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1. PUBLIC CONSULTATION [INITIAL]

1.1 Introduction

Consistent with the NRA's policy of consulting with all parties interested in the review process, the NRA published notices in the rural and metropolitan press calling for written submissions for the review of the chemical Chlorpyrifos. This attracted **32** submissions from members of the public, environmental, government and commodity groups.

The majority of submissions expressed views supporting the continued use of chlorpyrifos. There were a number of submissions which dealt with the detrimental effects that the use of this chemical has on the environment, public health and occupational safety. Comment supporting the continued availability of chlorpyrifos in the market was primarily from commodity groups who find this chemical a useful tool in the management of insect pests.

While all views expressed as a result of public consultation were considered in the review of Chlorpyrifos, these remain views of the authors of these public submissions, and not those of the NRA. The primary purpose of this section is to highlight the range of views resulting from public consultation. Any comments which have been supported with data, have been forwarded to the relevant agency for assessment, and are further considered in the relevant sections of the ECRP report for chlorpyrifos.

For the ease of presentation, views and concerns raised regarding Chlorpyrifos during this intitial public consultation have been categorised as follows.

- Those submissions which discuss any public health, environmental or occupational safety risks relating to this chemical, are presented under the heading 'Risk Identification'. The ways in which the level of risk associated with the use of chlorpyrifos can be minimised by particular user groups, is also discussed here.
- Those submissions which discuss the importance of chlorpyrifos in integrated pest management systems, as well as for the prevention of resistance in various sectors, are discussed under the second section entitled 'Integrated Pest Management/ Resistance Management'.
- The final section is where respendents' views on chlorpyrifos are expressed. This information is provided under the heading 'General Views on Chlorpyrifos'. This details the comparative advantages of chlorpyrifos in particular industries.

Most views expressed in the public submissions have been summarised in the following sections, and where views expressed in several submissions are similar or related, these have been consolidated.

1.2 Risk Identification

1.2.1 Public Health

The issue of possible health effects arising from the use of this chemical were discussed by 6 respondents [11,12,15,21,22, 29]. These comments ranged from general statements noting that chlorpyrifos is known to be detrimental to human health, right through to the detailing of specific symptoms of chlorpyrifos poisoning and bioaccumulation. These respondents also noted that chlorpyrifos is a cholinesterase inhibitor.

One respondent commented on the toxicity of chlorpyrifos in relation to other organophosphates [15]. Another commented that the importance and effectiveness of chlorpyrifos in various industries, outweighs the possible human toxicity effects associated with its use [27].

The Queensland Conservation Council and Queensland Consumers Association [11] submission, provided details of toxicological effects associated with exposure to organophosphate chemicals in general. Some of these symptoms included, nausea, vomiting, diarrhoea, abdominal cramps, headache, dizziness, eye pain, blurred vision, sweating and confusion. The comment was also made that, while these effects are widely recognised and mostly avoided, there is concern that many workers and their general practitioners may not be aware of, or diagnose the effects of chronic exposure. In the opinion of this respondent, these effects may be more widespread than is realised. The Total Environment Centre Inc. [29] submitted information which dealt with health issues related to chlorpyrifos exposure such as cholinesterase inhibition, metabolism and distribution in the mammalian body, acute toxicity, neurotoxicity, psychological and immunological effects. The issue of multiple chemical sensitivity was also raised. Details on the possible public health effects of chlorpyrifos were provided, and these have been forwarded onto the agencies for assessment.

The Australian Chemical Trauma Alliance [22] noted that other effects of exposure to chlorpyrifos may include immunogenic abnormalities, antibiotic sensitivity, decreased percentage of T-cells, skin flushing and a decline in urination.

A respondent from the termite control industry, representing Termi Mesh Australia Pty Ltd [24], noted that building treatments do not last the lifetime of a building and thus re-treatment is necessary. This re-application is extremely difficult, disruptive and exposes people to potentially toxic chemicals detrimental to their health. The effects to public health due to application for termite control were also discussed by Total Environment Centre Inc [29].

Several submissions received from industry groups indicated that although the effects of this group of chemicals are well documented, there has never been any report of anyone suffering health problems following exposure to chlorpyrifos. Many employers carry out regular worker health checks to ensure the continued health of their workers. These submissions noted that when used as directed, the chemical should pose no threat to the health of the user [3, 12, 15, 16, 23].

Other concerns which were raised by Total Environment Centre Inc., suggested that there may also be health concerns with the excipients used in formulations such as solvents, as well as the possibility of an increased toxicity when the product is used in conjunction with other pesticide formulations [29].

1.2.2 Environment

Several respondents [2, 10, 11, 15, 14, 16, 29] raised environmental concern associated with the use of chlorpyrifos and to the effects that this chemical has on the environment. These have been placed under the headings relevant to the particular area of environmental concern.

Waterways

The Queensland Department of Environment [2] in their submission, presented a report on monitoring results since 1995, carried out on the Brisbane River and its tributaries. There had been a number of reported fish-kills in these waterways and in most cases, chlorpyrifos was implicated. This contamination of the rivers was thought to be associated with under slab treatment of local households against termite infestation especially following rain.

The submission contained limited data, including teat results on the levels of chlorpyrifos present in water, fish tissue and sediment [2]. Of these, a significant proportion of the sites had chlorpyrifos detected in both water and fish tissue. Only 1 site recorded chlorpyrifos contamination in the sediment.

The respondent concluded that the formulation may not bind to soils sufficiently to minimise leaching into waterways. Also, the contamination may indicate that label warnings are not sufficiently prominent or are being disregarded. For example, over use or a lack of measures to prevent run-off in the event of rain [2].

The information presented by The Department of Environment and Natural Resources [10] related to their sampling of bore water to test for the presence of chlorpyrifos. These samples were taken from a range of areas encompassing several industries and thus different use patterns of the chemical. Of the 129 sites tested, only 3 showed contamination with chlorpyrifos. Two of these bores were under vineyards and the other under intensive cropping. The levels detected were 1000 times below the drinking water guideline [10].

The respondent concluded from these results that chlorpyrifos has a low potential for leaching through the soil. The contamination may therefore have been by direct contamination or via preferential flow paths [10].

The Rural Marketing And Supply Association (RMSA) also commented that chlorpyrifos is moderately soluble in water but tightly sorbed by soil and not expected to leach significantly. Chlorpyrifos is also thought to have a relatively short half life in the environment [4].

Many of the respondents indicated that chlorpyrifos has been shown to be highly toxic to fresh water fish, aquatic invertebrates, estuarine and marine organisms. A concentration of as low as 0.011 kg of active per hectare may cause death in fish and aquatic invertebrates, therefore chlorpyrifos should be confined to the target area. Chlorpyrifos accumulates in the tissues of aquatic organisms and is also thought to be persistent in the sediment and thus could be a hazard to sea bottom dwellers. Several submissions have expressed concerns that the decline in ‘bottom dwellers’ in creeks in Brisbane and Northern NSW, have occurred due to the increase in use of chlorpyrifos for termite control [2,11,15,24].

The Total Environment Centre provided information on the toxicity of chlorpyrifos to other organisms. Chlorpyrifos was considered toxic to aquatic crustaceans, water fleas and is highly toxic to fish. There were concerns of algal blooms occurring following the application of chlorpyrifos to waterways. Chlorpyrifos was thought to be partitioned from the water to the sediment upon entering waterways and is degraded in water by chemical hydrolysis and biodegradation. Many other areas of environmental concerns were raised and these will be considerd in the environmental assessment [29].

Soil

In many industries, chlorpyrifos is used due to its persistence in the soil. This persistence is an important property in the control of ground-dwelling insects, who only return to the surface every few days to feed [4, 3,15].

The opinion of the representative from the sugarcane industry was that because chlorpyrifos binds to clay particles, there would be little chance of movement into ground water. It would only leave the application site if erosion occurred and soil was deposited in waterways [16].

The Total Environments Centre Inc. commented that chlorpyrifos in the soil is long lived and persists in soil and sediments following low application rates, although persistence is increased up to years when high rates of chlorpyrifos are applied such as in termite control. Chlorpyrifos binds tightly to organic material and is therefore retained in the top soil layer. When the temperature decreases or there is an increase in organic matter or mixing of the chemical into the soil, there is a subsequent increase in the persistence of chlorpyrifos. When chlorpyrifos is left on exposed surfaces it rapidly evaporates. It is also degraded by sunlight [29].

Non-target species

There were concerns raised by one respondent that chlorpyrifos was toxic to wildlife, particularly to beneficial insects such as bees, birds and aquatic life [11]. An avian toxicity incident following the use of a granular formulation of chlorpyrifos was reported by one respondent. It was noted that the product label in question only indicated the potential toxicity of the product to birds and fish [30].

Within the grain industry, the application for chlorpyrifos is carried out within fairly closed systems thus minimising the effect on non-target species [12].

The Total Environment Centre commented that chlorpyrifos is toxic to soil organisms such as earthworms and nitrogen fixing bacteria, as well as being detrimental to beneficial predatory insects [29].

Container and waste disposal

Another submission raised concerns relating to the accumulation of contaminated drums at waste disposal sites or, in the case of recycling, disposal of rinsate into river systems which have had reported fish kills [24].

A number of industry representative groups commented on the effects of chlorpyrifos on the environment. The general opinion was that when used correctly, and disposed of in accordance with EPA requirements, there would be no damage to the environment. In some areas this was difficult due to the lack of appropriate facilities provided by local councils for the correct disposal of these chemicals [1, 12, 16, 4, 35].

Residues

The Department of Natural Resources and Environment Victoria, presented data dealing with instances of MRL violations for chlorpyrifos in a number of different commodities. Of the cases presented on 72 commodity samples, 24% had violated the MRL for chlorpyrifos by various degrees [25].

1.2.3 Occupational Safety

Many user industry groups stated that when used in accordance with the labelling directions, the products are effective and safe to the user and have been used safely for many years. The safety issues relating to a particular product, depends largely on the way in which it is applied to the target crop and also the type of formulation. This was considered to be well understood by growers [1, 3, 12, 15, 16].

Bureau of Sugar Experimental Stations (BSES) noted that in the sugarcane industry there are two common application methods, both considered by the respondent to be safe. The two forms in which this chemical is presented for application, is as controlled release granules or as an emulsifiable concentrate. In both cases the chemical is covered by soil immediately following application. There have been no adverse results reported from the use of the chemical in either of the two forms. These treatments are usually applied early in the growing season so the chemical would usually not be present at the time of harvest to expose the majority of workers [16].

It was reported by two companies in the termite control industry, Virotech Friendly Technology and Termi Mesh Australia P/L, that workers are not taking the appropriate steps to minimise their exposure to this chemical. This is particularly apparent for pre-construction treatment under slabs. There have been reports of the appropriate protective clothing not being worn by those applying the chemical, and others in the vicinity, such as concretors and builders, also not wearing appropriate clothing. In many instances the chemical is being applied when the weather conditions are not favourable, such as high wind and rain. There were also reports that the chemical is not being used in accordance with the label directions. This is especially so in perimeter treatments of buildings. The label requires the treatment to be performed by either trenching or rodding. The preferred method of chemical suppliers is for the perimeter to be trenched as it ensures a better application with all the soil being treated. According to the respondent, far too frequently, and particularly in the cities, the perimeter is not treated in this manner. Rather the chemical is lightly sprayed onto the surface of the soil which not only renders the barrier ineffective but also exposes non-target groups, for example children and pets. It was also noted that untrained workers are applying these chemicals and that there was a general failure in the industry to introduce, monitor and enforce any product stewardship [14, 24].

One termite control company noted that the image products in the market may contain impurities which may be more harmful to health than the actual chemical. These also were considered in many cases to be less effective possibly due to the physical properties of the emulsion particle [14].

It was concluded that the abuse of chlorpyrifos in the termite control industry may be due to the difficulty of physically identifying the presence, or nature, of contamination following application. A red vegetable dye has been incorporated into these products in some states to trace chlorpyrifos movement. The respondent felt that this should be an essential inclusion into all products to enforce correct application of the products [24].

A number of industry groups indicated that training courses are regularly being run for the chemical users. These are considered as important to ensure user adherence to safety requirements and to reduce chemical abuse [23, 27, 12, 13].

The Department Of Natural Resources And Environment also provided instances of complaints due to the use of chlorpyrifos in various situations. These ranged from unpleasant odour in the air due to spraying of cabbages and broccoli, death of bees from aerial spraying, residents overcome by odour after product application to a glasshouse for termites and mis-use of products contrary to label directions [25].

1.3 Integrated Pest Management and Resistance Management

The majority of the respondents indicated the importance of chlorpyrifos in integrated pest management programs in their respective industries. For this type of program to be effective, growers require access to a wide range of chemicals for management of pests through effective rotation programs. This is critical to Integrated Pest Management [1,3,7,8,12,13,16,17,23,15,27].

Chlorpyrifos is compatible with biological control organisms. This chemical allows the producer to maintain beneficial organisms at their optimum populations while still removing the insect pests. It was also noted that although the natural predators may be affected by the use of this chemical, they tend to recover rapidly which reduces the risk of secondary pest outbreaks following a single application [13,17,1].

The success of integrated pest management programs depends on the well managed and controlled use of chemicals that have minimal impact on biological control techniques. The most effective control is gained by minimising the risk of resistance to chemicals by the insects that are the target of these control techniques. This can only be obtained by chemical rotation together with the timely use of the biological controls [7].

In the vegetable industry there is increasing resistance to other organophosphates by insect pests such as cabbage white butterfly. Chlorpyrifos is an alternative organophosphate which can still be used in a rotation program without efficacy being lost due to resistance [3,15].

Chlorpyrifos is important for use in the grain industry in the control of *Sitophilus sp,* where insect growth regulators (IGR's) are no longer effective in rotation programs. Chlorpyrifos is also a useful alternative to fenitrothion in locust control [12].

In the fruit industry chlorpyrifos is an important component in fruit fly baits. It is also effective in this industry for 'crawler' control in stonefruit. The alternative chemicals for insect control in this crop are phytotoxic to some varieties [23]. Without this chemical the economic viability of many fruit growing enterprises may be lost [1,17].

Although chemical alternatives do exist and could be used as part of a rotation program, chlorpyrifos has a number of advantages and is therefore preferred over these other chemicals. It is important to have a selection of pesticides available which suit growers requirements and service a multitude of crops [13]. According to a representative from the Queensland Fruit and Vegetables Association, chlorpyrifos is less damaging to beneficial insects, less toxic to the operator, and important in the citrus industry to use late and early in the season when oils are not able to be used. It is used only when natural predators become ineffective [1].

With the limited number of suitable chemicals now available, any reduction would lead to more resistance pressure being placed on the remaining chemicals. Chemicals useful in an IPM approach, once removed from use, weakens the overall program by limiting the products available for rotation. This then forces the industry to increase chemical rates and apply more frequently those products still available which can lead to serious pest resistance to chemicals [7,13].

1.4 General Views on Chlorpyrifos

This information details the opinions of various user groups as to the benefits of chlorpyrifos in various industries, and what the alternative measures would be should chlorpyrifos be removed from use. The information below is sorted according to industry, showing the importance of chlorpyrifos in that particular industry environment.

Fruit and Vegetable Industry

Chlorpyrifos is chosen for use in the vegetable industry due to its persistence in the soil. This aids in the control of ground dwelling insect larvae which only return to the surface to feed every few days [2].

In the fruit growing industries, chlorpyrifos is used for the control of scale insects in mangoes and stone fruit. Natural predators of this insect are tolerant to chlorpyrifos when compared to other organophosphates. It is also used in low-chill stone fruit after harvest when there are increases in 'crawler' insect populations. Alternative chemicals for this purpose are phytotoxic to some varieties at this time. Less damaging and equally effective chemicals are not available [17]. Without chlorpyrifos there would be a move to a more traditional program that would require greater quantities of azinphos-methyl to achieve comparable results. Azinphos-methyl is known to have a detrimental effect on predator mites [23].

Chlorpyrifos is the most effective chemical against ants when applied in the form of trunk sprays. This barrier then allows natural predators to focus on the control of other pests which attack from above [17].

Chlorpyrifos is also being looked at as an alternative spotting bug spray for avocados. This is to reduce reliance on endosulfan. If effective, this could be used on other sub-tropical fruit. Chlorpyrifos is also being trialed as a bait spray. These are spot sprays, and without this chemical, there would have to be a move to whole canopy coversprays with fenthion or dimethoate. These 2 alternative chemicals severely affect biological control agents [17].

Chlorpyrifos is one of the few pesticides, and could be the only one, that is registered for use on kiwifruit. Without this chemical there would be no other treatments for control of scale insects during the growing season [19].

Chlorpyrifos is useful in combating resistance development through the rotation of alternative chemical groups [3].

At present there are limitations placed upon the fruit and vegetable industry due to their minor use of chemical products and consequent difficulties in securing registration. Should chlorpyrifos be removed from the market, sufficient time would be required so suitable alternatives could be identified [1].

Ornamental Crops

Chlorpyrifos is an important chemical for use on ornamental crops, however this industry is a relatively small user of agrochemicals. The likelihood of new chemicals being registered to replace chlorpyrifos is low due to the small demand, and thus low dollar return, on the extensive investment involved in chemical registration. The removal of chlorpyrifos would result in many off-label uses while growers await registration of new chemicals. Chlorpyrifos is the only available chemical allowed to be used in the control of Western Flower Thrip [13, 8].

Sugarcane Industry

In the sugarcane industry, it was noted that it is essential for chlorpyrifos to be retained. It is the chemical responsible for the management of the major pests in this crop. The product S*uscon blue*, is the only registered insecticide formulated for adequate control of cane grubs. There are alternatives but their use is restricted to where irrigation is available [16].

The products *Lorsban* and *Chlorfos,* which are emulsifiable concentrates, are the only registered formulations for the control of symphylans. There are more expensive options but these are not as accessible as the products containing chlorpyrifos [16].

Termite Control Industry

Termi Mesh Australia’s submission commented on the benefits to their industry if chlorpyrifos was removed. There would be a benefit to consumers in that alternative barriers for termite control last over the economic life of the home or building compared to current treatment which need to be re-applied after a number of years. This retreatment via hand spraying is expensive. All chlorpyrifos used is imported, whereas alternative barriers have the majority of their material manufactured in Australia [24].

The removal of this chemical would create potential for new products to enter the market which are much safer to the user as well as to the area being treated. The respondent stated that Australia should follow the example of the United States where the use of chlorpyrifos has been banned for internal domestic use for control of fleas and cockroaches [24].

The Grain Industry

Chlorpyrifos is used in the grain industry during the growing period against a wide range of pests of the growing crop. It is also used on forage crops to protect against insect attack. This is common in drought situations where pasture is limited [27]. The use of chlorpyrifos for pests control during the growing period is widely supported by the Grains Council of Australia. It is especially important in the control of ground dwelling insects which comprise a wide range of species [12].

Other uses

It was stated that chlorpyrifos is a cheaper chemical than the alternatives for control of soil borne insects in crops such as cotton [4].

A respondent from the Tasmanian Farmers and Graziers Association noted that it is a useful chemical for control of insects in a variety of Tasmanian industries and is a fundamental tool in effective pest management programs [15].

