RURAL INDUSTRIES
RESEARCH & DEVELOPMENT CORPORATION

Managing the Plant Protection Aspects of the Rural/Urban Interface

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by
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Foreword

Public perceptions of the use of pesticides for crop protection by Australia's rural industries are strongly negative. In particular, residents of outlying suburbs adjacent to rural land use areas are concerned about the health implications of the off-site movement of pesticides into their properties.

Pesticide use creates significant community problems whether the hazards are real or perceived. It is necessary to develop an accessible tool which will allow land planners, local government officers, primary producers and other interested parties to effectively assess the hazards of pesticide use in the rural/urban interface.

We have developed a draft version of a computer-based decision-support system (*Hazard Score*) which will allow relatively unskilled personnel to effectively assess pesticide hazards under a wide range of situations. *Hazard Score*, which is written in MS "Access", calculates pesticide hazards based on the pesticides used, their method of application, the prevailing weather conditions, the density and proximity of the local population, and the presence of buffer zones as barriers to pesticide drift.

Preliminary validation of *Hazard Score* has been conducted with site visits to 15 farms in SE Queensland, demonstrating the capacity of the programme to perform complex calculations in a wide range of situations. Liason with industry and other end users is on-going, and we have interacted with representatives of interest sectors of the community at a review and reference panel meting held at Gatton in November 1997.

to Peter Core
Managing Director
Rural Industries Research and Development Corporation

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Executive Summary

Australia is a highly urbanised country with an ever-increasing urban population. As the cities expand, they continue to encroach upon areas of rural land use. The result is a constantly moving interface between urban and rural land uses within which hazards may exist, and conflicts may arise. One particular source of hazard and conflict is the use, by rural industries, of pesticides for crop protection.

Pesticide use by Australia's rural industries is an extremely emotive issue, and the public's perceptions are, in general, strongly negative. These perceptions are often fuelled by misinformation and exaggeration by the popular press, but irrespective of the cause, they promote mistrust and conflict between rural and urban land users in the rural/urban interface. It is important to provide an easily accessible resource which will provide accurate information to all members of the rural/urban interface so that the pesticide hazards can be accurately decribed and reduced and then conflicts can be resolved.

The assessment of pesticide hazards is too complex for the lay person since there are so many interacting factors which may increase or reduce risk. Using a sufficiently complex computer model, it will be possible to allow relatively unskilled personnel to assess pesticide hazards for any given scenario. The various factors contributing to pesticide hazard are as follows:-

i) The pesticide used - particularly toxicity, and formulation.
ii) The method of application - including the equipment, the nozzles used, and the release height.
iii) The weather conditions - particularly wind speed, wind direction, temperature, relative humidity, and rain fall.
iv) The proximity and density of the human population - including presence of schools, hospitals, and other community centres.
v) The presence of barriers to drift of pesticide droplets - including shadehouses and vegetative buffer zones.
vi) The site characteristics - including the soil type, the slope and the depth of the water table.

Hazard Score is a computer-based decision-support system designed to assess pesticide hazards in the rural/urban interface. It is a user-friendly package written in Microsoft "Access". It consists of three main components:- i) the *Hazard Score* programme, ii) the *Hazard Score* manual, and iii)a database of relevant plant protection literature. The three components are inter-linked, such that the user, performing specific calculations can refer to both general and detailed information on the subject and find relevant supporting literature.

<u>i) The *Hazard Score* programme.</u>

The *Hazard Score* programme performs a series of assessments of the pesticide hazard in a range of different situations. Factors affecting the hazard score can be isolated as single components or treated together as complex assessments. For less skilled operators, a series of more generalised assessments can be used as "short-cuts" to provide a relative hazard score.

Single-component Assessments:

- Toxicity of a single pesticide.
- Toxicity of multiple pesticides.
- Summary of pesticide physical properties.
- Suitability of weather conditions.
- Method of application.
- Site characteristics.
- Density and proximity of local population.
- Cropping system type.
- Presence of barriers to drift.
- Wind direction and farm location.

Complex Assessments:

- Detailed assessment of the hazards of a single pesticide application.
- Drift risk from a single farm.
- Drift risk to an area bordered by more than one farm.
- Risk of groundwater contamination and on-site persistence.

Short-Cut Assessments:

- Drift risk from a single farm.
- Drift risk to an area bordered by more than one farm.

