We thank you for taking the time to consider this, and hope you choose to participate. Furthermore, we hope you enjoy the opportunity to make your contribution to what we hope will serve to improve the health of rural Victorians.

Yours sincerely

Liz Hanna
RN, RCCN, BA, MPH, FRCNA.
Doctoral Candidate – La Trobe University
Project Manager - Department of Human Services,
Convenor Environmental Health,
Public Health Association of Australia

Ph: 03 5761 128
Fax: 03 57622594
Liz.Hanna@dhs.vic.gov.au
Introductory Letter - to the primary health care providers

Date June 2003

Dear Doctor

Re Project:

ENVIRONMENTAL HEALTH & PRIMARY HEALTH CARE

The question has been asked “How would we identify environmental hazards occurring within a local community?” The initial response could easily be “That it would depend on how large and how acute the health impact.” However it is known that many insidious environmental hazards lead to chronic conditions. The question is clearly more complex and the focus is shifted towards health services. The issue now becomes “What mechanisms would best ensure that environmentally related health issues are recognized and minimised? This entails early identification, management, dissemination of the information, as well as providing community/patient education to reduce risks.

The Department of Human Services and La Trobe University are collaborating to investigate this issue within the Hume region. An outline describing the proposed project in more detail can be provided should you require further information.

Principally, the aim of the study is to learn what issues are important to local communities in rural Victoria in relation to environmental health. New evidence is emerging suggests that many factors within our environment can be hazardous to human health. However we do not know the extent this is occurring in Australia. This project aims to capture a snapshot of community concern and gather provider perspective on how the environment is impacting on the health of the local community.

This is where we need your help. Over recent months, a telephone survey of 1050 households in the Hume region was conducted to ascertain community exposure risks and self rated health status. The perspective of health providers servicing the region is regarded as vital to complete the picture. Liz Hanna, the project manager hopes to interview all primary health care providers serving the regions under study. The interview format can be either via personal interview, focus groups, paper survey, or telephone interview, which ever suits you best. The project aims to maximise the input from all health providers, while recognising demands on your time.

Participation in the project is entirely voluntary.

Your clinic will be contacted shortly to arrange a time at your convenience to discuss this further, should you agree to participate. An individual face to face, or telephone interview or paper survey should last approximately 15 minutes, focus groups could take up to an hour.

Specific information to be sought will be your perception of local environmental health issues, your assessment of the likelihood that GPs are trained and able to recognise environmentally related health problems, given the tight time constraints on practice, and usual referral patterns.
We anticipate that the study will provide information on the general health status of Victorians living in the North East and Goulburn Valley, and highlight regional environmental health risks that warrant attention. The final outcome of the project will be recommendations for an appropriate health service model “tailor-made” to suit rural Victoria. This may involve a new specialty of health professional, the introduction of continuing education modules, or changes to the practice of our existing range of health professionals, such as including environmental health assessments, changes to health reporting to ensure routine surveillance, or a selected combination of these plus other strategies. I seek your view on this.

All responses will remain confidential. The final report generated will only report comments from categories of health providers. Again, I wish to stress that participation is entirely voluntary, but we earnestly seek your assistance to help us gather the broadest perspective on this important issue. Your answers are important – even if your practice does not place you in contact with people who may be affected. To complete the environmental health picture of these communities, we need to know what health conditions are seen locally, and learn which exposures are of most concern.

This study is funded by the Hume Region, Department of Human Services, La Trobe University, and the National Health and Medical Research Council. Ethics approval has been received from the La Trobe University Human Ethics Committee. (Ref 02-92). This study forms part of a larger project, undertaken by Ms Liz Hanna, for her PhD. The complete project, including this survey, is under the full supervision of Professor Vivian Lin, Professor of Public Health and Public Policy & Head of School of Public Health, La Trobe University, Bundoora. Co-supervisor is Dr Tom Keating, Regional Director, Hume Region Department of Human Services.

Please forward initial queries to the Project Manager, Liz Hanna on telephone 03 5761 1248 email on Liz.Hanna@dhs.vic.gov.au. Any further questions regarding this project may be directed to the Senior Investigator, Professor Vivian Lin, of the School of Public Health, on telephone number 03 9479 1743.

If you have any complaints or queries that the researchers have not been able to answer to your satisfaction, you may contact the Ethics Liaison Officer, Human Ethics Committee, La Trobe University, Victoria, 3086, and quote the Reference No. (02-92) by Ph: 03 9479 1443, or email: humanethics@latrobe.edu.au.

We thank you for taking the time to consider this, and hope you choose to participate. Furthermore, we hope you enjoy the opportunity to contribute to this process to improve the health of rural Victorians.

Yours sincerely

Liz Hanna
MPH, BA, RN, RCCN, FRCNA.

- NHMRC Scholar – La Trobe University
- Project Manager - Department of Human Services,
- National Convenor Environmental Health - Public Health Association of Australia, http://www.phaa.net.au
- Australian Pesticide & Veterinary Medicine Authority - Community Consultative Committee Member
- National Public Health Partnership - Advisory Group Member
Hume Region Environmental Health Project Summary

The World Health Organisation estimates that over one third of global ill-health is caused by environmental factors. The State of the Environment Report notes that in Australia, we do not know the burden of ill-health attributable to environmental factors. However, we do know that the health of rural Australians is worse than city people, and not all this is caused by differentials in diets, smoking and drinking rates. Environmental factors may be contributing to this urban – rural difference.

The Hume Region DHS, La Trobe University, and NH&MRC are funding a study to investigate this issue. A recent telephone survey sought the views of community members in the Shepparton and Ovens & King Valley regions. This phase now seeks GP perspectives. Your Clinic will be contacted soon to arrange a time – at your convenience - for a short discussion.

The field of environmental health is growing and evidence of harm to human health is now indisputable, and can be sourced through a range of toxicological journals via MedLine searches & the US National Institute of Environmental Health Sciences journal ‘Environmental Health Perspectives’ (http://ehp.niehs.nih.gov/).

Australia, with our lower population densities and relative isolation, has not suffered the barrage of oil spills, nuclear accidents, river poisonings, and toxic fumes experienced elsewhere. So we have been lulled into a false sense of security. The problem is that we have no systematic way of measuring the impacts of the environment on human health. We simply do not know, and cannot know if or what problems may exist.

Australia needs a system of identifying, managing and monitoring health impacts from environmental exposures. The question is how should that system be designed?

A range of options are being considered.

1) Introduction of a new health care provider role, eg. environmental health nurse, or regional GP specialist role
2) Additional education programs across all strata within the existing health workforce; and for GPs, this might be via CME points
3) Introduction of new modules within current health curricula, medicine and other specialities.
4) Modification of the existing Environmental Health Officer role – by injecting greater focus on physiology, toxicology, and epidemiological research.
5) Do nothing – maintain status quo, await a major outbreak and respond only when forced.

A significant factor to consider is preparation for any eventual bio terrorism event or major accident, and having the ground force and systems in place to handle such events.

This stage of the study specifically seeks GP input into:

a) Approximate frequency of presentations indicating (possible) environmental exposure related ill – health
b) Most common conditions falling into this category
c) Do GPs actively seek exposure histories?
d) What structural factors would GPs recommend AND caution against for planning in health management and monitoring system (noting that efficacy of any system depends on integrity of data input – ie provider support)

Responses can be sent to: Chris Pickett GVGP
or direct to Liz Hanna Liz.Hanna@dhs.vic.gov.au
Ph: 0418 99 55 04 or 03 5761 1248
Advertisements for Community Meetings