Another respondent noted that this chemical should be de-registered or its uses severely restricted so as to prevent waterway contamination through overspray or run-off [17].

An environmental organisation cited a number of examples where label directions were not clear enough as to allow correct application and management of the product. Appropriate label information was considered by the respondent to be critical in reducing occupational or environmental exposure due to chlorpyrifos [29].

Pineapple grower representatives provided details of chlorpyrifos use in pineapple production, where chlorpyrifos is used as an effective tool for the control of a series of pests [31].

A respondent from Department of Agriculture, Western Australia provided details of a chemigation use of chlorpyrifos in potatoes [32]. According to the respondent, this off-label use practice is not widespread. An application for an NRA permit has been made regarding this use pattern.

2. EFFICACY ASSESSMENT

2.1 Introduction

One aspect of the contemporary assessment standards with which chemicals must comply to maintain registration is that use of products containing the chemical must be effective according to criteria determined by the NRA for the product.

Growers, commodity organisations, State departments of agriculture and the chemical industry have been surveyed for information on the performance of the chemical in the field, addressing aspects such as management strategies, methods of application and chemical failures. In particular, information has been sought on whether the present use of the chemical is the same as when it was first registered and whether the present label directions are still applicable.

These matters have been examined and the results presented in this section.

2.2 Current Usage

Chlorpyrifos, an organophosphorus insecticide dating from the mid 1960s, has gained wide use in agriculture, at industrial and building sites and in domestic applications. In agricultural applications, it is registered to control a broad range of insect pests across most crops as well as in turf and ornamental applications. In the home and in commercial sites it is used to control pests such as cockroaches, termites and fleas. It is also registered for use in flea collars for dogs and cats and in flea shampoos for dogs.

2.3 Registration Status

Chlorpyrifos is widely registered or approved for use throughout the world where it is used in ways that are largely similar to those in Australia. According to current information, it has not been removed from registration because of adverse decisions.

There are 164 (from NCRIS at 03/08/00) products containing chlorpyrifos currently registered in Australia.

In agricultural applications, chlorpyrifos is registered to control a broad range of insect pests across many crops including turf and ornamental crops. In the home and commercial sites it is registered for the control of pests such as cockroaches, termites and fleas. It is also registered for use in dog and cat flea collars and shampoos and in flea sprays for dogs.

The total amount of chlorpyrifos active ingredient imported into Australia during the financial year 1996-1997 was approximately 970,000 kilograms.

An estimate of the relative distribution of the use of chlorpyrifos (as active ingredient) by crop or application grouping is shown below in Table 2:

Table 2 - Estimate of chlorpyrifos usage by crop or application grouping

Crop/Application Grouping	**% of chlorpyrifos used in each**
anti-termite	28.6
cotton	20.9
sugar cane	18.8
vegetables	5.9
pome & stone fruit	4.7
general pests	4.5
other cereals	2.9
turf, home garden, other	2.4
pasture	2.3
tropical fruit	2.1
grape	2.1
canola	1.6
citrus	1.4
rice	1.4
subtropical fruit	0.3

It should be noted in relation to these estimates that seasonal factors play a role in determining pest population levels, pest complexes and areas planted to crops with registered applications resulting in variation in chlorpyrifos usage from year to year.

Crops or other use situations appearing on currently registered product labels have been listed in Table 3:

Table 3 – Registered Crops/Use Situations for chlorpyrifos

COMPANION ANIMALS/VETERINARY	CAT	DOG	CATTLE
AGRICULTURAL OR CROP USES	ANNUAL PASTURE-IMPROVED	APPLE	ASPARAGUS
AVOCADO	BANANA	BARLEY	BEAN
BEETROOT	BEETROOT SEED	BROAD BEAN	BROCCOLI
BRUSSELS SPROUT	CABBAGE	CANOLA OILSEED CROP	CANOLA SEED
CAPSICUM AND PEPPER	CARROT	CARROT SEED	CASSAVA
CAULIFLOWER	CELERY	CEREAL STUBBLE PASTURE	CHICKPEA
CHOKO	CHOU MOELLIER	CITRUS	CLOVER GROWN FOR FORAGE
CLOVER SEED CROP	COFFEE	COTTON	COTTON OILSEED
COWPEA	CRUCIFER	CUCUMBER	CUCURBIT
CUSTARD APPLE	DUBOISIA OR CORKWOOD	EGGPLANT	FABA BEAN
FIELD PEA	GHERKIN	GINGER	GRAPE
GREEN MUSTARD	HOPS	KALE	KIWI FRUIT
LEGUME	LEGUME	LETTUCE	LINSEED CROP
LINSEED OIL CROP	LOQUAT	LUCERNE	LUCERNE GROWN FOR FORAGE
LUCERNE PASTURE	LUCERNE PASTURE SEEDLING	LUPIN	MACROCARPA CYPRESS
MAIZE	MANGO	MARROW	MEDIC PASTURE
MEDICS GROWN FOR FORAGE	MELON	MILLET	MUNG BEAN

NAVY BEAN	OATS	OILSEED MUSTARD	OILSEED SEEDLING
ONION	ONION SEED	PARSNIP	PASSIONFRUIT
PASTURE ESTABLISHMENT	PASTURE PRE-SOWING	PASTURE SOD SOWN RICE	PEA
PEANUT OILSEED	PEAR	PERENNIAL PASTURE GRASS	PIGEONPEA
PINEAPPLE	POME FRUIT	POPPY OILSEED	POTATO
PUMPKIN	RADISH	RADISH SEED	RHUBARB
RICE	ROOT VEGETABLE	RYE	SAFFLOWER
SAFFLOWER OILSEED	SHALLOT	SHALLOT SEED	SILVER BEET
SORGHUM	SOYBEAN	SQUASH	STONE FRUIT
STRAWBERRY	SUGAR CANE	SUNFLOWER	SUNFLOWER OILSEED
SWEDE	SWEET POTATO	TOBACCO	TOMATO
TREE - SEE LABEL FOR VARIETY	TRITICALE	TURNIP	TURNIP SEED
WHEAT			
IN AND AROUND BUILDINGS OR PUBLIC AREAS	AGRICUL/FARM BUILDING UNDER CONSTRUCTION		
ANIMAL HOUSING	ANT TRACK OR NEST PEST CONTROL	BOWLING GREEN	BRICKWORK AND/OR PATH
BUILDING	BUILDING CONSTRUCTION	BUILDINGS - AROUND	BULB
COMMERCIAL BUILDING UNDER CONSTRUCTION	COMMERCIAL PREMISES - GENERAL	COMMERCIAL/INDUSTRIAL LAND	COMMERCIAL/INDUSTRIAL PREMISES
CRACKS AND/OR CREVICES	DOMESTIC PEST CONTROL	EMPTY ANIMAL AND/OR BIRD HOUSING/CAGE	FACTORY UNDER CONSTRUCTION
FOOD PROCESSING AND/OR PRESERVING PLANT	FOUNDATION OR VERTICAL BARRIER	GARDEN BED OR ROCKERY	GARDEN PEST CONTROL
GENERAL HOME GARDEN USE	GOLF GREEN - PUTTING	GOLF GREEN TURF	HIDE AND SKIN PREPARATION PEST CONTROL
HORIZONTAL BARRIER, AROUND OR UNDER	HOUSE - GENERAL	HOUSE UNDER CONSTRUCTION	INDUSTRIAL BUILDING UNDER CONSTRUCTION
INDUSTRIAL LAND OR AREA	INDUSTRIAL USE OF PEST CONTROL	KENNEL, ANIMAL LIVING AREA PEST CONTROL	LOG, POST AND POLE
ORNAMENTALS IN POTS	PATH	PATIO	PEST CONTROL ALONG FENCES
POLLUTED WATER	POTTED PLANT	PUBLIC PREMISES UNDER CONSTRUCTION	SHED (IN OR AROUND)
SHED,FACTORY,WAREHOUSE OR OTHER BUILDING	SHRUB, TREE	STORED ANIMAL HIDE AND SKIN	STRUCTURE - GENERAL
TENNIS COURT	TERMITE NEST OR COLONY	TIMBER	TOP SOIL AND SOIL
TREE STUMP	TURF AND LAWN	WALL SURFACE (INTERIOR AND/OR EXTERIOR)	WARDROBE
WATER-RESTRICTED AREA	WOODEN POLE		

Permits for use of chlorpyrifos have been issued by the NRA in certain circumstances such as minor and/or emergency uses and for trial purposes. Current permits issued by the NRA for chlorpyrifos, except trial permits which may be commercially confidential, are presented in the following table:

Table 4 - Permits issued for chlorpyrifos*

Crop/Situation	***Pest***
Black currant	Light brown apple moth
Capsicum (young plants only)	Western flower thrip
Compost heaps around pome, stone & citrus fruit orchards	Mediterranean fruit fly
Cucumber	Western flower thrip
Grape	European Earwig
Lettuce (seedling stage)	Western flower thrip
Onion (seedling stage)	Strawberry beetle
Ornamentals	Western flower thrip
Pine & eucalyptus plantations	African black beetle
Railway wagons for transporting rice	Warehouse beetle
Rice	Bloodworm
Silverbeet	Redlegged earth mite
Stonefruit	European Earwig
Tomato	Western flower thrip
Turf	Argentine stem weevil

*Note: These crops may appear on registered labels but not for rates of use, pests, use situations etc nominated in permits.

2.4 Current Use Patterns

Use in Agriculture

Chlorpyrifos is registered for the control of a wide range of pests, in part, because of its broad spectrum of activity. Responses from state authorities rated chlorpyrifos as an extremely versatile chemical important for the control of numerous economically significant insects.

The NRA received numerous responses to its call for information on chlorpyrifos use and efficacy. In particular, industry groups expressed strong support for the continued availability of chlorpyrifos. Among typical examples, one industry group representing the Queensland sugar producers regards chlorpyrifos as the single most important insecticide available to their industry. The Tasmanian Farmers and Graziers Association considers it a fundamental tool and states that it is the most commonly used organophosphate insecticide in Tasmanian agriculture and the one most frequently incorporated into resistance management programs. The Northern Victoria Fruitgrowers' Association stresses the value of chlorpyrifos to integrated pest management programs and believes it is required for the economic viability of many fruit-growing enterprises.

Use of the chemical takes many forms ranging from baits, granules and dusts to "in-furrow" spray treatments and broadacre spray treatments. The following paragraphs briefly summarise some of the current applications of this insecticide in Australia.

Chlorpyrifos is used throughout Australia for the control of soil associated insects such as cutworms, crickets, earwigs, wireworms, false wireworms and cockroaches. It is an important weapon against the root feeding larvae of bloodworm on rice and is also used in most states to control redlegged earth mite, lucerne flea, blackheaded cockchafer and pasture webworm.

Chlorpyrifos is used in all states for control of southern armyworm and common armyworm. Although fenitrothion is the pesticide of choice for locust control, chlorpyrifos is regarded as an important alternative and is registered in most states to control spur-throated locusts and plague locusts.

It is important with beans, capsicums and most vegetable crops against black field cricket, mole cricket, carrot weevil and vegetable weevil. In situations where alternative chemicals are registered, chlorpyrifos is preferred because it is comparatively less harmful to beneficial insects in IPM programs and is regarded as being less toxic to the operator.

Many vegetable crops such as onion, carrot, bean and sweetcorn require protection from cutworms as seedlings or transplants. Chlorpyrifos is chosen because its relative persistence in the soil enables it to be effective against soil inhabiting insects which may return to the surface only every few days. It is also widely used in early spray programs in brassica because it achieves a broad spectrum of activity against cutworm, aphid, cabbage moth and cabbage white butterfly with a single application.

Insecticide resistance in cabbage moth has emerged as a major problem worldwide. Chlorpyrifos, as an organophosphate, provides an important rotation chemical for resistance management in substitution for the commonly used synthetic pyrethroids or bacterial control methods.

In Queensland, chlorpyrifos is the only chemical registered for use on citrus, mangoes, avocado and banana to control a variety of pests such as the green tree ant, citrus rust thrips, fruit eating weevil, avocado leaf roller, light brown apple moth, pink wax scale and cluster caterpillars. Chlorpyrifos is the only chemical registered for pineapples against ants, canegrubs and white grubs and along with diazinon against mealybugs and pineapple scale.

In pome and stone fruit orchards, chlorpyrifos is used to control high pressure populations of light brown apple moth, looper, mealy bug and woolly aphid. It is also important in the control of light brown apple moth in grapes. Its relatively low impact on predatory mite populations makes it valuable in IPM programs.

Kiwi fruit producers in Victoria stress that it is extremely effective and important for control of light brown apple moth and scale in kiwi fruit production.

Chlorpyrifos is considered by growers of subtropical fruits to be the best registered product for use in fruit fly bait sprays. Since bait sprays are applied as spot-sprays and, therefore, avoid whole canopy cover sprays, they are especially important in IPM programs.

It is useful in control of hard and soft scales, particularly at the ‘crawler’ stage, in mangoes and low-chill stonefruit. Relatively high tolerance of beneficial predators to chlorpyrifos allows their rapid recovery after single applications and reduces the risk of secondary pest outbreak which often happens following use of other broad spectrum organophosphate or synthetic pyrethroid insecticides.

Chlorpyrifos is also the most effective available product for ant control using trunk sprays. As such it is an important component of IPM programs by preventing ants from destroying beneficial insects which parasitise and prey upon scales, mealybugs and aphids.

As mentioned earlier, the Queensland sugar industry considers chlorpyrifos to be the most important insecticide available to canegrowers. It is the only registered insecticide against symphylans and the most widely used chemical against wireworms, armyworms and locusts. In particular, according to sugar industry representatives, loss of chlorpyrifos for use against canegrubs could make large sections of the industry non-viable.

Barley and wheat ears are especially prone to lopping by summer infestations of armyworm, and chlorpyrifos is often used for control of this pest in Tasmania. It is also used in most States on pasture for control of black headed cockchafer, armyworm, lucerne flea and red legged earth mite, all of which are major pests.

From a somewhat different perspective, chlorpyrifos is considered an essential chemical in the preservation of subsurface drip irrigation systems (SSDI). Chlorpyrifos is periodically flushed through such systems to control soil insects such as field crickets which, if uncontrolled, can destroy a subsurface drip irrigation system by chewing through plastic tubing. SSDI systems are important and considered a major advance in irrigation technology since their use can reduce water consumption by 20 to 50% while achieving the same degree of plant health.

Veterinary Use

In the past, chlorpyrifos found greater use on food producing animals such as, for example, tick control on cattle. However, its current use on animals is limited to companion animals, except for a direct veterinary treatment in the form of an ear tag for cattle. Chlorpyrifos is used in slow release formulations in collars for flea control in cats and dogs. It is also registered for use in shampoos and in sprays for flea and tick control on dogs.

Domestic and Industrial Use

Chlorpyrifos is applied during the construction of domestic and commercial buildings to prevent termite infestation. Typically it is applied as an under slab treatment combined with a circum-foundation soil barrier treatment. Protection under slab can be expected to be effective for six to ten years whereas in more exposed sites such as perimeter treatments, protection typically lasts three to five years. With existing buildings, treatments are more expensive and elaborate requiring drilling through the slab and penetrating around the foundation at regular intervals. In addition to the high cost and inconvenience, sub-slab vapour barriers are compromised. Recently, some buildings have been constructed with special under-slab reticulation systems which are designed so that a chemical termiticide can be easily introduced beneath the concrete slab in later years.

Chlorpyrifos is also used in and around existing buildings to control termites, cockroaches, spiders, ants, beetles and mosquitos. External applications for termite control include direct application to nests and continuous-barrier soil treatments around the building to isolate the super structure. Internal application is typically done by spraying infested areas or areas where the target pest is likely to hide. In addition, low strength formulations in prepared bait traps are marketed for control of cockroaches around the home.

Chlorpyrifos is used in both residential and commercial environments, especially in turf and landscape gardens, to control problem pests such as lawn beetles, lawn armyworms, ants, earwigs, and African black beetles. For use with residential applications on lawns and in home gardens, most formulations are packed in child-proof containers and are usually about 10% or less as concentrated as formulations typical of agricultural applications.

State Nominated Uses

All State departments of agriculture/primary industries confirmed statements from growers and commodity organisations that it is important for the viability of many crops in Australia. Table 5 provides an indication of those crops and pests for which chlorpyrifos has been nominated to be important by state agricultural authorities.

Table 5 - Uses of chlorpyrifos nominated by State Departments of Agriculture/Primary Industries*

Crop/Use situation	State / Nominated Use							
	Qld	NSW	Vic	SA	WA	Tas	NT	ACT
Ornamentals and Turf	western flower thrip & wide range of soil pests	western flower thrip, mealy bug	African black beetle & disinfestataion of ornamentals prior to interstate movement	western flower thrip & range of caterpillars	range of soil pests	western flower thrip, Argentine ant & soil pests, esp. cutworm (*Agrotis*)		No essential uses nominated
Cotton	*Helicoverpa* spp.	*Helicoverpa* spp.						
Pasture and Forage seed crops		cockchafer	cockchafer, aphid, red legged earthmite grasshopper, brown pasture looper, web worm, lucerne flea, army & cutworm, sitona weevil , web worm, brown looper			cockchafer, lucerne flea, redlegged earth mite, grasshopper, armyworm & cutworm	cockchafer	
Oilseeds (including canola)	wireworm, false wireworm, wingless cockroach, cricket and earwig	wireworm & false wireworm	false wireworm	false wireworm				
Rice		bloodworm, armyworm						
Other Cereals	wireworm, false wireworm, wingless cockroach, cricket and earwig	armyworm	pests of stored grain	cereal curculio, wireworm, armyworm	range of pests	cockchafer, lucerne flea, redlegged earth mite, grasshopper, armyworm & cutworm	wireworm, false wireworm & other soil pests	
Legumes	wireworm, false wireworm, wingless cockroach, cricket and earwig		cow pea aphid					
Tobacco			wireworm, black beetle					
Vegetables (including potatoes, corn, crucifers, cucurbits tomatoes	western flower thrip, mealy bug, cutworm, cricket species, wireworm, false wireworm & other soil pests	wide range of pests incl. caterpillar, western flower thrip & soil pests	plutella, native budworm, vegetable & white fringed weevil, wireworm, cutworm & other soil pests	western flower thrip, cutworm & cricket	African black beetle & white fringed weevil	wingless grasshopper	wide range of soil pests	
Grapes		light brown apple moth	light brown apple moth as part of IPM	light brown apple moth & mealy bug	African black beetle & light brown apple moth	light brown apple moth, mealy bug	termite	

Citrus	fruit fly, ant			light brown apple moth, mealy bug & thrip	Argentine ant		termite	
Pome Fruits and Stone Fruits	fruit fly, mite control as part of IPM	light brown apple moth, apple dimpling bug, San Jose scale, woolly aphid, codling moth	apple dimpling bug & light brown apple moth as part of IPM	light brown apple moth, apple dimpling bug	light brown apple moth	light brown apple moth, woolly aphid & earwig		
Banana	sugarcane bud moth & range of pests						sugarcane bud moth	
Subtropical Fruits	fruit fly							
Building Industry	termite		termite	termite	termite		termite	

* Note: While these uses are considered essential there are other products registered for the nominated pests/use situations. In these situations chlorpyrifos is considered essential as it is mainly used as a part of a resistance management strategy or an integrated pest management strategy.