<u>ii) The *Hazard Score* Manual.</u>

The *Hazard Score* manual is designed to act as a text providing the necessary supporting information for users of the programme, giving explanations of processes and interactions, as well as related statistics and data. The *Hazard Score* manual contains the following chapters:

- Summary
- Introduction
- Pesticides and Public Health
- Know your Pesticide
- Plant Protection Legislation
- Understand your Environment
- The Influence of the Weather
- Know your Equipment
- Management Guidelines

<u>iii) The Database of Plant Protection Literature.</u>

The references for more than 700 journal articles, government documents and other papers are stored in the *Hazard Score* package with names of authors, date of publication, title, source of reference, key words and abstract compiled for most. The database is searchable, and is divided into the following sections:

- All references
- Government documents
- Off-target drift of pesticides
- Leaching of pesticides
- Volatilisation of pesticides
- Persistence of pesticides
- Pesticides and Health

Preliminary Validation.

Preliminary validation of the *Hazard Score* programme has been undertaken on 15 farms (beetroot; cotton; sweetcorn; broccoli; flower nursery; tomato (4); avocado (2); chilli pepper; rockmelon; capsicum(2)), demonstrating the ability of the programme to perform complex calculations in a wide range of different situations.

Liaison with End-Users.

Involvement with many sectors of the community/industry has been on-going throughout this project. This was highlighted by the meeting of a review and reference panel in November 1997. This panel consisted of a cross-section of representatives from producers and primary industry groups, town planners, government service industry regulators, academics and policy makers.

Introduction

This report describes the development of *Hazard Score*, a computer-based decision support system for the assessment of pesticide hazards in the rural/urban interface. *Hazard Score* is designed to respond to increasing conflicts resulting from the encroachment of urban land use into rural areas. In particular, *Hazard Score* will permit all sectors of the community with interest in the avoidance and amelioration of hazards and conflicts related to the use of pesticides, to accurately and effectively assess the risk. As a consequence, hazards, and conflicts resulting from perceived hazards, will be realistically reduced. This will promote the harmonious coexistence of urban and rural land users in the rural/urban interface, and support the continued growth of Australia's rural industries.

Microsoft® Access™ is the most commonly used data management programme on today's PC, and was chosen as the software in which to write *Hazard Score* because of its ability to handle large datasets in a user-friendly manner. The programme is entirely menu-driven so that unskilled personnel can move through its pathways by making simple decisions. Data that unskilled users would not have access to is stored in the programme and presented to the user as a series of simplified choices. Consequently, the programme is sufficiently sophisticated to perform complex calculations, and yet sufficiently user friendly so that unskilled personnel can use it to support management decisions.

Preliminary validation of the programme has been conducted from site visits to 15 farms (beetroot; cotton; sweetcorn; broccoli; flower nursery; tomato (4); avocado (2); chilli pepper; rockmelon; capsicum(2)). Data gathered from these farms demonstrates the ability of the programme to perform complex calculations of pesticide hazard in a wide range of situations.

A review and reference panel consisting of interested parties from rural industries, local government, Department of Primary Industries, Department of Natural Resources, University, Workplace Health and Safety, Canegrowers, Bureau of Sugar Experiment Stations, Queensland Rail, and Farm Safe, met at Gatton College in November 1997, to discuss the *Hazard Score* package (see appendix 16).

Objectives

The major objective of this research was to develop a decision-support system that would allow relatively unskilled personnel to assess plant protection hazards in the rural/urban interface.

Methodology

A computerised system was designed in Microsoft "Access" to fulfil the following criteria:-

i) Perform complex calculations of pesticide hazard in a wide range of scenarios.
ii) Demonstrate pesticide hazards under different crop production regimes.
iii) Provide back-up information and explanations of the assumptions.
iv) Provide references to supporting literature.
v) Indicate alternative management strategies which might be used to reduce hazard.
vi) Operate in a user-friendly fashion.

Calculations in Hazard Score *Programme*:

Single-Component Assessments.

- **Toxicity - Single Pesticide.** $\mathbf{T_s = (s\text{-}3)^3.fo.a.fr}$

This assessment provides a hazard score to a pesticide based on its toxicity, formulation, and the total quantity used.

where, s = poison schedule (data supplied - see appendix 1)
fo = formulation (data supplied - see appendix 2)
a = area treated (ha)
fr = number of applications

- **Toxicity - Multiple Pesticides.** $\mathbf{T_m = \Sigma\{(s\text{-}3)^3.fo.a.fr\}}$

This assessment provides a hazard score to a system using more than one chemical, based on their toxicities, formulations and the total quantities of each used.

- **Pesticide Physical Properties.**

These assessments provide a measure of the physical properties of the pesticides used affecting their concentrations in the environment (air, soil and water) through time.

Volatilisation Constant $\mathbf{V = Log_{10}w}$

where, w = Vapour pressure (mPa) (data supplied - see appendix 3).

Persistence Coefficient **G = g/100**

where, g = Field dissipation half-life in soil by any decay pathway, as reported by Agriculture Research Service of USDA. (data supplied - see appendix 3).