An examination of performance questionnaires for chlorpyrifos completed by growers, commodity organisations, State Departments of Agriculture and registrants indicates that its inclusion in IPM and resistance management programs is common.

Most State departments have also developed a group of recommended application programs which include chlorpyrifos as a major component in a defined insect control strategy. These programs are listed in Table 6:

Table 6 - *Application programs which include chlorpyrifos recommended by State departments of agriculture/primary industries*

State	***Pest Control Program***
Tasmania	Floriculture** - soil-living larvae of western flower thrip Control of a number of soil pests, esp. cutworm (*Agrotis* spp.) Pasture - lucerne flea, red legged earth mite, armyworm, cutworm, cockchafer Cereals - lucerne flea, red legged earth mite, armyworm, cutworm, cockchafer Pasture and forage (including cereals) seed crops - lucerne flea, red legged earth mite, armyworm, cutworm, cockchafer Apples* - light brown apple moth
Queensland	Avocado - leafroller Banana - a variety of banana fruit pests Broadacre seedling crops - black sunflower scarab and a variety of adult soil insects Furrow spray applications across a wide range of scenarios - a variety of soil insects Cotton - *Helicoverpa*** Oilseeds, grain legumes and cereals - wireworm, false wireworm and a variety of other soil inhabiting insects Orchards* - fruit fly baiting program Ornamentals - western flower thrip**, ant, cockroach & spider Paddocks, fencelines & animal shelters - termite control Wide range of additional crop situations - in furrow spray for soil insect control
South Australia	Ornamentals** - western flower thrip Vegetables** - western flower thrip Grapes - light brown apple moth Citrus* - mealy bug & thrip Apples* - apple dimpling bug Cereals- cereal curculio & wireworm
Western Australia	Potatoes - African black beetle, white fringed weevil Grape - light brown apple moth, African blackbeetle Tree fruit crops - light brown apple moth Citrus* - Argentine ant Pasture - variety of pests
Victoria	Canola - false wireworm Apple* - apple dimpling bug & light brown apple moth Grape* - light brown apple moth

New South Wales	Ornamentals* - western flower thrip Brassicas** - diamondback moth Cotton** - *Helicoverpa* spp. Rice** - bloodworm & armyworm Cereals - various pests, esp. armyworm Citrus - ant control Pome* & Stone Fruit - San Jose scale, apple dimpling bug, woolly aphid**
Northern Territory	Ornamentals & turf - cockchafer & other soil borne pests Pasture - cockchafer & other soil borne pests Cereals - cockchafer & other soil borne pests Vegetables - soil borne pests Bananas - sugarcane bud moth Grape - termite
Australian Capital Territory	none

*Integrated pest control program **Resistance management strategy

Based upon responses by State agencies the uses of the chemical is expected to increase as results of past and current trials are evaluated and promulgated throughout the agricultural community. Some of these new applications are already in use under trial permits. In addition to an increasing use of chlorpyrifos due to new applications, a portion of expected increased use will occur due to current expansion trends with existing registered uses. Some of those trends are outlined below by state.

New South Wales:

Chlorpyrifos usage is expected to increase with the anticipated increase of canola oil seed acreage.

Its use may continue to increase in cotton as a substitute for synthetic pyrethroids for which resistance is increasing and as a substitute for profenofos in areas where the public is sensitive to pesticide odour.

Because of objections by agricultural pilots to malathion seed treatments for rice, increasing numbers of rice growers are likely to use an additional direct-to-water spray of chlorpyrifos as an alternative to malathion on seed.

Northern Territory:

Use of chlorpyrifos for termite control in the building industry is expected to increase, at least in the short term, until barrier methods gain greater acceptance.

South Australia:

Expansion of grape plantings will increase the use of chlorpyrifos for control of light brown apple moth and mealy bug.

A possible expansion of citrus plantings will result in more chlorpyrifos used for control of light brown apple moth, mealy bug and thrip in citrus orchards.

The chemical may also see an increased use in termite control in the short term.

Queensland:

Chlorpyrifos is the major chemical presently used for the control of a range of soil insects such as wireworms, false wireworms, wingless cockroaches, various cricket species and black field earwigs in broadacre seedling crops. Its use is expected to increase in such cropping applications as a component of IPM systems, for example, as an active in baits.

Tasmania:

Use of chlorpyrifos is expected to increase in floriculture due to increased pressure from western flower thrips.

An increasing awareness of the role of the light brown apple moth in promoting Botrytis in grapevines is likely to stimulate use of chlorpyrifos in viticulture.

A decrease in chlorpyrifos consumption may occur with apple producers due to more use of mating disruption schemes for control of light brown apple moth and due to a short term possible decline in the apple industry because of problems arising from fire blight.

In general terms for a variety of different crops, an expanding agricultural industry in the state is likely to cause an increased demand for chlorpyrifos since soil pests are an ongoing problem and there are no alternative soil “stable” chemicals.

Victoria:

Failure of BT to control light brown apple moth in grapevine will result in an increased use of chlorpyrifos. Use may also increase in new vineyard plantings where soil insect pests are typically a problem.

A possible approval for use against false wireworm in canola may increase chlorpyrifos use in Victoria since there is no alternative control option.

Research in Victoria into non-chemical management tactics is progressing, but useful outcomes are not expected for another two to three years. Some currently available methods such as mating disruption of light brown apple moth are being improved but still require chemical augmentation where moth populations are high. Similarly, BT, pheromones and Trichogramma are being further tested in grapevines, but they are not always effective and are generally expensive. Regarding chemical alternatives to chlorpyrifos, some cause subsequent problems. For example, the only alternatives for the apple dimpling bug are the pyrethroids, but their use results in mite problems.

Western Australia:

Chlorpyrifos use is likely to increase for control of African black beetle in newly planted vineyards for the expanding viticulture industry of Western Australia.

A similar increase can be expected for black beetle control in both deciduous fruit crops and in potatoes.

Argentine ant infestations are increasing in Western Australia and will require greater chlorpyrifos use, especially in citrus orchards to maintain IPM programs.

Chlorpyrifos use may increase to control lucerne flea as resistance in the flea population builds to synthetic pyrethroids.

Termite populations are expected to increase with the phase out in recent years of organochlorine insecticides and may increase the demand for chlorpyrifos.

For termite control, chlorpyrifos is typically placed under concrete slabs during construction or for existing buildings, around slabs. Chlorpyrifos under-slab treatments provide protection for six to ten years and then may require retreatment. For that reason, and also its effectiveness can be significantly affected by weather conditions and applicator error, the under slab use of chlorpyrifos may diminish in the future if alternative methods gain greater acceptance.

As indicated above, a number of State departments of agriculture/primary industries are pursuing research into use of chlorpyrifos as outlined below in Table 7:

Table 7 - Current research trials with chlorpyrifos by State departments of agriculture/primary industries

State	***Crop/pest/situation***
New South Wales	*Vegetables & Ornamentals - cotton aphid, western flower thrip* *Rice - bloodworm* *Pome Fruit - codling moth*
Queensland	*Banana - controlled release ribbons for control of banana bunch pests* *use in bait sprays in fruit fly management in avocado, citrus, grapes and others* *testing for use as a rotational chemical in resistance management for control of silverleaf whitefly in cotton* *testing in baits for fruit fly control in tomato and possibly other vegetables as an alternative to cover sprays of dimethoate - a new use with important IPM implications in many vegetable crops if successful*
South Australia	*Citrus - mealy bug & thrip*
Tasmania	*Apple - light brown apple moth - improvement of IPM system*

Victoria	*Canola - false wireworm* *Apple - apple dimpling bug* *Thryptomena - leaf rolling Tortricid* *Orchard - light brown apple moth* *Fruit - testing of controlled release formulations*
Western Australia	*Potatoes - African black beetle & white fringed weevil* *Pasture - African black beetle* *Citrus - Argentine ant*
Northern Territory	*Cucurbits - false wireworm*
Australian Capital Territory	*No current efficacy trials*

2.5 Evaluation of Efficacy

Properties Related to Practical Use

Chlorpyrifos acts against insects primarily by contact and also ingestion and vapour action. Extensive tests have not shown any systemic activity of the chemical in plants. Chlorpyrifos has generally exhibited short residual activity on plant foliage with a half-life of one to two days, but it is effective for several weeks in turf thatch, in soil and on surfaces not exposed to direct sunlight.

Chlorpyrifos is a relatively stable compound. When stored in a closed container at temperatures below 37° C, there is negligible decomposition over a period of three years. Shelf-life testing at room temperature has demonstrated that stable products can be prepared from chlorpyrifos as liquid concentrates in aromatic solvents, as emulsifiable liquids, as dilute ready-to-use household sprays, both solvent and water based, as granular formulations in organic carriers and as baits.

Because chlorpyrifos has a low solubility in water (1 - 2 ppm), aqueous dilutions prepared for use are emulsions or suspensions of the chemical rather than true solutions. As such, the active chemical is less vulnerable to hydrolysis, and studies under different conditions have shown that most tank mixes are stable for several days regardless of the pH or salt content of the mix. Generally, chlorpyrifos is compatible with most pesticides except those with a strongly alkaline nature. Mixtures with other pesticides such as dichlorvos, pyrethrins, synthetic pyrethroids and growth regulators are mutually compatible. Similarly, chlorpyrifos is compatible with chlorinated hydrocarbons or other phosphate insecticides.

User Views on Efficacy

Information contained in the performance questionnaires from user industries indicated that it was still efficacious for the purposes claimed.

Registrants indicated that they did not have any information on any reduction in efficacy and had not received any complaints from users in relation to failure to control nominated pests using this chemical.

The NRA survey results from users of chlorpyrifos show satisfaction with the efficacy and usefulness of the chemical. Respondents included both large and small scale users. Many stated that they continued to use chlorpyrifos because they achieve positive, dependable control with excellent immediate results combined with ease of handling. Others stated simply that it still works well and that it is effective for longer a period than most alternatives. One point which was emphasised is that its residual activity in soil made it especially useful for controlling the many soil inhabiting insects for which it is registered. Some respondents also pointed out that it is the only insecticide registered for control of a number of important pest species.

Another aspect of chlorpyrifos which was frequently stressed in the survey was its importance in integrated pest management (IPM) programs. Many respondents stated that chlorpyrifos was most effective on target insects while being less damaging to beneficial ones. Orchardists pointed out that it is good for IPM because it can be spot sprayed, band sprayed or used in bait to target only certain insects without killing everything in the canopy and therefore leaving the beneficial insects unharmed. Some orchardists stated that predator mites were able to survive chlorpyrifos treatments.

The value of chlorpyrifos as an effective component of resistance management programs and its cost-effectiveness was often mentioned. Chlorpyrifos was also valued for its practical compatibility with other application program needs citing its compatibility with commonly used herbicides.

User Suggestions for Changes

The most frequently mentioned problem with use of chlorpyrifos was the difficulty and danger of pouring, especially from full containers. There were many instances of this complaint, but all suggested that manufacturers provide drums with more effective pouring spouts and vents to allow free flow of chemical. Some respondents stated that such a design should be required by the NRA. The pull out spout incorporated into many current drums was said to be an improvement but still difficult to pour from full containers. On a related issue, one respondent observed that plastic bags containing dust formulations were almost impossible to open without spillage.

The second most common complaint concerned the difficulty of disposal of empty containers. Users felt that suppliers should be responsible for recycling or destroying empty containers. One suggested that local authorities should provide facilities for disposal of used containers. Several respondents stated that it was quite difficult to adequately rinse the larger empty containers, especially 200 litre drums.

The choice of packaging material was stated as needing improvement by a number of users. Several stated that steel drums were a disadvantage because of rust problems while one respondent felt that steel drums were advantageous for disposal because once buried, they eventually rusted away. One registrant is moving toward greater use of a fibreboard carton with a high density polyethylene inner container. This packaging method reduces the amount of plastic used per container by 80% as compared to a standard polyethylene container.

Concerning the hazard of the chemical, one user stated that the label directions were inadequate as regards to re-entry periods. Another expressed concern over the toxicity of chlorpyrifos.

Finally two users cautioned that the efficacy of chlorpyrifos was diminished when applied during very hot conditions or if heavy rains came shortly after an application.

User Complaints

Several consumer complaints relating to cockroach baits and flea collars were received by registrants and appeared to be caused by formulation or packaging deficiencies or by use of out-dated product. In one case the consumer stated that no use by date was printed on the package.

With regard to an agricultural formulation, a complaint reported in 1995 involved a 5 litre can in which the contents had partially settled as sediment to the bottom due to a possible breakdown of the emulsifying agent during stressed storage.

Other than these cases, registrants indicate that they have not received any legitimate complaints from users in relation to labelling, handling or performance of the chemical.

Phytotoxicity

Some insecticide formulations may cause phytotoxic damage in some species of plant if applied in concentrations that are too high or if applied when the plant's physiological condition makes it more vulnerable than would otherwise be the case. For example, one label caution warns that applying chlorpyrifos to turf when the turf's nutritional status is low may result in a phytotoxic reaction. Although chlorpyrifos is not phytotoxic to most plant species when used as recommended, certain species have a vulnerability to the chemical.

Phytotoxic reactions in the floriculture industry with varieties of azalea, camellia, ficus, ivy, hibiscus, nephrolephis, poinsettia and rose have been known to occur. In Western Australia, a single instance of damage to potatoes was seen when chlorpyrifos was applied as an off-label use at a concentration higher than recommended for comparable crop applications. Queensland authorities state that high volume sprays of EC formulations are phytotoxic to immature banana fruit.

2.6 Integrated Pest Management

While the aim of integrated pest management (IPM) strategies is to control extreme population increases of pests without damaging predatory and parasitic insects, no pesticide discriminates perfectly between beneficial and damaging insects. Some chemicals have a lower relative toxicity against certain species of beneficial insects and arachnids as compared with target pest species. These chemicals are often said to be "soft" on beneficial insects. Integrated pest management strategies attempt to exploit such chemicals by preferentially using them at key stages of the growing season when it is most important to preserve an ecological balance of species in the developing crop.

For some communities of pest and beneficial species, chlorpyrifos has a favourable balance of relative toxicity. For example, in many vegetable applications, chlorpyrifos is preferred to other registered insecticides because it is regarded as softer on the relevant beneficial insect species as well as being less harmful to operators. It also tends to have a relatively low impact on predatory mite populations.

A different type of advantage related to its stability is that it lends itself to use in baits and to localised tree trunk treatments. Since bait sprays are applied as spot-sprays and, therefore, avoid whole canopy cover sprays, they are especially important in IPM programs. Chlorpyrifos is also the most effective available product for ant control using trunk sprays. As such it is an important component of IPM programs by preventing ants from destroying beneficial insects which parasitise and prey upon scales, mealybugs and aphids.

As part of an effort to promote good agricultural practice and reduce overall pesticide use, State agencies research and recommend Integrated Pest Management (IPM) programs for various crops. Currently recommended IPM strategies involving chlorpyrifos are shown below grouped by State.

<u>New South Wales</u>:

In rice, chlorpyrifos-based bloodworm control is integrated within an overall framework of rice pest management that integrates both cultural and chemical pest management.

In apples, it is part of a defined IPM strategy. In addition, there is a perception with apple growers that inclusion of chlorpyrifos in a seasonal program improves the control of codling moth. That aspect is currently being tested.

Chlorpyrifos is used as part of an IPM program for Helicoverpa spp. control in cotton.

<u>Northern Territory</u>:

No current recommendations for IPM programs.

Queensland:

Chlorpyrifos is used for ant control in citrus to suppress scales.

It is used in controlled release formulations for banana pest management.

It is used in fruit fly baits in citrus orchards.

Chlorpyrifos is an essential component of integrated mite control programs in pome and stone fruit.

South Australia:

Chlorpyrifos is a component in an IPM strategy for control of apple dimpling bug in pome and stone fruit.

It is used for control of mealy bug in citrus.

Tasmania:

In apples, chlorpyrifos is a useful adjunct for woolly aphid control (butt spray) where broad spectrum pesticides are often withheld.

Chlorpyrifos used against light brown apple moth is described as “the lynch pin” in control of European red mite by insecticide resistant predatory mites, a very effective IPM strategy in Tasmania.

Victoria:

Chlorpyrifos is an important component of orchard IPM programs. It has a less disruptive effect on beneficial species than does azinphos or methyl parathion in control of moths and apple dimpling bug in pome fruit as well as wireworms in tomatoes.

Control release formulations, which are under development and testing by the Institute of Horticultural Development at Knoxfield, are seen as part of an IPM strategy.

Chlorpyrifos is used as part of an IPM program for the control of light brown apple moth in grapevines where other treatments, for example Bts, have failed.

Western Australia:

To maintain a workable IPM strategy in citrus, it is necessary to control Argentine ants which otherwise patrol trees and protect pest species. Chlorpyrifos is used as a trunk treatment to keep Argentine ants out of citrus trees.

2.7 Resistance Management

Although chlorpyrifos has held its efficacy well, isolated cases of resistance have been observed. For instance, some resistance to chlorpyrifos in the banana weevil borer was recently reported in localised areas of Queensland.

Resistance management strategies are designed to retard the development of pesticide resistance in target insect species, typically by using pesticides from different chemical families at different times during the control season. State agencies and industry groups strongly encourage this practice. Resistance management strategies of which chlorpyrifos is a component are shown below grouped by crop group for each State.

New South Wales:

Ornamentals - Chlorpyrifos is a component in western flower thrip control.

Vegetables - It is used as an alternative to pyrethroids to delay resistance in diamond back moth on brassicas and Helicoverpa spp. on tomatoes and sweet corn.

Cotton - Chlorpyrifos is alternated with pyrethroids to control diamond back moth and Helicoverpa spp.

Rice - The development of pyrazole and pyrethroid pesticides for bloodworm control will allow chlorpyrifos to be integrated into a resistance prevention strategy. No resistance in bloodworm has been detected as yet, and the intention is to maintain that status.

Deciduous fruit - Chlorpyrifos may have a useful role against codling moth. Data from the USA suggests that there is no cross resistance in codling moth between azinphos-methyl and chlorpyrifos, a point not yet demonstrated in Australia. Similarly, chlorpyrifos may also be useful in rotation with fenoxycarb, also as yet unproven.

Northern Territory:

No current recommendations in any resistance management programs.

Queensland:

Cotton- Chlorpyrifos is under investigation for potential use in rotation with other chemicals for the control of Heliothis spp. in cotton.

South Australia:

Not currently recommending any resistance management programs involving chlorpyrifos.

Tasmania:

Floriculture- Chlorpyrifos is used as part of a group of chemicals to slow development of resistance in western flower thrips.

Victoria:

Pome fruits and stone fruits- Chlorpyrifos and azinphos-methyl are used alternatively for light brown apple moth control in orchards to reduce the pressure of resistance build up against azinphos-methyl.

Western Australia:

Not currently recommending any resistance management programs, however, chlorpyrifos is under investigation for possible inclusion in a number of programs.

Conclusions

There is a need for:

- continued availability of chlorpyrifos at current levels to maintain competitive production of important crops in Australia.
- continued development of integrated pest management and resistance management strategies so that pesticide use can be minimised while maintaining a satisfactory level of efficacy.
- continued research into improved ways to apply chlorpyrifos in its varying applications in order to reduce consumption per use situation while maintaining effectiveness.
- improved packaging for large sized containers of chlorpyrifos to improve safety to users and reduce spillage.
- investigation into improved methods for cleaning, disposal and possible recycling of containers.

3 TRADE ASSESSMENT

Introduction

One aspect with which chemicals must comply in order to achieve and maintain registration, is that use of the chemical must not result in any unacceptable risk to trade between Australia and other countries. Accordingly, a review of trade implications was conducted as part of the review of chlorpyrifos to ensure that registered products containing chlorpyrifos continue to comply with contemporary assessment standards.

In this section the potential effects of the withdrawal of, or modifications to the availability of chlorpyrifos, on the export of agricultural commodities has been examined, and an estimate made of the impact on Australian trade with other countries. It is emphasised that this section focuses only on the overseas trade and does not draw any conclusions on the impact of regulatory activity in relation to chlorpyrifos on the domestic trade.

In order to evaluate the risk to trade when reviewing chlorpyrifos, the following matters have been taken into consideration:

Compatibility of MRLs with trading partners (including whether or not MRLs have actually been set in the importing country, compatibility of use patterns etc);

Registration status in the importing countries (including whether or not the material is banned or restricted in those countries);

Review status in recognised international forums (such as the Codex Alimentarius Commission) and whether the importing country is a member of the reviewing organisations or recognises those organisations;

Detection of violative residues by the National Residue Survey;

Detection of violative residues in domestic produce which may indicate problems with overall use patterns;

Violations of importing countries' residue limits as a result of any residue monitoring carried out by the importing countries.

3.1 Registration Status

The registered products in Australia containing chlorpyrifos and the associated use patterns, are detailed in the Efficacy Assessment section of this report.

Overseas registration and regulatory status

Chlorpyrifos is registered in many countries including the following:

Denmark	Netherlands	Germany	Greece
Ireland	Belgium	Austria	UK
Luxemburg	France	Spain	Poland
Czechoslovakia	Finland	Hungary	Portugal
Italy	Sweden	Yugoslavia	Romania

Some of the trade names of chlorpyrifos used in these countries are Dursban 4 E, Dursban 25 WP, Dursban EC, Dursban 5G, Terial 12L, Lorsban 12 EC, Pyrinex 48, Dumex, and Kill Star, and these are produced by a number of different companies.

From the available information on chlorpyrifos, its use was not banned in any countries. A number of countries had placed restrictions on the use of this chemical which included the following:

- chlorpyrifos is not be used on flowering crops in the UK, Belgium and France as it is toxic to bees;
- several homegarden uses have been withdrawn in the USA;
- Germany does not allow use of chlorpyrifos in cereals, oil yielding plants or herbs;
- the UK has additional restrictions on the use of chlorpyrifos. These are as follows:

  Do not apply to young lettuce, or treat potatoes under severe drought stress
  Do not apply to sugar beet under stress of within 4 days of application of a herbicide
  Do not mix with highly alkaline materials. Not compatible with Zineb
  Do not contaminate waterways, ponds or ditches;

- in Yugoslavia, a restriction is placed on granular formulations of chlorpyrifos, that they should not be applied to soils where they are to be used for cultivation of carrots, parsley or celery.

Among the international regulatory developments for chlorpyrifos are the actions of the United States Environmental Protection Agency (US EPA) on chlorpyrifos in 1997 and 1999. The WHO/FAO Joint Meeting on Pesticide Residues (JMPR) and the European Union have either completed, on-going or impending regulatory action on chlorpyrifos.

US EPA

On 16 August 2000, the US EPA released a further revised risk assessment for chlorpyrifos for public comment stating that the following use changes have been agreed upon with the registrants:

• Eliminating use on tomatoes and revoking the associated tolerance;
• Restricting use on apples to pre-bloom (dormant) applications;
• Eliminating all indoor residential uses (except fully contained ant baits in child resistance packaging).
• Eliminating all outdoor residential uses (except limited public health uses).
• Eliminating all indoor and outdoor non-residential uses except:
- Use on golf courses
- Limited public health uses (i.e. mosquito control and fire ant mounds)
- Limited use in industrial settings (e.g. manufacturing plants, ship holds)
• Eliminating whole house "post-construction" termiticide use.
• Phasing out limited post-construction spot and local termiticide treatments by 2002.
• Phasing out pre-construction termiticide treatments by 2005.
• In addition to these agreed upon actions the US EPA will also propose to revoke the tolerance on tomatoes and reduce the tolerances on apples and grapes to 0.01

ppm which reflect the proposed new use patterns.

In June 2000, the US EPA released a revised health effects assessment and a revised ecological risk assessment on chlorpyrifos for public comment. These assessments may undergo further revision depending on the public comment.

The health effects assessment for chlorpyrifos has established an acute dietary reference dose (ARfD) of 0.005 mg/kg/day based on a no-observed adverse effect level (NOAEL) of 0.5 mg/kg/day from an acute oral rat blood time-course study, and using a 100-fold safety factor. The chronic RfD (equivalent to the ADI) was proposed to be 0.0003 mg/kg bw/day based on an oral NOAEL of 0.03 mg/kg/day from a 2-year dog study, and using a 100-fold safety factor. These figures are considerably lower than the corresponding values recommended in the ECRP report, due in part to the US EPA decision not to use the available human studies to derive these dietary intake standards.

The preliminary health effects assessment for chlorpyrifos made the following conclusions on worker safety, which are essentially maintained in the revised risk assessment.

Fifteen major agricultural, animal premises, and/or greenhouse exposure scenarios were identified to represent the extent of chlorpyrifos use (excluding domestic pest control). Four of the scenarios had unacceptable MOE for all application rates evaluated. Of the other 11 scenarios, at least one application rate in each scenario showed unacceptable MOE (MOE that exceed The Health Effects Division's (HED) level of concern, ie. less than 100).

There was only one domestic pest control scenario for occupational pesticide handlers with acceptable MOE (MOE that did not exceed HED's level of concern, ie. greater than 100): mixer/loader of lawn care products by LCO wearing PPE.

Restricted Entry Intervals (REI) were set for all field crops (2 to 4 days). For citrus and tree nuts and fruit crops a REI of 5-6 days was set for harvesting and 4 days for scouting.

The NOHSC review determined the most suitable NOEL for use in the OHS risk assessment to be 0.03 mg/kg/day, established in a human short-term repeated dose study (Coulston et al., 1972). The US EPA OHS risk assessment uses a much greater safety factor and higher application rates compared to the ECRP review.

In its June 2000 risk summary, the US EPA stated that application of chlorpyrifos poses acute and reproductive risks to many non-target aquatic and terrestrial animals for all outdoor uses reviewed. Risks are highest to aquatic fauna, particularly from aerial application, and amphibians appear particularly sensitive. Among terrestrial species, birds appear to be more at risk than most mammals. These predictions, using the standard risk quotient methodology, are supported by the occurrence of wildlife casualties in a range of field studies, and by wildlife incident reports. The US EPA also documents widespread aquatic contamination by chlorpyrifos.

The US EPA suggests a number of application modifications for risk mitigation, including reduced application rates, reduced number of applications, increased time intervals (preferably 2-3 weeks) between treatments, avoidance of aerial application, enforcement of buffer zones for spray drift mitigation, and ensuring that air blast applications are directed away from sensitive areas. It expected that final regulatory outcomes will be adopted after the current public comment phase.

WHO/FAO Joint Meeting on Pesticide Residues (JMPR)

The toxicology of chlorpyrifos has been reviewed internationally by the JMPR most recently in September 1999. The 1999 JMPR meeting affirmed the Acceptable Daily Intake (ADI) of 0.01 mg/kg bw based on the no observed adverse effect level (NOAEL) for brain cholinesterase activity of 1 mg/kg bw/day in a number of animal studies, and using a 100-fold safety factor, and the NOAEL for erythrocyte cholinesterase inhibition in a human study, and using a 10-fold safety factor. An Acute Dietary Reference Dose (ARfD) was established at 0.1 mg/kg bw, based on a NOAEL of 1 mg/kg bw for the inhibition of erythrocyte cholinesterase activity in a 1999 human study, and using a 10x safety factor.

European Union (EU)

The EU selected chlorpyrifos as one of about 90 compounds to be reviewed on a priority basis in 1994. Spain is the rapporteur country for this assessment, which is still on-going.

The United Kingdom (UK)

Following its consideration of chlorpyrifos, the UK Advisory Committee on Pesticides (ACP) was content that no immediate action was indicated against this chemical at this stage.

It has required further information on patterns of usage and work rates for both contractors and farm operators and a four-week study measuring cholinesterase activity in dogs.

3.2 Use patterns in other countries

Chlorpyrifos is used in other countries, in ways largely similar to those in Australia. It is used for the control of many different insect pest species in different crops. Some of the insect pests controlled are peach aphids, apple codling moth, corn ground beetles, wireworms, cabbage flea beetles, cockchafer, mole crickets, aphids, winter moths, cabbage root flies, beet leaf mites, rose totrix moths, cutworms, dipterous larvae, crane fly larvae, red spider mites, vine weevils, caterpillars, sawflies, suckers, raspberry beetles, pine shoot beetles, wheat bulb fly and cabbage root fly.

Detailed information on specific use patterns in other countries is not readily available, although useful information on the registered uses and withholding periods is contained in The European Directory of Agrochemical Products.

3.3 Exports of Australian Produce to Other Countries

Use of chlorpyrifos in Australian agriculture, horticulture, home and commercial situations, impacts significantly on Australia's exports of commodities because of the widespread use of this chemical. The major crops on which chlorpyrifos is used are cotton, vegetables, sugarcane, pome and stone fruit, with a smaller amount used on citrus fruit.

By far the largest horticultural export crop on which chlorpyrifos is used is oranges followed by pome fruit. Cotton is Australia's fourth largest agricultural export crop, with oilseeds and grain legumes also being significant export crops. The use of chlorpyrifos is also important for a number of smaller export crops and although these are presently of relatively little value, they could become important in years to come.

Stone fruits are presently not a major export crop however, significant increases in exports of stone fruits are expected over the next 5 years as a result of rapidly expanding production.[1]

The loss of chlorpyrifos for use in any industries where its use has been identified as important for the control of various insect pests, would not only affect the domestic market, but has the potential to restrict Australia's trade. The major crops on which chlorpyrifos is used contributes significantly to Australia's export industry with the loss of chlorpyrifos may bring about a potential loss to the Australian economy of some $2.7 billion.

The other export crops, grouped as tropical and sub-tropical fruits, contribute approximately $20-$30 million to the Australian export earnings. This is not just fresh fruit but also preserves and juices. The loss of chlorpyrifos from use in these crops would also impact on Australian exports.

The export quantity, estimated value and main markets for the key crops on which chlorpyrifos is used are detailed below.

Cotton

Cotton is established as Australia's fourth largest rural export with approximately 92% of the Australian cotton crop sold off shore. More than 70% is exported to Japan, South Korea and Indonesia but significant amounts are also sold to Taiwan, Malaysia, Thailand, Hong Kong, The Philippines, Italy and Germany. Australia is the third largest exporter of cotton in the world market.

[1] Horticulture Australia, 1995

In 1995/96 Australia exported 311.4kt of raw cotton worth $762.2 million. The Asian market purchased 281.4kt, the main purchasers being Japan (69.1 kt) and Indonesia (99.1 kt), while 24.9 kt were sold to Europe (17.1 kt to Italy) and the remaining 5.1 kt sold to other countries.

While the cotton fibre is the backbone of the crop, most parts of the plant have economic value. Cottonseed is Australia's largest oilseed crop and is used to produce cooking oil and high-protein animal feed as well as being a source of seed for the following crop. In 1995/96 Australia exported 157.74kt of cottonseed, 0.18kt of cottonseed oil and 4.08kt of cottonseed and sunflower seed meal.

Of all the chlorpyrifos used in Australian agriculture and horticulture, 21% of this is used on cotton for the control of a number of insect pests including *Helicoverpa spp*.

Vegetables

Vegetable production in Australia is composed of production of a large number of different vegetables, each contributing relatively small amounts to the total value. The exception to this is potatoes which in 1994/95 had a gross value of production of $382 million.

Australian exports of vegetables in 1995/96 were worth approximately $186.9 million. The major importers of Australian vegetables at this time were Japan ($43.91 million), Singapore ($37.56 million), Malaysia ($33.96 million), Hong Kong ($23.99 million), New Zealand ($13.13 million) and Germany ($4.88 million). The major vegetable exported in 1995/96 was asparagus followed closely by carrots, cauliflower and onions. Asian markets offer the greatest market opportunity for Australian vegetable growers. For this market to increase, Australia needs to satisfy the requirements of this specialised market.

Without the availability of chlorpyrifos to the vegetable industry (approximately 6% of all chlorpyrifos used is for vegetables), a wide range of pests could not be controlled.

Sugar cane

As Australia's second largest export crop and Queensland's second most valuable rural commodity, raw sugar is a major contributor to the Australian economy. More than 80% of Australian sugar produced is exported. In 1995/96 4989 kt of sugar were produced with 3981kt of this being exported. The value of this export crop was $1.5 billion.

The main export markets for Australian sugar are Canada, China, Japan, South Korea, Malaysia, New Zealand, and Taiwan. Other major customers are Singapore and the US with new markets for Australian sugar including Bulgaria, Dubai, Egypt, Mexico, The Philippines, Slovenia and Vietnam.

The use of chlorpyrifos in sugarcane constitutes 19% of the total use of chlorpyrifos. As noted earlier it is considered as one of the most important insecticides available to growers in this industry.

Pome Fruit

Apples

During the early 70's Australia was a major world apple exporter, mainly to the UK. However with the UK entering the European Union exports have fluctuated. The major outlet now for Australian apples is South East Asia, which purchased approximately 83% of the 1996 crop. Singapore (31% of sales), Malaysia (29%) and Indonesia (8%) accounted for most sales in 1996, but the UK, European and Scandinavian countries also accounted for 5% of sales that year. In 1995 34,257 tonnes of apples were exported worth approximately $35.431 million.
There are no imports of fresh apples into Australia due largely to quarantine regulations prohibiting importation from countries with the disease fireblight.

Pears

22% or 34kt of pears, with a value of $33.6 million are exported from Australia. Of these exports, 60% are to South East Asia, with the main markets being Singapore $9.8 million (29%), Malaysia $4.5 million (13%), Indonesia $3 million (9%), and Hong Kong $2.5 million (7.5%). The UK and Europe are also important markets, purchasing $8.8 million (25%) worth of Australian pears while the USA and Canada purchased $1.9 million (5.6%) in 1996. It should be noted that fresh pears are the second most valuable horticultural export product after oranges.

Stone Fruit

Apricots

In 1993/94 Australia exported approximately 204t of fresh apricots. The main markets for these were Hong Kong and Saudi Arabia. However, there is the potential for exports of fresh apricots to South East Asia and the Persian Gulf, but these would be in competition with those from South Africa and Chile where cost of production is much lower. Canned and dried apricots are also exported.

Cherries

In 1993/94, 509.2t of fresh cherries were exported. The major markets for these were Taiwan (214.4t), Hong Kong (112.5t) and Singapore (68.1t).

Peaches

In 1992/93 Australia exported 1010t of fresh peaches, the major markets being Hong Kong, Singapore, Taiwan and Malaysia.

For both the stone and pome fruit group, the percentage of total chlorpyrifos used on these crops is 4.7%. Chlorpyrifos was nominated as an essential chemical for the control of many pests of these fruit crops which without chlorpyrifos would be difficult to control.

Citrus

Australia exports fresh citrus fruit to a number of countries and in 1992/93 this export market was worth $107.1 million. The major countries to which Australian citrus fruit is exported are Hong Kong, Japan, Indonesia, UK, Singapore, Canada, USA, Malaysia, New Zealand and the Middle East. The citrus fruit export industry also includes processed citrus products, which in 1992/93 valued $22 million.

Although only 1.4% of total chlorpyrifos used is on citrus fruit, this crop is the largest horticultural export crop. The control of a number of pests rely on the availability of chlorpyrifos and its loss would jeopardise the multi million dollar export industry for citrus fruit.

Other

Although beef is not produced using chlorpyrifos as an input, it is nevertheless affected by the use of this chemical in Australian agricultural and horticultural production. Because of the nature of the chemical, residues can accumulate in the fat of mammals from direct exposure to spray drift and/or from consuming produce which has been treated with chlorpyrifos during production. The Australian beef export industry is worth approximately $3.8 billion. In 1995/96, Australia exported 738,350t of beef to more than 70 countries. Japan remains Australia's largest export market with the US also a large market for Australian beef, mainly for processing. Other major export markets include Korea, Canada, Indonesia, Philippines and Europe. Australia also exports live animals, with the major markets being South East Asia, Philippines and Egypt.

3.4 Potential Trade Problems

Maximum Residue Limits (MRLs)

It is anticipated that trade difficulties will arise in most cases from residue issues. Because there is some incompatibilities between Australian MRLs and overseas countries' MRLs for chlorpyrifos, it is possible for residue violations to occur in crops which are produced according to Good Agricultural Practice.

The maximum residue limit (MRL) is defined as the maximum concentration of a residue, resulting from the officially authorised safe use of an agricultural or veterinary chemical, that is recommended to be legally permitted or recognised as acceptable in or on a food, agricultural commodity, or animals feed. [2]

[2] MRL Standard, 1998

Australian MRLs are set by Commonwealth government authorities and are then adopted by the State governments for inclusion into their legislation. No agricultural chemical is registered for use unless MRLs have been set for that use of the chemical or has been exempted from the need to set an MRL (where the chemical would not occur in food or the level of residue is considered to be of no toxicological significance).

The chlorpyrifos MRLs established in Australia for various crops, are detailed below in Table 1.

Table 1: Australian MRLs for chlorpyrifos

Crop	**MRL mg/kg**	Crop	**MRL mg/kg**
Asparagus	0.5	Oilseed	0.01
Avocado	0.5	Passionfruit	*0.05
Banana	*0.1	Pig, edible offal of	0.1
Brassica (cole or cabbage) vegetables, head cabbages, flowerhead cabbages	0.5	Pig meat, in the fat	0.1
Cassava	*0.02	Pineapple	0.5
Cattle, edible offal of	2	Pome fruits	0.2
Cattle meat (in the fat)	2	Potato	0.05
Celery	T5	Poultry, edible offal of	0.1
Cereal grains (except sorghum)	0.1	Poultry meat (in the fat)	0.1
Citrus fruit	0.5	Sheep edible offal of	0.1
Cotton seed	0.05	Sheep meat in the fat	0.1
Cotton seed oil, crude	0.2	Sorghum	3
Dried fruits	2	Stone fruits	1
Eggs	*0.01	Strawberry	0.05
Ginger root	*0.01	Sugar cane	0.1
Grapes	1	Tomato	0.5
Kiwifruit	2	Tree nuts	0.2
Mango	*0.05	Vegetables (except asparagus, brassica vegetables, cassava, celery, potato, tomato)	*0.01
Milks (in the fat)	0.2		

*** The MRL is set at or about the limit of analytical quantitation**
T denotes that the MRL, residue definition or use, is temporary to enable further work to be carried out in Australia or overseas and will be reconsidered at some future date. It is also used in cases where an MRL is being phased out.