Leaching Constant $\mathbf{L = g.(1/\sqrt{K_{oc}})}$

where, K_{oc} = Organic carbon sorption coefficient ($K_{oc} = K_D$ x 100/% o.c., where K_D = sorption coefficient between soil and water: $K_D C'_{soil}/C'_{water}$, where C' = Concentration (ppm)) (data supplied - see appendix 3).

- **Method of Application.** **A = n.e.h.(1/z)**

This assessment provides a hazard score based on the impact of different application methods upon the generation of small, air-mobile pesticide droplets.

where, n = (200/diameter of 10% fine portion of droplet spectrum (μm)) as measured by image analysis. This data is supplied and used if the farmer knows the catalogue code of the nozzle used (see appendix 4) - if not, n = nozzle type (data supplied - see appendix 5).
e = equipment type used (data supplied - see appendix 6).
h = height of release of chemical (m).
z = use of any drift reduction technique (data supplied - see appendix 7).

- **Suitability of Weather.**

This assessment provides hazard scores based on the impact of different weather conditions upon the aerial movement of pesticide droplets and the volatilisation and aerial movement of vapourised pesticide, and the impact of rainfall on surface run-off and leaching of pesticides.

Vapour Drift **V_d = function of: v x t/r**

where, v = Wind speed (km/h)
t = Temperature (^{0}C)
r = Relative humidity (%)

Droplet Drift **D_d = function of: v x t/r**

Surface Run-off/Leaching **R = function of rainfall (mm/d)**

- **Site Characteristics.**

These data provide scores for the impact of different site charateristics on the movement of pesticides in/on the soil.

Soil pH.	**S_1**	(Data supplied - Appendix 8)
Soil % organic matter.	**S_2**	(Data supplied - Appendix 9)
Soil Texture.	**S_3**	(Data supplied - Appendix 10)
Slope of site	**S_4**	(Data supplied - Appendix 11)
Depth of Water Table.	**S_5**	(Data supplied - Appendix 12)

- **Local Community.** **$P = p_1.p_2.p_3.p_4$**

This assessment provides a score for the hazard to local residents based on the density and proximity of the population.

where, p_1 = Number of residences within 100m of application site.
p_2 = Number of residences within 1 km of application site.
p_3 = Number of schools, hospitals, or other centres of community activity within 1 km of application site.
p_4 = Population density of city, town shire or statistical local area in question (Data supplied - Appendix 13).

- **Cropping System.** **Cropping System Score. C**
(Data supplied - Appendix 14)

This assessment provides a summarised overall hazard score for different cropping systems for use only as part of the "short-cut" assessments.

- **Barriers to Off-Target Drift.** **$B = (b_1.h_1) + (b_2.h_2) + (b_3.h_3)$ (simplified version)**

This assessment gives a score for barriers to off-site movement of pesticides (eg. vegetative buffer zones) based on their ability to intercept airborne pesticide droplets.

where, b_{1-3} = Type of barrier (Data supplied - Appendix 15) closest (1), middle (2) and furthest (3) from
farm boundary.
h_{1-3} = Height of barrier (m).

- **Wind Direction/Farm Location.** **$W = [Cos(\alpha-\beta)].w.d$** **(simplified version)**

Provides a score based on the relative position of the pesticide source (farm) and susceptible area (eg. residential area) with respect to the wind direction.

where, α = Wind direction (selected from 16 - point compass bearing)
β = Direction of Farm (selected from 16 - point compass bearing)
w = Wind Speed (km/h)
d = Distance from perimeter of farm to perimeter of sensitive area (m).

Complex Assessments

- **Assessment of the Hazard of a Single Pesticide Application.**

This assessment calculates detailed hazard scores for all aspects of a single pesticide application, and is a complex function of the following single-component assessments:-

T_s, V, G, L, A, V_d, D_d, R, S_1, S_2, S_3, S_4, S_5, P & B

- **Assessment of the Drift Risk from a Single Farm.**

This assessment calculates the risk of off-site aerial drift of pesticides from a farm, and is a complex function of the following single-component assessments:-

T_m, A, V_d, D_d, P & B

- **Assessment of the Drift Risk to an Area bordered by more than one Farm.**

This assessment calculates the risk of off-site aerial drift of pesticides into a susceptible area (eg residential area/hospital) from surrounding farmland, and is a complex function of the following single-component assessments:-

T_m, A, V_d, D_d, P, B & W

- **Assessment of the Risk of Groundwater Contamination and On-Site Persistence.**

This assessment calculates the hazard of pesticides with respect to their movement in/on the soil, and is a complex function of the following single-component assessments:-

T_m, G, L, R, S_1, S_2, S_3, S_4, & S_5

Short-Cut Assessments

- **Assessment of the Drift Risk from a Single Farm**

This assessment provides a simplified score for the risk of off-site aerial movement of pesticides from a farm, and is a complex function of the following single-component assessments:-