A number of Australia's trading partners accept Codex MRLs for chlorpyrifos. The Codex MRLs in a number of cases are lower than Australian MRLs (eg 0.3 mg/kg compared to 0.5 mg/kg for citrus fruit). It is therefore possible that, where Codex MRLs have been adopted, there could be residues above an importing country's MRL following normal use in Australian agricultural or horticultural production. This is also true for the MRLs that are set by individual countries.

The following table provides examples of where Australian, Codex and other countries MRLs differ and therefore the possibility of residue violations affecting Australia's trade may occur.

Table 2: Comparison of Codex, Australian and other trading partners MRLs for chlorpyrifos:

	MRL mg/kg						
Commodity	**Codex**	**Australia**	**Singapore**	**USA**	**Germany**	**Japan**	**UK**
Apple	1	0.2 (pome fruit)	1	1.5	0.5 (pome fruit)	1.0	0.2 (pome fruit)
Cabbages, head	0.05*	0.5 (brassicas)	0.05	1	0.05 (other foods plant origin)	2.0	0.05
Carrots	0.5	*0.01 (vegetables)	0.5	-	0.1	0.5	0.1
Cattle (meat)	2	2	0.2 (fat)	0.05	-	-	0.05
Celery	0.05*	T5	0.05	-	0.05 (other foods plant origin)	-	-
Citrus fruit	0.3	0.5	0.3	1	0.3	0.3	0.3
Cottonseed	0.05*	0.05	-	0.2	0.05 (other foods plant origin)	0.05	0.05
Cottonseed oil	0.05*	0.2	0.05	-	0.05 (other foods plant origin)	-	0.05
Grapes	1	1	1	-	0.5	1.0	0.5
Kiwifruit	2	2	2	2	2	2.0	2
Lettuce	0.1	*0.01 (vegetables)	0.1	-	0.05 (other foods plant origin)	0.1	0.05
Mushrooms	0.05*	*0.01 (vegetables)	0.05	0.1	0.05 (other foods plant origin)	0.05	0.05
Onions	0.05*	*0.01 (vegetables)	0.05	0.5	0.05 (other foods plant origin)	0.05	0.01
Pears	0.5	0.2 (stone fruit)	0.5	0.01	0.5 (pome fruit)	0.5	0.05 (stone fruit)
Peppers	0.5	0.01 (vegetables)	0.5	1	0.05 (other foods plant origin)	-	0.5
Potatoes	0.05*	0.05	0.05	-	0.05 (other foods plant origin)	0.05	0.05
Tomato	0.5	0.5	0.5	0.5	0.05 (other foods plant origin)	0.5	0.5

***The MRL is set at or about the limit of detection**

An associated difficulty with MRLs is that the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) has recommended the removal of the Codex general fruit and vegetable MRLs for all chemicals, replacing them with individual fruit and vegetable MRLs provided that these are supported by appropriate data. This inevitably means that the crop /MRL combination on Australian registered labels based on Codex general fruit or vegetable MRLs will no longer be supported when these general MRLs are removed.

The following information expands on the information in table 2, identifying areas where potential trade problems may arise. It should be noted that as a major importer of Australian produce, MRLs set in Japan for particular crops are the same as, or greater than those set in Australia. This would indicate that it would be unlikely that chlorpyrifos residue violations would occur in crops exported to Japan.

Cotton

The Australian MRL for chlorpyrifos in cottonseed is 0.05 mg/kg and 0.2 mg/kg for cottonseed oil. The codex MRL is the same as Australia for cotton seed but is only 0.05 for cotton seed oil. Other countries MRLs set for chlorpyrifos in cottonseed are the same as or higher than the Australian MRL, however the MRL for cotton seed oil higher than that of codex and other MRLs. This could be a source of residue violations.

Sugar cane

The Australian MRL set for chlorpyrifos in sugarcane is 0.1 mg/kg. The only other MRL for sugarcane found was for Spain and was set at 0.05mg/kg. As noted earlier, Spain is not a major importer of Australian sugar.

Vegetables

Australia has an MRL of 0.01 mg/kg for the general vegetable group however there are a number of vegetables which are exceptions to this MRL (see Table 1).

No country to which Australia exports asparagus has a lower MRL for chlorpyrifos use in vegetables than that set in Australia. For the brassicas there is only the European Union (EU) MRL of 0.05 mg/kg that is lower than the Australian MRL. For celery only Kenya and Korea have a lower MRL of 0.05 mg/kg and for potatoes the only MRL that is lower than the Australian MRL of 0.05 mg/kg is Brazil (0.01 mg/kg). The MRL for tomatoes in NZ is 0.2 mg/kg whereas the Australian MRL is 0.5 mg/kg. This is the only MRL lower than the Australian one for tomatoes. These lower MRLs are unlikely to cause any breaches of MRLs as these countries do not import large amounts of Australian produce.

Stone fruit

For stone fruit the Australian MRL for chlorpyrifos is 1.0 mg/kg. New Zealand and Taiwan also have this MRL for stone fruit. Australia exports a significant amount of stone fruit to Taiwan but not to New Zealand. Other countries where MRLs are established for the stone fruit group are UK (0.05 mg/kg) and France (0.2 mg/kg) however these are not major importers of Australian stone fruit.

Some countries list their MRL's separately for each member of the stone fruit family. These MRLs are listed below in mg/kg according to fruit and country.

Apricots: South Africa (0.05); Spain (0.5)
Cherries: Spain (0.5); Switzerland (0.2); Austria (0.2); Denmark (0.5); EEC (0.05) and Korea (0.5).
Peaches: Mexico (0.05); South Africa (0.05); Spain (0.05); Switzerland (0.2); USA (0.01); Austria (0.2); Denmark (0.5); EEC (0.05); Italy (0.2) and Korea (0.5).

All of the MRLs listed above have the potential to cause residue violations as they are lower than the Australian MRL. The MRLs for our major markets for stone fruit Hong Kong, Singapore, Taiwan and Malaysia, are equal to or higher than the Australian MRL.

Pome fruit

The Australian MRL for chlorpyrifos in pome fruit is 0.2 mg/kg. This is the same as, or lower than other countries MRLs for the pome fruit group and therefore residue violations would be unlikely to occur in export produce. However, some countries when listing their MRL have listed the members of this group of fruit separately giving each member a different MRL. For example, the MRL that is established for apples in Mexico and South Africa is 0.05 mg/kg compared to Australian pome fruit MRL of 0.2 mg/kg. The MRL for pears in Mexico and South Africa is 0.05 and in Korea the established MRL is 0.1. Although these lower MRLs would be cause for concern regarding potential trade violations in countries importing Australian produce treated with chlorpyrifos, Australia's main markets for pome fruits do not include these countries. It could, however cause trade problems in the future should Australia wish to enter these markets.

Citrus

The Australian MRL for citrus is based on the complete group, as are all other countries MRLs. The Australian MRL for chlorpyrifos in citrus fruit is 0.5 mg/kg. The countries who have an MRL lower than that set in Australia, with the MRL in all cases being 0.3 mg/kg are Netherlands, Norway, Singapore, South Africa, Spain, Switzerland, UK, Austria, Belgium, Brazil, Chile, Denmark, EEC, France, Germany, Israel, Italy.

The differences in citrus fruit MRLs in the above cases have the potential to cause residue violations when Australian fruit is exported to these countries.

Other comments

When comparing chlorpyrifos MRLs for crops between different countries, a number of things, apart from the MRL assigned for a particular crop, need to be considered.

The residue definition for chlorpyrifos in one country may not be identical to that used in another country. Chlorpyrifos could be defined as either the parent compound, or may include a number of the metabolites. In this situation, taking into account only the MRL value for chlorpyrifos in any particular crop, an inaccurate comparison between countries would be made.

(2) The listing of individual crops under a generic group may also cause inaccuracies when comparing MRLs. An example is the definitions that are used in Taiwan. The fruits classified under the pome fruit category include not only apples and pears, but also peaches, apricots and a number of other fruits which Australia would classify under a different category. Their stone fruit category includes fruit such as mangoes, loquats and kiwifruit. This may also occur in other countries however the action by JMPR to remove group MRLs for fruit and vegetables would help solve this.

Harmonisation of Australian MRLs with those of Codex and other countries for groupings of crops, MRLs and residue definitions, would be a way to reduce the chances for residue violations in export crops.

3.5 Residue Detections

Where chemicals are used according to the label directions, residues above the Australian MRL are unlikely to occur in domestic markets. However, there is the potential for MRL violations in export markets. If chemicals are used contrary to label instructions, there is a risk of residues occurring in produce at a level above the Australian MRL. Examples of possible misuse include: failure to observe the withholding period; applying too much chemical; repeating a treatment too soon after a previous one; and using a chemical on a crop or commodity for which there is no registered use.

Another source of residues is unintended exposure of plants and animals to chemicals. This can occur, for example through spray drift from treatment of an adjacent crop, or poor animal and chemical management.[3]

The National Residue Survey results in 1996 indicated that Australian produce is of a high standard, as few of the samples contained chemical residues above acceptable levels. Test results from a total of 46482 samples where all chemicals were tested for, showed that only 140 samples carried residues above the MRL.

Organophosphate residues are becoming less frequent in meat species with less than 1% of the samples having detectable residues. The organophosphate detected in 1996 were diazinon (5 residues), ethion (5 residues), fenthion (4 residues), chlorpyrifos (1 residue).

[3] National Residue Survey 1996

There have been no residues above the MRL since 1992 and all of the organophosphate residues detected in the past 2 years have been less than the MRL.

Wheat

In 1996, 3193 organophosphate pesticide analyses were conducted on wheat with 1435 samples where residues were detected. In order of frequency, the residues detected were chlorpyrifos-methyl, fenitrothion, and dichlorvos. Chlorpyrifos was also detected. Of all of the organophosphate residues, 85% were below one-fifth MRL, 98.1% were below half the MRL and none were above.

Barley

In 1996, 779 organophosphate pesticide analyses were conducted with 431 detections of residues. None of these were of chlorpyrifos, however, some residues of chlorpyrifos-methyl were found.

Sorghum, lupins, oats, field peas, chickpeas and canola

No residues were detected of chlorpyrifos during 1996 in any of the above crops.

3.6 Domestic Produce Surveys

Pesticide Residue in Horticultural Produce – lettuce survey 1997

Reports from the Department of Primary Industries South Australia, indicated that of their recent residue surveys, only one detected any residue violations. A Pome Fruit Survey, Stone Fruit Survey and a Horticultural Survey on Tomatoes, Zuchchini, Capsicum and Cucumbers all were free of residue violations. However a survey of lettuce found 9 samples of chlorpyrifos above the MRL.

Five violations were traced back to use of chlorpyrifos on lettuce seedlings in a nursery and not applied by the grower. The grower purchased the seedlings and when harvested were found to contain residues above the MRL. The supplier stopped using chlorpyrifos for treatment of seedlings.

Another two violations were traced back to spray drift and another two were traced back to being from either or both below ground application of chlorpyrifos and from above ground soil spraying with chlorpyrifos prior to planting.

Flemington Market Pesticide Residue Survey

New South Wales Agriculture provided information on samples taken from produce where residues exceeded the MRL for chlorpyrifos. In the 1997 survey 3 violations in apples of 0.26, 0.26, and 0.25 mg/kg occurred (MRL 0.20 mg/kg), 2 violations in bananas of 0.17 and 0.23 (MRL is 0.10 mg/kg) and 1 violation in Lebanese cucumbers of 0.05 (the MRL is 0.01 mg/kg). From 1989-1997 the total number of residue violations was 100 with 19 of these being attributed to chlorpyrifos.

These types of situations leading to breaches of the MRL for any crop could occur in export crops, which then have the potential to threaten our export industry.

The Australian Total Diet Survey

The purpose of the Australian Total Diet Survey (formally the Australian Market Basket Survey) is to monitor pesticides and contaminants present food and estimate their intakes in the diets of Australians.

For the organophosphate pesticides, the estimated dietary intakes in 1994 were all within acceptable safety standards. However, results from analysis of food samples detected chlorpyrifos residues. Residues exceeding the MRL for chlorpyrifos were found in commodities at the following levels:

Beans: 0.04 mg/kg

Capsicum: 5 samples of 0.04, 0.13, 0.14, 0.15 and 0.25 mg/kg

Pumpkin: 0.11 mg/kg was found

The MRL for chlorpyrifos in vegetables 0.01 mg/kg.

Fresh grapes: 2 samples of 0.02 and 0.15 mg/kg

The MRL for chlorpyrifos in grapes is 0.01 mg/kg

Notably, all of these MRL violations, were detected in produce destined for domestic consumption. Problems for Australia's overseas trade in these commodities could be expected should such violations be detected in produce destined for export.

3.7 Conclusions

continued availability of chlorpyrifos for several agricultural and horticultural production systems;

monitoring of Australian export produce for chlorpyrifos residues by the National Residue Survey; and

harmonisation of Australian MRLs for chlorpyrifos with those of Codex and other countries to reduce the potential for residue violations.

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4. RESIDUES ASSESSMENT

4.1 Introduction

Chlorpyrifos is a chemical being reviewed in the second cycle the NRA's Existing Chemicals Review Program (ECRP). This evaluation presents the residue findings of that review. Re-evaluation of the residue data was appropriate as many of the present chlorpyrifos MRLs were established in the 1970's and 1980's on the basis of residue studies which would possibly not now be considered sufficient to justify establishment of those MRLs.

Chlorpyrifos is an insecticide used to control foliage and soil-borne insect pests on a large number of food and feed crops. While there are now no direct livestock animal treatments registered in Australia, treatment of livestock premises is permissible and livestock exposure could occur through eating of chlorpyrifos treated forage or fodder.

Material specifically submitted for the ECRP and from submissions previously made for registration purposes and retrieved by the Commonwealth Department of Community Services and Health or the NRA was considered in the residue review. Because chlorpyrifos has a long registration history, it is possible that all residue studies previously submitted for evaluation were not retrieved. Information in the Commonwealth Department of Primary Industries and Energy's National Residue Survey, the Australia New Zealand Food Authority's Australian Market Basket Survey, chlorpyrifos evaluations by the FAO/WHO Joint Meeting on Pesticide Residues (JMPR) and the NRA's draft ECRP efficacy and trade reports (NRA Draft Efficacy Assessment Report Chlorpyrifos. 9 December 1997 and NRA draft Trade Report for Chlorpyrifos, 26/2/98 Internal NRA documents) on chlorpyrifos was also used or noted in the residue evaluation.

The key elements of this report are an appraisal of the data and information presented and a series of recommendations and "Issues" that seek additional comment on certain matters. Information of Australian label use patterns and Australian MRLs, metabolism, analytical methodology, residue and other data presented on chlorpyrifos is also presented as are considerations of the fat solubility and the dietary intake of chlorpyrifos. Summaries of the Australian and of relevant overseas results are provided as attachments to the report.

Identity (From "A World Compendium The Pesticide Manual Incorporating the Agrochemicals Handbook", Tenth Edition, Editor: Clive Tomlin, 1994).
Active Constituent: Chlorpyrifos
NRA file numbers: 92/09249, R-00019, R-00200, R-00208, RP-0962
Trade Names: Records in the National Registration Authority (NRA) list almost 100 products with chlorpyrifos as an active constituent. Eight of those products are for use on cats or dogs and were not considered in detail in this review.

Dursban* Micro-Lo Termiticide and Pesticide, Dursban* Pre-Construction Termiticide, Dursban* Turf-500 Insecticide, Predator 300 Insecticide, Dursban* PC Termiticide and

Insecticide, Lorsban* 500 W Insecticide, and Lorsban* 500 EC Insecticide were identified as "pioneer" products by DowElanco.

Product labels examined were those supplied by applicants or available within the NRA.

Tobacco uses have not been considered in this evaluation.

ISO Common name: Chlorpyrifos
Chemical name:
IUPAC *O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate
CA *O,O*-diethyl *O*-(3,5,6-trichloro-2-pyridinyl) phosphorothioate
CAS No.: [2921-88-2]
Development code: Dowco 179
Official code: OMS 971; ENT 27 311

Physical and chemical properties
Molecular formula: $C_9H_{11}Cl_3NO_3PS$; Molecular weight: 350.6
Vapour pressure: 2.7 mPa (25^0C)
Solubility (25^0C): c. 1.4 mg/L in water. 450 (methanol) to 7900 (benzene) g/kg.

Octanol-water partition coefficient
Kow: 50 000 ($\log P_{ow}$ 4.7). The FAO Manual on the Submission and Evaluation of Pesticide Residues Data for the Estimation of Maximum Residue Levels in Food and Feed (FAO, Rome, 1997, page 40)
states that when the $\log P_{ow}$ value exceeds 4, the compound would generally be designated as fat-soluble. Consequently chlorpyrifos is described by the Codex Alimentarius as "Chlorpyrifos (fat soluble) and cattle, chicken, sheep, and turkey meat MRLs set by the Codex are set with the designation "(fat)" signifying that the MRL applies to the fat of the meat.

Formulations
The NRA's records refer to registrations of emulsifiable concentrate, paint, wettable powder, ultra low volume, granular, dust, medallion collar (for cats and dogs), pellet, bait, aqueous concentrate, liquid concentrate, and slow release generator (in bait) chlorpyrifos formulations.

4.2 Appraisal

The appraisal has evaluated the data and information available to reach conclusions as to whether current Australian MRLs for chlorpyrifos remain supported on residue grounds. Further details on trials etc. are available in the remainder of the report.

When the data were insufficient, it has generally been recommended that the present MRL be given a temporary status. Retention of "temporary" MRLs would be dependent on undertakings that relevant residue data be generated and submitted to the NRA for evaluation within appropriate time-frames.

Also included in the evaluation were chlorpyrifos's metabolism, analysis in foods, fate in processing and the environment, fat solubility, and levels in food in commerce and consumption.

The appraisal's findings are:

Animal metabolism - In rats, orally administered radiolabelled chlorpyrifos was readily distributed to all organs and tissues. Fat was the site of highest deposition. The majority of the radioactivity was excreted via the urine within 72 hours and residues in tissues also depleted. In fat, chlorpyrifos had a calculated half-life of about 62 hours compared to 10-16 hours in liver, kidney, and muscle. Chlorpyrifos was identified as the major residue component in tissues along with 3,5,6-trichloro-2-pyridinol. The site of highest chlorpyrifos residues was the fat.

In two lactating goats given radiolabelled chlorpyrifos in the diet at 16 and 21 ppm over 10 days, the majority of the administered dose was recovered in the urine and faeces. Plateau concentrations of radiolabelled material were reached after 116 hours in the urine and 93 hours in the faeces. Chlorpyrifos made up the majority of the radiolabelled material in fat (74 and 79%, 0.06 and 0.14 ppm) with 3,5,6-trichloro-2-pyridinol in lesser amounts (19 and 23%, 0.01 and 0.02 ppm). In liver and kidney, chlorpyrifos residues were <0.01 ppm. Total milk residues appeared to reach plateau values after 2 to 3 days. Chlorpyrifos was identified as the major residue in the milk (67-74% of the total milk activity, equivalent to approximately 0.02 ppm chlorpyrifos). Residues of 3,5,6-trichloro-2-pyridinol made up 13-20% (0.002 to 0.003 ppm) of the milk radioactivity. Eighteen hours after a dermal application of radiolabelled chlorpyrifos to goats at 22 mg chlorpyrifos/kg of body weight, maximum chlorpyrifos residues were in the fat (0.65 ppm, 78% of the total carbon 14 residue). Residues of chlorpyrifos in liver, kidney and muscle were either not detected or less than 0.1 ppm. The maximum 3,5,6-trichloro-2-pyridinol residue was in the kidney (0.44 ppm, 60% of the total carbon 14 residue).

When a lactating cow was fed chlorpyrifos at 5 ppm in the diet for 4 days, no chlorpyrifos was reported detected in the milk or urine.

Plant metabolism - Fourteen days after apples were sprayed with carbon 14 chlorpyrifos, the majority of the radioactivity was associated with the peel. There were very low amounts of radioactivity in the apple flesh. Treatment of apples with non-radiolabelled chlorpyrifos confirmed that chlorpyrifos residues were mainly on the apple surface.

Cranberry beans grown in a nutrient solution containing carbon 14 labelled chlorpyrifos demonstrated that the majority of the material was associated with the root system and that very little radioactivity entered the plant and that which did was water soluble. In the roots chlorpyrifos was the major residue. When corn was grown in soil or sand containing radiolabelled chlorpyrifos, the plants absorbed only small amounts of the radiolabel.

Snap bean and corn seeds were treated with carbon 14 labelled chlorpyrifos and the distribution of the radiolabel measured in the growing plants. The results did not identify the nature of the radiolabelled material found in the plants but did show quantifiable radioactivity was present in the growing plants for at least 6 weeks after sowing.

Soybeans were given a carbon 14 chlorpyrifos/ha foliar spray and harvested 14 days later. Chlorpyrifos residues in the soybeans were low (0.01 ppm, 2.6% of the radiolabel in the bean), and present in the forage and field trash at about 1 to 2 ppm (respectively about 29 and 36% of the radioactivity in the forage and trash).

Field corn was given soil and foliar treatments with carbon 14 chlorpyrifos. Green forage and dry fodder and grain were harvested at 96 and 139 days after planting. Chlorpyrifos in the green forage made up about 3% (0.05 ppm) of the total carbon 14 present. In the dry fodder, chlorpyrifos was present at 0.08 ppm (about 2% of the total carbon 14 present while in the grain there were no significant levels of chlorpyrifos or 3,5,6-trichloro-2-pyridinol. 3,5,6-Trichloro-2-pyridinol was identified as a major residue in the forage (30% of the total carbon 14 residue, approximately 0.5 ppm) and as minor component in the dry fodder (approximately 0.12 ppm, 3% of the total carbon 14 residue).

When leaves growing on corn, soybean, and sugar beet were treated with carbon 14 chlorpyrifos at rates of 1000-6000 ppm, results from the corn showed that about 70% of the applied radioactivity had volatilized after 1 day and that after 8 days, 95% in total had volatilized. Sixteen days after treatment, the corn, soybean, and sugar beet residues contained 0.1-1.5% chlorpyrifos with polar fractions present shown to contain approximately 50% 3,5,6-trichloro-2-pyridinol after hydrolysis.

Fish metabolism - in a static flow system, goldfish exposed to an initial concentration of 50 ppm carbon 14 chlorpyrifos showed that chlorpyrifos residues were taken up by the tissues and reached plateau values. Metabolism or degradation occurred in the tissues over time to give 3,5,6-trichloro-2-pyridinol.

Metabolism overview - the metabolism of chlorpyrifos in animals, plants, and fish was satisfactorily detailed in the reports evaluated.

The animal metabolism studies identify chlorpyrifos as an excretable and metabolisable fat soluble pesticide. The lactating goat study provided evidence that plateau levels were reached in the milk during a 10 day exposure at 16 and 21 ppm chlorpyrifos in the diet. This and the observation that plateau values were seen in the urine and faeces indicate that a plateauing of residues in fat and other tissues could also be expected. Metabolism and animal feeding study results together with residue and monitoring data indicate that bioaccumulation has not been identified as an issue of concern with chlorpyrifos.

The plant metabolism studies point to chlorpyrifos being retained on the treated surfaces, not readily translocated and breaking down to 3,5,6-trichloro-2-pyridinol.

Loss of chlorpyrifos through volatilization was shown to be significant in a corn study and this could also occur in other situations.

A fish metabolism study showed tissue up-take of the chlorpyrifos, the reaching of plateau levels, and breakdown to 3,5,6-trichloro-2-pyridinol.

The residue of concern with both plants and animals is chlorpyrifos.

Methods of residue analysis - The reports evaluated confirm that determination of chlorpyrifos is readily achieved at satisfactory limits of quantitation and with adequate recoveries in a wide variety of plant and animal matrices. The methods reviewed used traditional extraction and clean-up techniques with gas chromatographic determination. Although not required by the residue definition, 3,5,6-trichloro-2-pyridinol residues are also determinable by well established methods of analysis.

Residue definition - the plant and animal metabolism studies identify chlorpyrifos and 3,5,6-trichloro-2-pyridinol as the key residues and show chlorpyrifos to be a fat soluble pesticide.

Adequate analytical methodology is available to measure both residues. Measurement of chlorpyrifos alone would be capable of monitoring compliance with good agricultural practice and consequently, it is recommended that the current residue definition of "chlorpyrifos" not be changed. This definition is consistent with the Codex Alimentarius residue definition for chlorpyrifos and with the proposed recommendation in the draft US Reregistration Eligibility Decision (RED) for chlorpyrifos that the US residue definition be set as chlorpyrifos rather than chlorpyrifos and 3,5,6-trichloro-2-pyridinol.

The understanding that there are no toxicological concerns with 3,5,6-trichloro-2-pyridinol, provides reason and support for not including this metabolite in the residue definition.

Chlorpyrifos residues resulting from supervised trials - Australian residue data were available for apples (trials conducted in 1972), avocados (1985 and 1986), bananas (1981 and 1996), celery (1996), cotton, including cotton fodder (1986 and 1996), grapes (1976, 1984, and 1993), maize (1980), mango (1987), passionfruit (1988), potatoes (1983 and 1986), sorghum (1974), sugarcane (1983 and 1985), and wheat (1983).

Overseas residue data were submitted for apples, apricots, barley, beans, carrots, cherries (sweet and sour), corn (maize), cotton, cucumber, gooseberries, grapes, kiwi fruit, lettuce (leaf and head), lima beans, nectarines, oats, onions, oranges, peaches, peas, pears, plums, potatoes, prunes, pumpkin, raspberries, snapbeans, sorghum, soybeans, strawberries, sugar beet, sunflower seed, wheat, and wine. A number of processing studies were included in these data.

Studies on chlorpyrifos residues in alfalfa, cotton fodder, grass, and pastures were also evaluated.

In the evaluation process, use patterns of the "pioneer" products from DowElanco were generally used to define "the use pattern". In other cases, the use pattern of an appropriate, registered product was referred to.

Re-evaluations of the current MRLs - In relation to the current MRLs (as established in the NRA's "MRL Standard"), the following conclusions were reached (Reference to "DowElanco Use Pattern Tables" refers to the use pattern information submitted by DowElanco (DowElanco Australia Limited. Chemical Industry Surveys. July, 97. DowElanco ECRP submission) for Lorsban 500EC and Lorsban 500W):

<u>Table 1 entries</u>

Asparagus - the current MRL of 0.5 mg/kg was established in 1984, where the National Health and Medical Research Council's Pesticides and Agricultural Chemical Committee's (PACC) report noted that the data to support the MRL was limited and somewhat deficient. No residue studies were presented for the ECRP review. The use pattern is covered under the "vegetables" category and allows baiting (50 g chlorpyrifos/10 kg bait/ha) and foliar spray treatments at 25-35 g chlorpyrifos/100L or 240-400 g chlorpyrifos/ha. Baiting would be expected to result in little if any residues in the harvested asparagus. The absence of data and quality of the initial data mean that the current MRL for asparagus can not be considered supported by residue data. It is recommended the current asparagus MRL of 0.5 mg/kg be given temporary status.

Avocado - the current MRL of 0.5 mg/kg was established in 1988 by the PACC with a 7 day withholding period. The label use pattern is for either spraying an EC 500 formulation at 25 or 50 g chlorpyrifos/100L or 500 or 1000 g chlorpyrifos/ha or use on the trees with a bait and a requirement that the treatment avoid contact with the fruit. A 7 day withholding period applies with multiple applications as necessary for the spray application. Bait type applications are not expected to result in residues as the fruit is not contacted and chlorpyrifos is not considered to act systemically.

Use pattern tables provided by DowElanco indicate that there are 1 to 3 applications per season depending on pest pressure. Applications are possible at any stage (most likely at early flowering/fruiting). High and low volume spraying occurs.

Two Australian foliar spraying trials were evaluated. In the first, high volume spraying (single application) at 1000 and 2000 g chlorpyrifos/ha (1x and 2x label rates, assumed equivalent to 50 and 100 g chlorpyrifos/100L) gave residues at day 7 of 0.37 and 1.9 mg/kg respectively. In the second trial, eleven applications at 50 g chlorpyrifos/100 L and 100 g chlorpyrifos/100 L (stated to be double the normal use rate) were applied. Residues at day 7 after last treatment were 0.22 (50 g/100 L treatment) and 0.81 (100 g/100 L treatment) mg/kg.

Based on the limited data presented, which shows that day 7 residues from trials conducted at 1x the label rate were 0.37 and 0.22 mg/kg, it was concluded that the current MRL could remain unchanged. Although the data package did refer to a residue of 0.81 mg/kg, the study was conducted at the apparent use rate of 100 g chlorpyrifos/hl, which is twice the label rate. This result was excluded, which allowed retention of the current MRL.

Banana - In 1997, the Chemistry and Residue Evaluation Section in the NRA recommended the present temporary MRL of 0.5 mg/kg for bananas. The former MRL of *0.1 mg/kg had been set by the PACC in 1981 with a 14 day withholding period.

A number of current use patterns were identified. The first uses a 250 or 500WP or a 500EC formulation applied to the butt and soil for borer control twice a season. The WP use patterns specify a 14 day withholding period for bananas without reference to the use pattern while the EC use pattern clearly identifies that for borer control, a withholding period is not applicable. Given that translocation of chlorpyrifos is not expected and the fruit would not be contacted with the spray, the EC withholding period statement for borer control appears more appropriate.

The second use pattern is aerial or ground foliar spray with either a 250 or 500 WP or a 500 EC at rates of 100 g chlorpyrifos/100L or 1000 g chlorpyrifos/ha. Multiple applications as needed for control are permitted between flower appearance and finger exposure. There is a 14 day withholding period for this use pattern. This would appear to be the critical good agricultural practice with respect to residues.

A third use pattern relates to a permit issued by the NRA in 1997 which allows the use of a chlorpyrifos impregnated ribbon placed in conventional banana bunch covers to control various pests. A 70 day withholding period is set.

A fourth use pattern was also referred to in data submitted. This involved treatment of bagged bananas with chlorpyrifos dust. This use does not appear on the labels of the pioneer products and may be either unregistered or done under a permit issued before the NRA took over the registration role of agricultural and veterinary chemicals.

According to the DowElanco use pattern tables, there can be up to 3 foliar applications (during the season with occasionally more needed under heavy pest pressure) between appearance of the flower bell and finger exposure. Applications are generally applied by ground rig, high volume sprayers. Post-harvest spraying also occurs (one application to base of tree with a follow-up application during flowering or fruiting). This last use pattern would not be expected to be of residue concern.

Residue data evaluated came from two sets of trials. The first was a 1981 study. 800 g chlorpyrifos (as Lorsban 50 EC)/ha was applied aerially as a single foliar application with bananas sampled at 24 hours and 14 days after the application. Residues in the peel and pulp were determined with corrected results reported as “not detected”.

The second set came from a 1996 study in which a 1% dust formulation was prepared and discharged within the polyethylene dust cover.

Maximum residues in bananas (calculated from skin and pulp values) for what was described as the 1x rate of 5 g of a 1% chlorpyrifos dust were between 0.03 and 0.1 mg/kg in unwashed bananas and between 0.02 and 0.16 mg/kg in washed fruit. The study report noted that the main drawback with the dust method was uneven dust deposition leading to excessive residues.

Consideration of the very limited data evaluated supports the NRA decision that a temporary banana MRL of 0.5 mg/kg be established. This MRL is to be withdrawn in the year 2000 unless adequate residue data are provided to support retention of a banana MRL. The ECRP evaluation shows that such data need to address the currently registered foliar use pattern as well as the dusting practice situations. The data would be expected to address residue levels from ground and multiple applications.

The draft ECRP chlorpyrifos trade report noted that a 1997 survey of chlorpyrifos residues in bananas had been conducted by New South Wales Agriculture. Residues of 0.17 and 0.23 mg/kg were found. These results confirm that the current 0.1 mg/kg MRL is in need of review and that the 0.5 mg/kg MRL recommended by the NRA is probably of the correct order of magnitude for current use patterns.

Failure to present banana residue data could result in the deletion of the banana MRL for *all* uses except perhaps borer control where argument that residues are unlikely to occur could result in an MRL being set at the limit of quantitation.

The critical GAP may be the dusting process. Lack of appropriate residue data would result in the elimination of that use pattern.

Brassica (cole or cabbage) vegetables, Head cabbages, Flowerhead brassicas - In 1977 PACC set a provisional chlorpyrifos MRL for cole crops at 0.5 ppm with a 7 day withholding period and requested more residue data on cole crops including cauliflower. An overseas study (Hallack, C.B. and Walker, S.M. (1976) Determination of residues of chlorpyrifos (Dowco*179) in cabbage and cauliflower treated with Dursban* 4 Insecticide. UK) was presented in response to the PACC request but that committee decided to await Australian residue data. These were presented in 1979 and allowed the PACC to confirm the 0.5 ppm MRL for cole crops with a 5 day withholding period.

The DowElanco use pattern tables stated that brassica or cole crops would be given up to 5 ground rig sprays at any stage in the growing season. Seedling or transplant treatments usually involved only one application.

Australian or overseas data were not presented for the ECRP residue review. Consequently, the current MRL for these commodities is not considered to have been shown to be supported by residue data. It is recommended the current MRL of 0.5 mg/kg be given temporary status and appropriate residue data provided.

Cassava - the PACC in 1980 decided that chlorpyrifos could be used on cassava at the seedling stage at a rate of 350 g/ha and in 1986 set the present cassava MRL of *0.02

mg/kg. No Australian or overseas residue data to support this use has been submitted to the ECRP review.

The DowElanco use pattern tables stated that cassava would be rarely given more than one high volume spray and that at the seedling stage.

Given the early use pattern, significant residues are unlikely in the harvested product and the current MRL appears reasonable. If residue data are available, they should be submitted to allow confirmation of the present MRL's acceptability.

Cattle, Edible offal of and **Cattle meat [in the fat]** each have an established MRL of 2 mg chlorpyrifos/kg. This value was initially set by the PACC in 1970 to allow for the use of chlorpyrifos as an insecticidal cattle spray for lice control. The product concerned was not to be used on lactating cattle. The original recommendation was "2 ppm in the fat of meat of cattle" and inclusion of the same value for offal appears to have come at a later date, possibly during a revision of the MRL Standard.

There is no known registered use pattern cattle treatment with chlorpyrifos formulations in Australia. Consequently, the current MRL needs revision as the routes of chlorpyrifos exposure are now by eating of chlorpyrifos treated fodder or forage or by adventitious exposure to chlorpyrifos in farm animal buildings which have been given insecticidal treatments. The data generated from the National Residue Survey on chlorpyrifos residues in cattle fat support this belief as they show the current value of 2 mg/kg now appears excessive.

Argument presented in the "Meat, mammalian" entry of the Appraisal (*q.v.*) allowed the recommendation to be made that the current cattle meat [in the fat] MRL of 2 mg/kg be replaced by a meat, mammalian (in the fat) MRL of 0.5 mg/kg. Similarly an edible offal, mammalian MRL of 0.1 mg/kg, can replace the cattle, edible offal MRL of 2 mg/kg. Both recommended MRLs are to be of temporary status until sufficient details of chlorpyrifos residues in animal forage and fodder have been obtained through the chlorpyrifos ECRP process and the matter reviewed for final decision.

Celery - The currently recommend MRL for celery is a temporary 5 mg/kg with a 14 day withholding period. This was recommended by the NRA on the basis of residue data presented in 1996. These showed chlorpyrifos residues in this crop were exceeding the group MRL of *0.01 mg/kg (set for "vegetables" in 1976). The residue data examined in this review support this action and the establishment and retention of the temporary MRL of 5 mg/kg.

Retention of a celery chlorpyrifos MRL is dependent on the provision of appropriate residue data by mid-1999.

Cereal grains [except sorghum] - The 0.1 mg/kg MRL for these commodities was set by the PACC in 1976. The PACC record did not indicate the nature or extent of the residue data package used to set this level. A sorghum grain MRL of 3 mg/kg had previously been set by the PACC in 1974 to cover the use of chlorpyrifos to control spur throated locust. In 1985 the committee recorded that while chlorpyrifos was not used as a grain protectant, there was some crop usage and that no action, presumably in respect to the cereal grain MRL, was necessary at that time. The Codex Alimentarius has a rice MRL of 0.1 mg/kg and has not established a cereals MRL. In the USA, numerous chlorpyrifos tolerances and administrative guidelines have been set for individual cereals, e.g. barley, corn, oats, sorghum, and wheat with values such as 0.3 ppm for barley grain, 0.1 ppm for corn grain, and 0.5 ppm for wheat grain set. In some cases the US residue definition includes the pyridinol metabolite and in other only parent chlorpyrifos. The US action indicates a possibility of finite chlorpyrifos residues being found in treated grains when appropriate use patterns are employed.

In Australia, there is a large range of foliar application rates. The lowest appears to be 35 g chlorpyrifos/ha for control of lucerne flea. Other use rates include 70, 150, 230, 350 and 450 g chlorpyrifos/ha with the maximum rate being 750 g chlorpyrifos/ha for the control of adult and late stage spur throated locusts. Treatment is often related to pest pressure and can be throughout the growing season and involve multiple applications. A 10 day harvest withholding period and a 2 day grazing withholding period have been established for cereal crops given foliar chlorpyrifos treatment. Registered uses cover aerial and ground foliar applications and seed treatments.

Cereal seed treatments with EC formulations use 60 g chlorpyrifos/100 kg of seed. A dust and a WP formulation (each containing 250 g chlorpyrifos/kg) allow cereal seed treatment at rates of up to 200 g chlorpyrifos/100 kg of seed. Harvest withholding periods would be not be expected applicable to such use.