T_m, P, C & B

Assessment of the Drift Risk to an Area Bordered by more than one Farm

This assessment provides a simplified calculation of the risk of off-site aerial drift of pesticides into a susceptible area (eg residential area/hospital) from surrounding farmland, and is a complex function of the following single-component assessments:-

T_m, P, C, B & W

Preliminary Validation of *Hazard Score* Programme.
Preliminary validations were performed on 15 farms (beetroot; cotton; sweetcorn; broccoli; flower nursery; tomato (4); avocado (2); chilli pepper; rockmelon; capsicum(2)). Site visits were made to each farm, and all data relevant to pesticide hazard gathered by critical observation, farmer interviews, and studies of cadastral and other maps of the area. The data was then applied to the *Hazard Score* programme. The outputs demonstrated the ability of the programme to perform complex calculations of pesticide hazard for all the farms studied. Furthermore, through the programme outputs, it was possible to demonstrate to farmers the modifications to management strategies which could be made in order to reduce pesticide hazard. Samples of the programme outputs are submitted as appendix 17.

Review and Reference Panel.
A review and reference panel met at Gatton college in November 1997 to discuss the *Hazard Score* package. Representatives of all sectors of the community involved in the management of plant protection hazards in the rural/urban interface attended (see enclosed list - Appendix 16).

Hazard Score was well recieved by the panel, and all members saw the package as a tool which they would find useful in their own roles in the management of pesticide hazard. Some specific suggestions were made regarding improvement/further development of the package:-

- It was suggested that the name of the package be changed from *Hazard Score* to something less emotive. A more appropriate name for the package will be chosen during Phase II of its development.
- It was suggested that a linkage between relevant regulatory areas was needed since each state operates under a separate mandate (eg. resctriction of schedule 7 usage in Victoria).
- “Risk maps” could be developed by area from the programme. This is part of the mandate of a new project funded by SRDC to futher develop and apply the programme to the sugar industry.
- The pesticide hazard to environemtally sensitive areas such as wetlands/catchments can not be assessed with the present version of *Hazard Score*, which is designed to identify the risk to public health. The proposal submitted to RIRDC as Phase II of this project would expand the programme to include these assessments.
- It was suggested that cross-indexing of registered products to the cropping systems be included in the programme.
- At the suggestion of the panel, for ease of interpretation ,all calculations within the programme have been brought onto a 1-10 scale, where 1 represents the least hazard, and 10 represents the most hazard.

Detailed Results

The detailed results of this research are submitted as a draft version of the *Hazard Score* package. The programme requires *Microsoft Access 2.0* or later and a 486 PC or better.

Discussion of Results and Implications

Hazard Score is already a powerful tool capable of dealing with the complex phenomena related to risk management in pesticide use. With *Hazard Score*, unskilled operators can observe the interaction of different operational, weather, site and human variables upon the potential hazard of pesticide use. Continued development of the package will fine-tune its accuracy and make it more user-friendly.

The implications of the present findings are that it is possible to create a model that is complex enough to perform sophisticated calculations and yet user friendly enough to be useful to decision makers in rural and urban planning positions. It will also provide information for those wishing to reduce hazard or compare plant protection strategies in particular cropping systems.

Further modifications are underway to tailor the package for the suagar industry. Plans also exist to produce specialised packages for vegetable growers and nurseries in the near future.

Recommendations

The further development of this project is recommended so that a refined version of *Hazard Score* can be completed and made available to land planners, local governments, primary producers, and other parties interested in assessing and ameliorating the hazards and conflicts related to plant protection practices in the rural/urban interface. The final product should be a saleable item widely available in the community.

Intellectual Property

The intellectual property generated by this research will be shared between RIRDC, The University, and other sponsors.

Communications Strategy

The *Hazard Score* package will run on vitrually any PC (type 486 or later) that has Microsoft Access version 2.0 or later. Microsoft Access comes bundled with Microsoft Office, the most popular software in Australia.

Communication of the findings of this research will occur through a number of channels. Primarily, the use of the computer package itself which will be made available for sale to the public. Secondarily, summaries of findings, and scientific aspects of the project in general will be published in the industry press and scientific journals.

The continuing involvement of different sectors of the industry/community (see Appendix 16) will be on-going, and will assist in advertising and distribution of the *Hazard Score* package. For example, liaison with Canegrowers and BSES will extend the packge to sugarcane farmers in the near future during the second phase of development of the product.

Appendix 1.

Sample of data providing toxicity scores to pesticides based on poison schedule. All agricultural chemicals registered for use in Australia are included in Hazard Score package.