The DowElanco use pattern tables stated that cereals would have up to three applications depending on pest pressure with applications at any crop stage (including seed dressing or pre-planting). Control of *orthopterans* (locust and grasshopper) generally requires one application (but this is dependent on the swarm size) which can be any time during the crop's development. Rice treatments can be at any stage of growth with usually one or two applications.

<u>*Cereal seed treatments*</u> **-**

The Australian data reviewed contained a summary of a maize study in which chlorpyrifos was applied to the soil as a band at seed sowing at a rate of 500 g chlorpyrifos/ha and a wheat trial in which seed was treated with 200 g chlorpyrifos/100 kg of seed. Neither study gave complete details and the wheat correspondence referred to seed treatment rates of 2000 and 200 ppm for the one trial. While both sets of results indicated residues in the harvested grain were <0.01 mg/kg and complied with the current cereals MRL of 0.1 mg/kg, the quality of the information supplied would not meet today's standards. The data are not, on their own, sufficient to show that seed dressing would lead to residues complying with the 0.1 mg/kg MRL.

The overseas studies included seed dressing treatments on corn at 55-167 g chlorpyrifos/100 kg of seed plus results from seed dressing treatments on beans, pumpkins, cucumbers, and peas, the seeds of which had been treated at 55-220 g chlorpyrifos/100 kg seed. No detectable residues were detected in any of the harvested corn commodities and residues in other harvested commodities were also generally <0.1 mg/kg.

On the basis of the entire information set on chlorpyrifos residues in crops grown from treated seeds, there is little likelihood of chlorpyrifos residues in cereals grains grown from seeds treated at 60 or 200 g chlorpyrifos/100 kg of seed exceeding the MRL of 0.1 mg/kg.

Establishment of a grazing withholding period for cereal seed treatments was also considered. US data from corn grown from seeds treated at 110 and 165 g chlorpyrifos/100 kg of seed showed that residues in the green plants were <0.01 ppm 28 days after treatment. It was also recognised that feeding of animals at up to 10 and 30 (for cattle) ppm chlorpyrifos in the feed is unlikely to result in animal commodity MRL violations, and that there may be little crop to eat at 28 days and that residues levels could well be of the order of 0.01 ppm at that time. Consequently there was not considered to be a need to establish a grazing withholding period or restraint on the feeding or eating of treated fodder or forage by animals after chlorpyrifos cereal seed treatments.

In reaching these conclusions on cereal seed treatments, it was noted that no information on residues in rice from a chlorpyrifos seed treatment were available. It is considered that residues in harvested rice and rice fodder and forage will be negligible because of the expected dilution and breakdown in the aquatic environment. Consequently there does not appear to be any reason at this time to require generation of residue data for rice and rice fodder and forage grown from chlorpyrifos treated rice seeds.

Cereal foliar treatments -
No Australian cereal crop data for this type of use pattern were presented. Overseas studies using foliar applications gave the following results:

Crop, location, year	**Rate g chlor-pyrifos/ha**	**Number of appli-cations**	**Pre-harvest interval (days)**	**Chlorpyrifos grain residues mg/kg**
Wheat, United Kingdom, 1994	336	3	18	<0.01
Wheat, Germany, 1992	240	1	56-59	<0.01
Barley, Canada, 1991	420 or 480	1	42-47	0.02
			63-67	not detected
Barley, Canada, 1991	576	1	30-32	0.19
		4 or 5	27-29	0.17
			32	0.06
Oats, Canada, 1991	420 or 480	1	42-46	0.01
			63-66	0.03
Oats, Canada, 1991	576	1	30-31	0.02
		4 or 5	27-31	0.03
Wheat, Canada, 1991	420 or 480	1	42	0.01

			44-48	not detected
Wheat, Canada, 1991	576	1	29-33	0.03
		4 or 5	27-29	0.05

These results indicate that at rates less than the 750 g/ha maximum allowed in Australia and with withholding periods longer than the Australian 10 day period, residues were generally lower than the present cereals MRL of 0.1 mg/kg (barley may be an exception).

In the absence of Australian foliar residue data, and because of the importance of cereals as a food commodity and the use patterns which allow use on an “as required” basis, it is recommended that the current “Cereal grains [except sorghum]” MRL be given a temporary status while residue data from a representative number of cereal grains including wheat, corn, and rice are generated to support setting of a full MRL.

Such residue data would also consider and establish harvest and grazing withholding periods. It is particularly important that the major cereals grown for export, including rice with its unique growing situation, have sufficient residue data generated to support sustainable, realistic MRLs and withholding periods.

Citrus fruits - the current MRL of 0.5 mg/kg was set by the PACC in 1978 with a 14 day withholding period. Present use patterns are as a strip or patch low on the tree and mixed with a bait, a foliar spray, and as a butt and ground spray.

Provided contact with the fruit is not allowed to occur, the bait and butt/ground applications are not expected to result in chlorpyrifos residues in the fruit (a 14 day withholding period is applicable to all these uses at present). Foliar applications are either 50 g chlorpyrifos/100 L with 2 applications or, for wingless grasshopper control, 25 g chlorpyrifos/100 L or 250 g chlorpyrifos/ha without advice on the number of applications.

The DowElanco use pattern tables stated that citrus would generally have one application (with a subsequent application for heavy infestations) at any crop stage. High volume spraying was referenced for control of some pests.

Australian citrus residue data were not presented for residue evaluation. South African orange studies (single application, 1975) showed that chlorpyrifos levels after a 48 g chlorpyrifos/100L spray and a 24 day withholding period were 0.1 mg/kg and 0.05 mg/kg after 55 days. In other South African trials using single applications, residues were still readily measurable (0.01-0.28 ppm) at withholding periods of approximately 140-250 days. In USA trials conducted at a calculated rate of 90 g chlorpyrifos/100L at low and high volume and sampled at 14 and 30 day withholding periods, chlorpyrifos residues were:

Low volume, 14 days withholding period 0.27-3.8 ppm and at 30 days, 0.78 and 1.0 ppm.

High volume, 14 days withholding period 0.41-0.99 ppm and at 30 days, 0.15 and 0.23 ppm.

This overseas data indicate that the present Australian citrus MRL of 0.5 mg/kg is probably of the right order of magnitude, but in the absence of supporting Australian residue data from oranges and lemons, the Australian MRL must be made temporary while relevant Australian data are generated. Such data should also address the g chlorpyrifos/hl and g chlorpyrifos/ha residue relationship.

Cotton seed - The NRA, in 1996, recommended an MRL of 0.05 mg/kg for cotton seed with a 28 day withholding period based on a 300 g/l ULV formulation use pattern used at 1500 g chlorpyrifos/ha. The PACC had in 1976 recommended that cotton seed be included in an oilseed MRL of 0.05 mg/kg, which was at some later time revised to 0.01 mg/kg.

The current use patterns have a variety of withholding periods/grazing restraints - 500 EC formulations for specific cotton use set either a 2 day grazing restraint and no harvest withholding period or state that harvest and grazing withholding periods are not applicable even though equivalent use patterns are being considered. The maximum use rate in these circumstances is 750 g chlorpyrifos/ha.

When considered under “oilseeds”, no harvest withholding periods and a 2 day grazing withholding period are set and the maximum use rate is 450 g/ha. When applied as a 300 g/L ULV formulation at 1.5 kg chlorpyrifos/ha, 28 day harvest and cotton fodder/grazing withholding periods have been recommended by the NRA.

The present cotton use patterns are a bait treatment (mixed with cracked wheat), foliar, and soil treatments with EC and ULV formulations. This situation is complicated by advice from DowElanco that the ULV formulation could be used as an EC formulation if required. A first appraisal of this situation indicated there was a need to consider the zero and 2 day withholding periods in the light of the 28 days recommended for the ULV use.

Soil baits are not expected to result in significant chlorpyrifos residues in the treated crop and are not considered further other than to note that grazing restraints of 2 days specified by some labels would apply to this use pattern.

The EC use pattern allows 750 g chlorpyrifos/ha with respraying for some pests. A use pattern for young cotton plants sets a 450 g chlorpyrifos/ha rate. A harvest withholding period is not specified although some products do set a 2 day grazing withholding period. Where the use is early season, absence of a harvest withholding period is acceptable. Late season applications could be expected to give finite chlorpyrifos residues.

The ULV use pattern label provided allows in furrow treatment at planting at a rate of 750 g chlorpyrifos/ha while a foliar application using 750 g chlorpyrifos/ha with regular repeat sprays and a 10 day withholding period is also permitted. This use pattern has however been changed according to a 1996 NRA evaluation of the use of the 300 g/L ULV formulation on cotton. The revised use pattern is 2 applications/season with an application rate of 1.5 kg chlorpyrifos/ha and a harvest withholding period of 28 days.

The DowElanco use pattern tables stated that cotton would have up to three applications depending on pest pressure with applications at any crop stage (including seed dressing) with control of Pink spotted bollworm moth usually having only one application at the post-squaring stage. Control of *orthopterans* (locust and grasshopper) generally requires one application (but dependent on the swarm size) which can be any time during the crop's development. Control of Cotton flea beetle and Redshouldered leaf beetle at up to 750 g chlorpyrifos/ha with generally one application at any stage is a current use pattern. Aerial spraying is specifically conducted in some situations.

In Australian studies conducted in 1986, residues from a single treatment at 750 g chlorpyrifos/ha were not detected 10 days after the treatment. Residues were not detected in the cotton seed 14 days after four applications of chlorpyrifos at either 750 or 1500 g/ha. These results would indicate no measurable residues were expected, although the limit of detection of the methodology used was 0.025 mg/kg and not 0.01 mg/kg as would have been required by the oilseed MRL.

The 1996 studies had the 300 g/L formulation applied at 1500 or 3000 g chlorpyrifos/ha (as single or double applications) with the cottonseed harvested 28 days after the last treatment. Residues from the 1500 g/ha treatments were <0.01-0.04 mg/kg while those from the 3000 g/ha treatments were all ≤0.01 mg/kg. The data were taken as supporting the 0.05 mg/kg chlorpyrifos in cottonseed MRL. The 3000 g/ha results indicated that an MRL of 0.1 mg/kg, which could be argued from the 1500 g/ha results, would probably not be required. Australian residue data evaluated from these 1996 trials came from use of the ULV formulation used in a EC mode (broadcast application) (advice from DowElanco, February 1998.).

US cotton seed data from 1974, 1975, and 1982 were also evaluated. These studies were from aerial and ground applications and used EC or ULV type formulations containing approximately 4 lb. chlorpyrifos/gallon (approximately 480 g chlorpyrifos/L and considered equivalent in terms of concentration to the 500 EC formulation type used in Australia.). Multiple applications were used and cottonseed harvested at intervals of 0 to 38 days after final treatment. The use rates for final applications were generally either 560 or 1120 g chlorpyrifos/ha with multiple applications compared to the 750 g chlorpyrifos/ha allowed under the Australian EC use patterns.

In the US 1974 studies, 9 applications at 1120 (or 2240) g chlorpyrifos/ha were made by foliar ground application and seed harvested over 14 days when residues were respectively 0.16 and 0.14 ppm. Immediately after the final sprayings, residue levels were 1.4 and 4 ppm chlorpyrifos respectively. In the 1975 studies, foliar ground applications (early season at 0.28 kg chlorpyrifos/ha at four locations, and late season (11-13 applications at 1120 g chlorpyrifos/ha) were applied and seed sampled at 6, 15, 31, and 34 days after final treatment. Chlorpyrifos residues at the respective times were: 0.06, 0.06, not detected, and 0.14 ppm. Aerial applications were made at three locations in the 1975 studies with multiple final applications at 1120 g chlorpyrifos/ha and harvesting at 8, 18, and 38 days at the three different sites. Respective residues levels were not detected, 0.11, and 0.05 ppm.

The 1982 US studies were all ULV aerial applications with Lorsban 4E or similar formulations. Two, four, eight, or 10 applications were applied at four sites at 560 g chlorpyrifos/ha and seed harvested at 14 to 31 days. Results were:

Withholding period (days): **Number of Applications**	**14**	**21**	**24**	**28**	**31**
2			not detected		not detected
4	0.27	0.08			
8	0.03, 0.07	0.03, 0.14			
10		0.24, 0.65		0.30, 0.34	

Use of EC formulations in the US studies, conducted at rates greater than the 750 g chlorpyrifos/ha allowed in the Australian use patterns, demonstrated that finite residues were possible in the harvested cotton seed. The ULV data from the US two applications trial is consistent with the residues reported in the Australian trials conducted at higher rates (750, 1500, and 3000 g chlorpyrifos/ha) and which gave residues of <0.05 mg/kg. The 1982 trials study report noted that the total number of applications had an impact on the residue levels found in the cottonseed with the highest residues resulting from the most applications applied in the highest spray volume (5 gallons/acre, 47 litres/ha). When fewer applications were applied, residues were lower.

The Australian and US data were taken to support the current cottonseed MRL of 0.05 mg/kg for both EC and ULV applications provided a 28 day harvest withholding period and a 28 day cotton fodder/grazing feeding restraint are applied. This would minimise the risk of exposure to unacceptable levels of chlorpyrifos residues and is of a similar magnitude to preharvest intervals recommended for adoption in the US for broadcast and foliar chlorpyrifos applications to cotton (14 and 40 day PHIs are recommended).

Cotton seed oil, crude - The NRA, in 1997, recommended that the previous chlorpyrifos MRL for cotton seed oil, crude of 0.05 mg/kg (established in 1988 by the PACC with a 10 day withholding period specified) be replaced by an MRL of 0.2 mg/kg with a 28 day withholding period. This recommendation was on the basis of residue data generated in Australian trials using a 300 g chlorpyrifos/litre ULV formulation.

Australian and US cotton seed and cotton seed oil, crude residue data were evaluated for this ECRP chlorpyrifos review.

The US data came from studies conducted in the mid-seventies at a rate of 1120 g chlorpyrifos/ha with an EC formulation (the Australian use pattern with EC formulations allows 750 g chlorpyrifos/ha). Cotton seed oil crude residues were 0.01 and 0.17 ppm from seed containing 0.06 and 0.11 ppm chlorpyrifos (seed sampled at postharvest intervals of 15 and 18 days respectively.

1986 Australian data came from use of a 300 g/L ULV formulation applied four times aerially at 1/2x and 1x the rate now allowed for this formulation. Seed was collected 14 days after last treatment. Residues in the oil were <0.025 and 0.14 ppm from seed containing <0.025 ppm chlorpyrifos. After a single application at 750 g/ha, the 1986 study reported that for postharvest intervals of between days 0 and 3, the cotton seed residues were all <0.025 ppm while the oil from the seed had chlorpyrifos residues of 0.34 to 0.16 ppm. After a 21 day PHI, seed given a single treatment had no measurable chlorpyrifos residues while the oil had <0.025 ppm chlorpyrifos.

The 1996 Australian data came from ground applications of the 300 g/L formulation at the current use pattern rate (1500 g chlorpyrifos/ha) and twice that rate. Cotton was harvested at the label harvest withholding period of 28 days and seed and crude oil chlorpyrifos residues determined as shown in the next table.

All of the cottonseed extractions were laboratory scale with the US studies reported to have used 10-50 lb. (approximately 5-20 kg) of cottonseed for the processing. The laboratory processing used could have resulted in contamination of the seed with lint or trash containing chlorpyrifos residues. While this could account for some of the residues seen in the crude oil, there are considered to be indications of the possible occurrence of chlorpyrifos residues in the oil at levels of up to about the 0.2 mg/kg level.

Rate (g chlorpyrifos/ha)	No. of applications	Chlorpyrifos in seed (mg/kg)	Chlorpyrifos in oil (mg/kg)
1500 (NSW trial)	1	<0.01	0.02
3000 (NSW trial)	1	≤0.01	0.03
1500 (NSW trial)	2	<0.01	0.03
3000 (NSW trial)	2	≤0.01	0.02, 0.02, & 0.06
1500 (QLD trial)	2	0.04	0.20 & 0.24
3000 (QLD trial)	2	0.01	0.85 & 0.89

On the basis of the conclusion that contamination had possibly occurred in the Queensland oil samples leading to an overestimation of residues, no change has been recommended to the present cottonseed oil, crude MRL of 0.2 mg/kg.

Dried fruits - The MRL of 2 mg/kg was established by the PACC in 1981 based on residue data for grapes and sultanas. Australian data on chlorpyrifos residues in dried fruit (sultanas) was available from studies conducted in 1984 and 1993.

The Australian chlorpyrifos use patterns for grapes are for the 250 and 500 WP and 500 EC formulations and allow multiple sprays at 25 g chlorpyrifos/100L or 250 g chlorpyrifos/ha. A 14 day harvest withholding period is set. A 50 g chlorpyrifos/100L use on grape vines before berries close with a second application allowed after 14 days to control mealybug and tuber mealybug is a use pattern on a registered product label. As the time of application for the 50 g chlorpyrifos/100L use is up until berry closure, it seems reasonable to expect minimal residue consequences from this use, however the matter is referred to again under the discussions on grapes. The use to control mealybugs is not on the label of the pioneer product, which does allow a 50 g chlorpyrifos/100L rate for control of scale post-pruning. This latter use is not expected to cause a residue issue.

In the 1984 trial, the concentration of chlorpyrifos/100L applied was near the 25 g chlorpyrifos/100L label rate but the amount applied/ha exceeded that permitted by the label and the trial has not been considered as conducted according to good agricultural practice. No samples were taken at a 14 day withholding period. However the data provided indicated that residues in dried grapes made from grapes sampled at 7 and 35 days after treatment were 1.3 and 0.4 mg/kg (grape residues were 1.1 mg/kg after a 7 day withholding period and 0.2 mg/kg after 35 days). At twice the 25 g chlorpyrifos/100L label rate treatment, the day seven grape and dried fruit residues were 5.4 and 4.4 mg/kg respectively. By day 35, these value were, again respectively, 1.0 and 1.1 mg/kg.

The 1993 trials were conducted at 25 and 50 g chlorpyrifos/100L and showed that dried fruit residues from grapes harvested at a 14 day withholding period after a single 25 g/100L treatment were between 0.06 and 0.13 mg/kg (the grape residues were 0.16-0.3 mg/kg). For a 50 chlorpyrifos/hl application (twice the maximum label rate and at 2.94 kg chlorpyrifos/ha, 10x the label per hectare rate), day 7 grape residues were 1.9 to 2.9 mg/kg and dried fruit made from those grapes, 0.43-1.4 mg/kg. At day 21, the grape residues were 1.3-1.8 mg/kg and the dried fruit, 0.68-1.8 mg/kg. At day 14 in this trial grape residues were 1.5-2.4 mg/kg with no dried fruit being made from grapes taken at that time.

While the data base supporting the current MRL is not large, it would support establishment of a “Dried grapes (currents, raisins, and sultanas” MRL of 2 mg/kg. This is especially the case in the light of the decision by the NRA that the grape MRL be amended to 1 mg/kg (see below) and the approximate 0.5 to 1 concentration factors seen between grape and dried fruit residue levels.

It is however recommended that the present “Dried fruits” entry be deleted in the absence of any relevant supporting residue data.