Trade Name	Active Ingredient	Poison Schedule	Toxicity Score
2,4-D, AMINE 500	2,4-D, AMINE	5	2
2,4-D, AMINE 500	2,4-D, AMINE	5	2
2,4-D, ESTER 800	2,4-D, ETHYL	5	2
2,4-D, SULV 500B	2,4-D, BUTYL	5	2
2,4-DB	2,4-DB	5	2
2,4-DB 400	2,4-DB	5	2
4-IN-1 DIP	PIPERONYL	6	3
4-IN-1 DIP	ROTENONE	6	3
4-IN-1-DIP	DIAZINON	6	3
ABATE 100E	TEMEPHOS	6	3
ABATE 10SG	TEMEPHOS	6	3
ABATE 50SG	TEMEPHOS	6	3
ACATAK	FLUAZURON	6	3
ACCELERATE	ENDOTHAL	6	3
ACHIEVE WG	TRALKOZYDIM	6	3
ACTELLIC	PRIMIPHOS-	6	3
ACTELLIC 900SF	PRIMIPHOS-	6	3
ACTIVATOR	ALKYL		1
ACTIVATOR	ISOPROPANOL		1
ACTRIL DS	2,4-D, AMINE	6	3
ACTRIL DS	IOXYNIL	6	3
AD-HERE	MINERAL OIL		1
AEROSOL	CHLORFENVIPH	7	4
AEROSOL	DIBUTYL	7	4
AF 100	CALCIUM	5	2
AF RUBBER VINE	2,4-D, BUTYL	5	2
AF-300	2,4-D, ACID	5	2
AF-302	DICHLORPROP	5	2
AFALON	LINURON		1
AFUGAN	PYRAZOPHOS	6	3
AGAPROP	PROPAZINE		1
AGRAL	NON-IONIC		1
AGRIDEX	NON-IONIC		1
AGRIGAS M	METHYL	7	4
AGRIGAS MC	CHLOROPICRIN	7	4
AGRIGAS MC	METHYL	7	4
AGRIMEC	ABAMECTIN	6	3
AGSLO M H	MALEIC		1
AGSPRAY 100	GLYPHOSATE	5	2
AGTRYNE MA	MCPA,	5	2
AGTRYNE MA	TERBUTRYN	5	2
ALANAP-L	NAPTALAM	6	3
ALAR	DAMINOZIDE		1
AL-BAN	BENZALKONIUM		1
ALFACRON 500	AZAMETHIPHOS	6	3
ALGO	DICHLOROPHEN	6	3
ALIETTE WG	FOSETYL-AL	6	3
ALL SEASONS	PETROLEUM OIL		1
ALL SEASONS	PETROLEUM OIL		1

Appendix 2.

List of formulation types of pesticides used in Australia with a hazard score applied to each.

Formulation Type	Formulation	Score
Spray	Emulsifiable Concentrate	3
Spray	Water miscible liquid (Liquid)	3
Spray	Wettable powder	3
Spray	Water soluble powder	3
Spray	Gel	3
Spray	Oil solution	3
Spray	Soluble pellets	3
Spray	Flowable or sprayable suspension	2
Spray	Flowable microencapsulated suspension	2
Spray	ULV (Ultralow volume) concentrates	5
Spray	Fogging concentrates	5
Dust	Undiluted toxic agent	5
Dust	Toxic agent with active diluent	5
Dust	Toxic agent with inert diluent	5
Dust	Aerosol dust	5
Granular	Inert carrier impregnated with pesticide	2
Granular	Soluble granules	2
Granular	Water dispersible granules	2
Fumigant	Soil treatment liquid that vaporises	10
Fumigant	Greenhouse smoke generator	4
Fertiliser/pesticide		2
Bait		5
Slow-release insecticide	Microencapsulated	2

Appendix 3.

Sample of data providing scores for key physical properties of pesticides affecting their movement in the air, soil and water. Hazard Score contains data for most pesticides registered for use in Australia.

Active Ingredient	Volatilisation Coefficient	Leaching Coefficient	Persistence Coefficient
1,2-Dichloropropane	0	0	10
1-Napthaleneacetamide	0		
1-Naphthylacetic acid	1	1	0
2,4,5-T acid	0	2	0
2,4,5-T amine salts	0	2	0
2,4,5-T esters	2	2	0
2,4-D acid	0	2	0
2,4-D butoxy	0	1	0
2,4-DB dimethylamine	0	1	0
Abamectin	0	0	0
Acephate	0	9	0
Acifluorfen sodium salt	0	1	0
Acrolein	8	10	0
Alachlor	1	1	0
Aldicarb	1	3	1
Aldoxycarb	2	5	0
Aldrin	1	0	4
Ametryn	1	1	1
Aminocarb	1	2	0
Amitraz	1	0	0
Amitrole	0	2	0
Ancymidol	0	2	0
Anilazine	0	0	0
Arsenic acid	0		
Asulam sodium	0	1	0
Atrazine	0	1	2

Appendix 4.

Sample of data for droplet spectra of most nozzles used in Australia. Includes VMD (volume median diameter), which is the droplet size at which half the spray volume is composed of larger droplets and half the spray volume is composed of smaller droplets, and 10% fines, which is the droplet size at which 10% of the spray volume is composed if smaller droplets. VMD gives a measure of the overall droplet size, and 10% fines gives a measure of the size of the smaller, more drift-prone droplets.

Manufacturer	Nozzle Code	Pressure	VMD	10%
Albuz	Green	20	137	38
Albuz	Green	25	118	30
Albuz	Green	30	105	26
Albuz	Green	5	147.93	67.13
Albuz	Green	5	221	80.955
Albuz	Green	7.5	143.34	60.74
Albuz	Lilac	5	109	66.25
Albuz	Lilac	10	88	51
Albuz	Lilac	20	75.88	35.37
Albuz	Lilac	5	94.42	58.68
Albuz	Lilac	15	81.33	38.11
Albuz	Orange	10	109.88	48.36
Albuz	Orange	10	136	43.8
Albuz	Orange	13	113	47
Albuz	Orange	15	111.99	40.5
Albuz	Orange	15	123	36
Albuz	Orange	20	108.88	37.5

Appendix 5.

Sample of data contained in Hazard Score which assigns a score to nozzle types, based on their production of fine droplets when operated at different pressures.

Droplet	Nozzle Type	Pressure (Bar)	Blade Angle	Score
Air Shear	-	1-5	-	5
Air Shear	-	10+	-	20
Air Shear	-	6-10	-	10
Hydraulic	Flat Fan	1-2	-	1
Hydraulic	Flat Fan	3-5	-	2
Hydraulic	Flat Fan	5+	-	3
Hydraulic	Hollow Cone	1-2	-	2
Hydraulic	Hollow Cone	3-5	-	2
Hydraulic	Hollow Cone	5+	-	4
Hydraulic	Solid Cone	1-2	-	1
Hydraulic	Solid Cone	3-5	-	1
Hydraulic	Solid Cone	5+	-	1
Spinning Cage	-	-	45	20
Spinning Cage	-	-	90	30

Appendix 6.

Scores assigned to different types of application equipments based on their production of fine droplets.

Equipment Type	Score
Aircraft-mounted hydraulic nozzle	50
Aircraft-mounted spinning cage	40
Fogger	20
Knapsack Mistblower	10
Knapsack Sprayer	3
Knapsack Sprayer (overhead)	4
Pedestrian-operated CDA	2
Tree injection	1
Tree Sprayer - Axial fan	10
Tree Sprayer - Cross-flow fan	15
Tree Sprayer - Tunnel	3
Vehicle-mounted CDA	2
Vehicle-mounted hydraulic nozzle	3
Vehicle-mounted. Air-assisted	10
Weed wiper	1

Appendix 7.

Scores assigned to different techniques based on their ability to reduce the production or movement of small droplets.

Drift Reduction Technique	Comments	Score
Shielded Boom		10
Spray thickener	Chemical Included in formulation	2
Surfactant	Depends upon specific chemical	0.75
Evaporation/Volatilisation retardant		1
None		1

Appendix 8.

Scores assigned to different soil pH based on the impact of pH upon the binding of most pesticides to soil colloids.

Soil pH	Score
Acid (,6)	3
Neutral (6-7)	2
Alkaline (>7)	1

Appendix 9.

Scores assigned to different soils reflect the ability of organic matter to restrict the movement of most pesticides.

Description	Score
Organic matter greater than 5%	1
Organic matter 2-5%	2
Organic matter 1-2%	3
Organic matter less than 1%	4

Appendix 10.
Scores assigned to different soil types with respect to the movement of pesticides in soils of different clay/sand contents.

Decriptor	Description	Score
Texture	Sand	9
Texture	Sandy loam	8
Texture	Loamy sand	7
Texture	Loam	6
Texture	Loamy clay	5
Texture	Silty loam	4
Texture	Clay loam	3
Texture	Silt	2
Texture	Clay	1

Appendix 11.
Scores assigned to sites based on their slope, with respect to the leaching and run-off of pesticides.

Description	Score
Very steep slope (greater than 15%)	5
Steep slope (10-14%)	4
Moderate slope (6-9%)	3
Slight slope (2-5%)	2
Flat land (less than 2%)	1

Appendix 12.
Scores assigned to sites based on the depth of the water table with respect to the likelihood of contamination of waterways.

Description	Score
Water table less than 1m from surface	4
Water table 2-5m from surface	3
Water table 6-10m from surface	2
Water table more than 10m from surface	1

Appendix 13.
Sample of data for all statistical local areas (cities, towns, shires, suburbs) of Queensland showing population density.

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Region	City/Town/Shire	SLA	Area (sq km)	Population	Popn/sq km
Brisbane			4594	1525501	332
Brisbane	Brisbane City		1146	820590	716
Brisbane	Brisbane City	Acacia Ridge	9	7046	783
Brisbane	Brisbane City	Albion	1	2428	2428
Brisbane	Brisbane City	Alderley	2	4606	2303
Brisbane	Brisbane City	Algester	4	7581	1895
Brisbane	Brisbane City	Annerley	3	8936	2979
Brisbane	Brisbane City	Anstead	11	958	87
Brisbane	Brisbane City	Archerfield	5	625	125

Brisbane	Brisbane City	Ascot	3	4884	1628
Brisbane	Brisbane City	Ashgrove	6	11274	1879
Brisbane	Brisbane City	Aspley	6	11049	1841
Brisbane	Brisbane City	Bald hills	14	5624	402
Brisbane	Brisbane City	Balmoral	1	3243	3243
Brisbane	Brisbane City	Banyo	6	5098	849
Brisbane	Brisbane City	Bardon	6	8498	1416
Brisbane	Brisbane City	Bellbowrie	7	3807	544
Brisbane	Brisbane City	Belmont-Mackenzie	13	3386	260
Brisbane	Brisbane City	Berrinba-Karawatha	11	359	33
Brisbane	Brisbane City	Boondall	11	7452	677
Brisbane	Brisbane City	Bowen hills	2	736	368

Appendix 14.

Sample of scores assigned to different cropping systems based on normal pesticide application practices. Used in the programme in the "short-cut" assessments.

Crop	Cropping	Score
Capsicums	Conventional	50
Capsicums	IPM	25
Citrus	Conventional	40
Citrus	IPM	20
Cotton	B.t.	10
Cotton	Conventional	50
Cotton	IPM	20
Macadamias	Conventional	40
Macadamias	IPM	20
Pasture	Grazed - cattle	1
Plant Nurseries	Conventional	75
Plant Nurseries	IPM	30
Potatoes	Conventional	25
Potatoes	IPM	15
Sugar cane	Plant	15
Sugar cane	Ratoon	5
Tomatoes	Conventional	75
Tomatoes	IPM	25
Wheat	Conventional	1
Wheat	Min-till	2
Wheat	No-till	3

Appendix 15.

Scores assigned to vegetative buffers and other barriers based on their ability to intercept airborne pesticide droplets.

	Type of buffer	Score
1	Trees/shrubs with an open network of thin rough foliage (eg. Casuarina)	500
2	Trees/shrubs with medium non-waxy foliage (eg Meleleuca, Callistemon)	100
3	Double Sarlon Shade Cloth (50%)	75
4	Natural Vegetation (Eucalypts, Acacias and understory)	50
5	Open land - grasses and herbaceous vegetation	10
6	Open land - no vegetation	5
7	Solid Wall	0.5
8	Application made inside a greenhouse	10000
9	Application made inside a shadehouse	5000
11	Mixed Vegetation - Trees plus understory vegetation	75
12	None	1

Appendix 16.

Delegates of *Hazard Score* Review and Reference Panel, Gatton College, 28/10/97.

Battaglia, Rob	Department of Primary Industries, Gatton.
Bibo, Jenny	Department of Primary Industries, Brisbane.
Brown, Rob	Rural Industries Research and Development Corp., Melbourne.
Bunker, John	Redlands Nursery, Redland Bay.
Cunningham, Geoff	Department of Primary Industries, Bundaberg.
Cupples, James	Queensland Farm Safe, Thuringowa.
Ferguson, Keith	Workplace Health and Safety, Brisbane.
Hallett, Steve	University of Queensland, Gatton.
Ham, Selena	Department of Natural Resources, Brisbane.
Harden, John	University of Queensland, Gattton.
Hughes, Peter	Department of Primary Industries, Dalby.
Milford, Bernard	Canegrowers, Brisbane.
Mortimer, Monro	Department of Environment, Brisbane.
Langford, Peter	Queensland Rail, Brisbane.
McMahon, Gavin	Bureau of Sugar Experiment Stations, Brisbane.
Naylor, Barry	Queensland Nursery Industy Association, Brisbane.
Sargent, Cameron	Department of Primary Industries, Ipswich.
Trost, Greg	Canegrowers, Brisbane.
Whitehead, John	University of Queensland, Gatton.

Appendix 17
Case Study Examples

Farm 1.
Sugarcane
Nambour
20 ha.

Pesticides:	Suscon Blue (x1).	Granular	
	Cane Sett (x1)	Spray	
	2,4-D amine	Spray	Pesticide Index = 4
Application:	Vehicle Mounted Boom		
	Flat fan nozzles		
	3 bar pressure		
	Height 0.5m		Application Index = 4
Weather:	20 C		
	75% RH		
	Windspeed 5 km/h		Vapour drift index = 2
			Droplet drift index = 3
Population:	6 residences within 100m		
	213 residences within 1km		
	Population density of area 21/sq.km		
	1 school within 1km		Population Index = 4
Buffer Zones:	Nil		Buffer Index = 10
			Total Hazard = 6

Management options to reduce hazard identified:

1. Use shielded booms. Application Index is reduced from 4 to 2. Total Hazard is reduced from 6 to 5.
2. Erect shade-cloth wall around perimeter of paddock. Buffer index is reduced from 10 to 7. Total Hazard is reduced from 5 to 4.

Farm 2.
Tomatoes
Redland Bay
2 ha

Pesticides:	Bromafume (x1)	Fumigation	
	Dithane (x10)	Spray	
	Lannate (x7)	Spray	
	Ambush (x7)	Spray	
	Heliothion (x7)	Spray	
	Copper (x4)	Spray	Pesticide Index = 7
Application:	Vehicle-mounted boom		
	Flat fan nozzle		

	3 bar pressure Height 0.5m	Application Index = 4
Weather:	22 C 75% RH Wind speed 7 km/h	Vapour drift index = 3 Droplet drift index = 4
Population:	8 residences within 100m 473 residences within 1km 1 school, 1 church Population density 116/sq.km	Population index = 6
Buffer zones:	Line of natural vegetation (trees 15m in height with understory)	Buffer index = 4
		Total hazard = 6

Management options to reduce hazard identified:

1. Plant a line of trees with rough foliage (eg Casuarina). Buffer index reduced from 4 to 1. Total hazard is reduced from 6 to 4.

Farm 3.
Avocadoes
Maryborough
13 ha

Pesticides:	Copper (x8)	Spray	
	Endosulfan (x8)	Spray	
	Roundup (x2)	Spray (boom spray)	
	Phosphorous acid	Tree injection	Pesticide Index = 8*

* Score dominated (97%) by endosulfan.

Application:	Air-blast sprayer Release height 7m	Application index = 8
Weather:	25 C 75% RH Wind speed 10 km/h	Vapour drift index = 4 Droplet drift index = 5
Population:	43 residences within 100m 520 residences within 1km 1 hospital within 1km Population density of area 21/sq.km	Population index = 5
Buffer zones:	Nil	Buffer Index = 10
		Total Hazard = 10

Management options:

1. Plant line of trees with rough foliage (eg Casuarina). Buffer index reduced from 10 to 2. Total Hazard reduced from 10 to 8.
2. Cease spraying of Endosulfan. Pesticide Index reduced from 8 to 5. Total Hazard reduced from 8 to 6.

Summary

"MANAGING THE PLANT PROTECTION ASPECTS OF THE RURAL/URBAN INTERFACE"

Objectives
The major objective of this project was to develop a user-friendly computer-based package to support decision makers in the rural/urban interface in the management of pesticide hazards.

Background
Australia is a highly urbanised country whose cities are constantly increasing in size, and encroaching on areas of rural land use. At the fringes of cities, hazards and conflicts occur as a result of plant protection practices, particularly those involving the use of pesticides. Conflicts are fuelled by misinformation and exaggeration by the popular press. It is necessary to provide a tool which can accurately assess pesticide hazards in this rural/urban interface.

Research
1. The *Hazard Score* package was developed as a tool for the assessment and teaching of the nature and extent of pesticide hazards in the rural/urban interface. Large amounts of data relevant to pesticide parameters (human toxicity, physical properties), human population, weather effects, application equipment and nozzles, buffer zone effects are stored within the programme, and are accessed automatically during hazard assessments.
2. Preliminary validation of the programme parameters has been performed with data collected from site visits to 15 farms in SE Queensland. The ability of the programme to perform complex calculations in a wide range of situations has been established.
3. On-going liaison with the industry/community has been on-going, and representatives of each sector expect the package to be of direct relevance to their needs in managing pesticide hazards in the rural/urban interface.

Outcomes
A draft version of *Hazard Score* has been written in Microsoft Access, which is capable of performing complex calculations of pesticide hazards in a wide range of different situations. The programme is designed to be used by either skilled or non-skilled operators, performing a range of complex and simplified assessments of pesticide hazard. The package contains the *Hazard Score* programme, which performs the calculations and a supporting manual and extensive database of plant protection literature.

Implications
Availability of *Hazard Score* will, 1) allow land planners to understand pesticide hazards prior to sub-division of land in rural areas, 2) help producers to find logical ways of reducing the impact of off-site pesticide movement, 3) provide regulators with a means of studying pesticide hazards, and 4) provide a tool for resolution of pesticide-related conflicts in the rural/urban interface. The use of *Hazard Score* will promote the harmonious co-existence of rural and urban land users in the rural/urban interface and assist the steady and sustained growth of Australia's rural industries.

Project Details: RIRDC Project No. UQ-48A

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