Eggs - the current MRL of *0.01 mg/kg was set by the PACC in 1983 on the basis of that value covering adventitious chlorpyrifos contamination from use of chlorpyrifos as a termiticide in and around farm buildings. In a poultry feeding study, laying hens were fed between 0.3 and 10 ppm chlorpyrifos in the diet for 30 or 45 days and chlorpyrifos residues in eggs collected over the 45 day period determined. In all cases the levels were <0.01 ppm. Provided laying poultry are not exposed to chlorpyrifos residues in the feed (including cereal grain, cotton meal etc.) of greater than 10 ppm which is considered to be the maximum realistic upper limit, retention of the present egg MRL of *0.01 mg/kg is supported by the study. Based on the maximum cereal residue MRL being 3 mg/kg and the cotton fodder etc. not being used for poultry, dietary exposure is expected to be well below the 10 ppm level. Dietary exposure from cotton meal is expected to be negligible. Additional support for the current MRLs being satisfactory comes from the absence of chlorpyrifos residues in egg samples analysed by the National Residue Survey.

Ginger, root- In 1979 the PACC decided that use of chlorpyrifos on ginger was a minor use situation for control of cutworm and African black beetle at a use rate of 350-540 g/ha and established the present MRL of *0.01 mg/kg. The present use pattern is for a maximum of 450 g chlorpyrifos/ha with an apparent early season or soil application.

The DowElanco use pattern tables stated that ginger is given one high volume spray at seedling stage.

Although no residue data were evaluated, the use pattern and MRL equivalent to no quantifiable chlorpyrifos residues have been taken to support retention of the present MRL.

Grapes - The NRA, in 1996, recommended that the then MRL of *0.01 mg/kg for chlorpyrifos in grapes be amended to 1 mg/kg on the basis of a review of the available grape residue data. A requirement to change the label instructions with respect to the number of applications and intervals between applications is being held over until completion of the chlorpyrifos ECRP evaluation on the basis that many labels are affected.

The present use patterns are for 500 EC and 250 and 500 WP formulations which allow multiple applications to grape vines at either 25 g chlorpyrifos/100L or 250 g chlorpyrifos/ha. A 14 day harvest withholding period is established.

The DowElanco use pattern tables stated that grapevines could have 1 to 5 sprays (high or low volume) per year. Applications are from early berry set to bunch formation with scale control at the post-pruning stage when no leaves were present.

There is a registered 500 EC product which allows 50 g chlorpyrifos/100L to control mealybugs on grapevines with applications up until berry closure. A 14 day withholding period is set for this use. Control of mealybugs on grapevines by chlorpyrifos is not allowed on the pioneer product labels. The EC product label allows a 50 g chlorpyrifos/100L use to control scale on vines as a dormant, post-pruning spray but this is not expected to result in a residue issue.

Australian grape residue data from trials conducted at or near 25 or 50 g chlorpyrifos/100L were conducted in 1976, 1984, and 1996. The chlorpyrifos residues in the grapes from a 14 or 15 days withholding period were:

Date, location	Rate	Chlorpyrifos mg/kg	Comment
1976 trial (South Australia)	25 g/hl 50 g/hl	<0.01 <0.01	Volume spray/ha not recorded
1984 trial (Victoria)	20 g/hl	no 14 day samples taken (day 7, 1.1 and day 35, 0.2	Volume spray/ha ~6000 litres which exceed the recommended
	40 g/hl	no 14 day samples taken (day 7, 5.4 and day 35, 1.0	label use rate and trial is not according to GAP.
1993 trial (South Australia)	25 g/hl 50 g/hl	0.99 and 1.4 3.2 and 3.8	Volume spray/ha 2700 litres which exceed recommended GAP.
1993 trial (Victoria)	25 g/hl	0.06-0.1	Volume spray/ha 1500 litres
1993 trial (Victoria)	25 g/hl	0.16-0.3	Volume spray/ha 1500 litres
1993 trial (Victoria)	50 g/hl	1.5-2.4	Mis-use situation, 10x rate/ha (but only 2x rate/hl).

Overseas grape residue data contained no trials conducted at 25 g chlorpyrifos/hl. Residues in grapes treated in South Africa at 36 or 37.5 g chlorpyrifos/hl and harvested after a 14 day pre-harvest interval were 0.49, 0.26, and 0.97 mg/kg. Other treatment rates or sampling periods were not considered consistent with the Australian use patterns.

The NRA's decision to set the MRL at 1.0 mg/kg was based on the Australian 1976 and 1993 Victorian data from the trials considered to fall within good agricultural practice. The 1984 and 1993 South Australian data were not taken into account as the spray volumes exceeded 1500 litres/ha which the NRA was advised represented a move from good agricultural practice.

The 50 g chlorpyrifos/100L use to control mealybugs requires application to the bunches before the berries close (bunch closure) with a repeat spray 14 days later if necessary. Informal advice from the wine industry indicated that bunch closure occurs approximately 8 to 10 weeks before harvest.

The Australian residue data from trials conducted at 40 or 50 g chlorpyrifos/100L (acknowledging that their rates/ha were excessive) show chlorpyrifos residues at 14 days were between 1.5 and 3.8 mg/kg. Such values exceed the current 1 mg/kg MRL for grapes. Even at 28 or 35 days, chlorpyrifos residues were between 0.84 and 1.4 mg/kg. An Israeli study conducted at 48 g chlorpyrifos/hl reported chlorpyrifos residues of 1.1 mg/kg after a 14 day preharvest interval and 0.49 mg/kg after 21 days.

Based on this material it would appear that a 14 day harvest withholding period is possibly inappropriate with respect to the timing of application for mealybug control.

This assumes bunch closure takes place no later than 8 weeks before harvest and that a second spray is given no later than 6 weeks before harvest.

It is recommended that the current MRL be given a temporary status until data generated from trials conducted according to the mealybug use pattern have been presented to the NRA and evaluated to allow an appropriate MRL/withholding period decision for this use to be made.

This has the advantage of still allowing use of chlorpyrifos for mealybug control as this pest is understood to be of concern in the table grape industry where their presence can render grapes unmarketable.

Support for this approach comes from the draft Efficacy report which noted that in South Australia extension of grape plantings were to increase the need for chlorpyrifos to control light brown apple moth and mealybug.

Setting a 6-8 week withholding period to allow use of chlorpyrifos to control mealybug might be expected to result in residues complying with the present grape MRL of 1 mg/kg. However, in the absence of good data to this effect and the uncertainty as to whether such a time period is compatible with good agricultural practice, this approach has not been recommended at this time. Should feedback permit a 6-8 week withholding period, such data may not be required

Other use patterns are considered likely to result in residues meeting the current 1 mg/kg grape MRL with a 14 day withholding period.

Wine - There are currently no MRLs for wine. Results of two Australian residue studies in wines made from treated grapes were presented. The trials were conducted at 25 and 50 g chlorpyrifos/100L with the latter considered to be outside good agricultural practice because its rate of chlorpyrifos/ha was >10x the label rate. Grapes taken 14 days after treatment were used to make wines. Results (mg chlorpyrifos/kg) were:

Rate	Grapes	Wine
25 g/hl	0.16-0.3	<0.005
50 g/hl	1.5-2.4	0.006

Israeli grape residue data included wine analyses. Wine made from grapes treated once with 25 g chlorpyrifos/ha and harvested 45 days after treatment had chlorpyrifos residues of <0.02 ppm. When treated once at 48 g chlorpyrifos/ha and harvested over a 21 day period, grapes had chlorpyrifos residues of about 3.4 ppm at day 0 and 1.1 ppm at day 14. Wine made from these grapes had chlorpyrifos residues of approximately 0.02 ppm for the day 0 harvested grapes and <0.01 ppm for the day 14 harvested grapes. After a single treatment at 72 g chlorpyrifos/ha and harvesting immediately afterwards, grapes had chlorpyrifos residues of almost 2 ppm, while the wine made from these grapes had chlorpyrifos residues of 0.01 ppm.

Taken as a whole, these results indicate that the grape chlorpyrifos use patterns are not expected to result in significant chlorpyrifos residues in wine made from treated grapes.

Grapevine leaves - An absence of residue data on chlorpyrifos levels in or on grapevine leaves following chlorpyrifos treatment and the known use of grape leaves in foods, has resulted in some product labels bearing a prohibition on the use of chlorpyrifos treated grapevine leaves being used for human consumption. In the absence of residue data, which would allow re-evaluation of this situation, the need for the prohibition has been reconsidered. Grape leaves are most probably an insignificant component of the diet with processing expected to reduce the level of any chlorpyrifos present . It is also noted that there is an apparent absence of any acute effects from chlorpyrifos residues after eating of grape leaves. Consequently, the recommendation is made that the prohibition be removed. If a case for the retention of the statement is made, the prohibition should be extended to the labels of all chlorpyrifos formulations, which allow treatment of grapes. Prudence requires that grape leaves are not taken from recently sprayed vines and that leaves are thoroughly washed before being used as food items.

Kiwifruit - In 1988, the PACC established the current MRL of 2 mg/kg on the basis that this was the Codex Alimentarius MRL. The present label use patterns are for 250 or 500 WP of 500 EC formulations at 25 g chlorpyrifos/100L or 500 g chlorpyrifos/ ha. The EC formulations note that application is not to be during or after blossoming. Scale control is allowed on one EC label with multiple applications at 3-4 weeks while the pests are active. The WP formulations allow multiple post-blossom treatment (14 then 21-28 days). A 14 day harvest withholding period is set.

The DowElanco use pattern tables stated that kiwifruit would generally be given one or up to three high or low volume sprays at the pre-blossom stage.

Extensive data from New Zealand were presented using EC and WP formulations with multiple applications at and above the label rates. Residues of chlorpyrifos calculated to be in whole kiwifruit taken within 14 (±1) days after the last treatment were as shown in the next set of data. These results support retention of the current kiwifruit MRL of 2 mg chlorpyrifos/kg.

50 W	25 g ai/hl	500 g ai/ha	1 application	0.10 mg chlorpyrifos/kg
50 EC	25 g ai/hl	750 g ai/ha	4 applications	0.70 mg chlorpyrifos/kg
50 W,	25 g ai/hl	750 g ai/ha	4 applications	0.31 mg chlorpyrifos/kg
40 EC		800 g ai/ha	5 applications	1.3 mg chlorpyrifos/kg
50 W		750 g ai/ha	5 applications	0.81 mg chlorpyrifos/kg
50 EC	25 g ai/hl	500 g ai/ha	9 applications	0.97 mg chlorpyrifos/kg
50 W,	25 g ai/hl	500 g ai/ha	9 applications	1.1 mg chlorpyrifos/kg
40 EC	40 g ai/hl	800 g ai/ha	9 applications	1.2 mg chlorpyrifos/kg

Mango - the present MRL of *0.05 mg/kg was set by the PACC in 1988. The current use pattern is for 500 EC formulations used at 50 g chlorpyrifos/100L to control scale and 100 g chlorpyrifos/100L on some labels to control green tree ants. A 21 day withholding period applies to both uses.

The DowElanco use pattern tables stated that mangoes would be given one or two applications, usually with high volume applicators, at any time during the growth stage.

Residue data from two Australian studies conducted at 100 and 200 g chlorpyrifos/100L showed that chlorpyrifos residues at day 21 were 0.04 mg/kg for the 100 g/100L rate and 0.07 mg/kg for the 200 g/100L rate.

This data base is not large and it might not be surprising to find residues in the range of 0.01-0.05 mg/kg. However in the absence of any known residue problems associated with the use patterns and the residue results presented, no change is recommended to the present MRL. If residue data from grower operated trials are available they should be submitted to confirm that 0.05 mg/kg is a satisfactory level for the MRL.

Meat, mammalian, in the fat – with the cessation of direct animal treatments with chlorpyrifos, review of the current meat commodity MRLs is relevant and the establishment of meat, mammalian and edible offal, mammalian MRLs becomes a possibility.

Any chlorpyrifos exposure to livestock would now be by consumption of treated fodder or forage or by adventitious contamination in chlorpyrifos treated animal quarters. This last route is not expected to be of major significance as the exposures should be intermittent and result in transient residues. Contamination by spray drift is a mis-use situation.

With regard to exposure through fodder and forage, the draft ECRP efficacy report stated that the major crop use of chlorpyrifos is on cotton followed closely by sugar cane. Uses on cereals, pasture, pome and stone fruits, and vegetables, are minor compared to the cotton and sugarcane uses.

Cattle can be exposed to chlorpyrifos through feeding of cotton fodder or grazing on treated pasture. Sheep exposure would probably be most likely through grazing on treated pasture while pig exposure is expected to be minimal (cotton fodder and grazing of pastures being of minor importance in the feeding of these animals).

The data on chlorpyrifos residues levels in cotton fodder (stubble, not trash), pasture, and other sources such as pomace indicate that the most likely source of significance will be cotton fodder (stubble) where an MRL of 30 mg/kg has been set. However, cotton fodder is not expected to normally be a major constituent of the cattle feed. Rather cotton meals or hulls would be of more importance and there, the residues are expected to be less than 0.05 mg/kg and to have no significant residue implications. Sugarcane residues are expected to be negligible and not to be of significance in animal feeds. Chlorpyrifos exposure from pomaces etc. would not be expected to result in exposures greater than 10 ppm chlorpyrifos in the total diet.

Examination of the available information points to a realistic maximum daily dietary chlorpyrifos intake of 10 ppm. Using the results from a 10 ppm chlorpyrifos cattle feeding study allows the recommendation that a temporary meat, mammalian (in the fat) MRL of 0.5 mg/kg be set. The meat, mammalian entry, rather than a cattle meat entry, is appropriate for the reasons given in the following paragraphs.

Grazing of recently treated pasture may expose cattle to chlorpyrifos residues but the ready breakdown of this chemical after application means exposure to high chlorpyrifos concentrations would only be of short duration. Such exposure is not expected to be of major residue significance because of the residue breakdown on the plant, metabolism of the ingested chlorpyrifos and ready depletion of chlorpyrifos deposited in the animal fat.

Should exposure to higher chlorpyrifos concentrations occur, the ready fat depletion will allow a realistic withdrawal from slaughter interval to be used. During this time the residues would reduce to the desired concentration. The data evaluated in the cattle feeding study showed that a withholding from slaughter interval of 28 days would be expected to result in no significant chlorpyrifos residues if exposure of a transient nature to the anticipated concentrations of chlorpyrifos in animal feeds occurs.

Sheep exposure to chlorpyrifos is expected to be primarily by grazing treated pasture. The National Residue Survey data indicate that residues exceeding the current sheep meat, in the fat MRL of 0.1 mg/kg will be detected at low frequency (a maximum value of 0.2 mg/kg in sheep meat in the fat has been reported). As this use is probably from grazing according to good agricultural practice, a raising of the sheep meat MRL is indicated. Setting the level at 0.5 mg/kg (as a temporary meat mammalian, in the fat, entry) would allow for these occasional detections and prevent unnecessary MRL violations.

Pigs are not expected to have any significant exposure to chlorpyrifos through feeding on pastures. Exposure through eating of feeds prepared from chlorpyrifos treated produce should not result in residues of significance. The absence of chlorpyrifos residues in pig fat samples analysed in the National Residue Survey support this belief. While the current pig meat, in the fat MRL of 0.1 mg/kg is sustainable, it could be replaced by the temporary meat mammalian, in the fat MRL of 0.5 mg/kg.

Because there are no increases of exposure to chlorpyrifos proposed, there should be no increase in the actual chlorpyrifos residue concentrations in pig meat. The establishment of the meat mammalian, in the fat MRL conveniently places the entries for cattle, sheep, and pig meats into one entry based on the highest expected residues but at the same time, not causing any increase in actual chlorpyrifos levels in those commodities. The MRL is to be of temporary status until sufficient details of chlorpyrifos residues in animal forage and fodder have been obtained through the chlorpyrifos ECRP process to allow a final decision.

In reaching these conclusions, information from the National Residues Survey, the metabolism of chlorpyrifos in plants and animals, animal feeding studies, likely residue levels in animal feeds, and dietary intakes of animal feeds have been taken into account. The critical factors are considered to be the intake from forage crops and the residue levels in those crops. Based on the weight of evidence available, the likely levels of residues in animal commodities are expected to be low and not necessarily near the recommended MRL value which is based on cumulative worst case considerations. Consequently it has been considered justified to set a temporary meat, mammalian (in the fat) MRL at this time. When data on residue levels in forage etc. come in via the ECRP process, the animal commodity MRLs will be adjusted accordingly and set as confirmed values.

Milks [in the fat] - this MRL of 0.2 mg/kg was set by the PACC in 1978. The “in the fat” basis means that chlorpyrifos is fat soluble and the MRL applies to the fat portion of the milk. On the basis that milk fat makes up 4% of milk, the 0.2 mg/kg value on a whole milk basis would be a calculated 0.008 mg/kg. This is set in practice at 0.01 mg/kg (the Codex Alimentarius milks MRL is set at *0.01 mg/kg and the US milk fat tolerance of 0.25 mg/kg is equivalent to 0.01 mg/kg in the whole milk).

A lactating cattle feeding study indicated that provided the dietary chlorpyrifos level is not more than 10 ppm, then cattle milk chlorpyrifos residues are expected to be <0.01 ppm. At 30 ppm chlorpyrifos in the diet, whole milk residues were 0.01 mg/kg. A lactating goat metabolism study indicated that in goats fed at 16 or 21 ppm in the diet for 10 days had chlorpyrifos residues in the milk of the order of 0.02 ppm. In the absence of other goat data, it is expected that levels of chlorpyrifos in the milk would less than 0.02 ppm if the levels of exposure were about 10 ppm in the feed.

No change is considered required to the present milks [in the fat] MRL on the basis of the information presented and the belief that any dietary exposure to chlorpyrifos residues at much more than 10 ppm are expected to be of a transient nature. Exposure to levels of 30 ppm are expected to be infrequent and should still result in residues complying with the MRL.

Edible offal, mammalian - as already considered under the “Meat, mammalian, in the fat” discussion, cattle, sheep, and pigs are not expected to be routinely exposed to more than 10 ppm chlorpyrifos residues in the feed. Also the cessation of direct animal treatments means the current cattle edible offal MRL of 2 mg/kg is no longer appropriate and needs to be revised to reflect likely chlorpyrifos exposure through eating chlorpyrifos treated feeds or inadvertent and transient exposure to chlorpyrifos in treated animal quarters.

Animal transfer studies showed that chlorpyrifos does not accumulate in liver or kidney and was present at levels of <0.1 mg/kg in cattle fed at up to 30 ppm chlorpyrifos in the diet and in pigs fed at up to 10 ppm chlorpyrifos in the diet. As the expected maximum dietary chlorpyrifos concentration is of the order of 10 ppm, establishment of a temporary edible offal, mammalian MRL of 0.1 mg/kg is recommended. Such a value allows the lowering of the present cattle, edible offal MRL to a realistic value, which is the same as the present sheep and pig edible offal MRLs. The MRL is to be of temporary status until sufficient details of chlorpyrifos residues in animal forage and fodder have been obtained through the chlorpyrifos ECRP process to allow a final decision to be made.

Oil seed (except cottonseed)- the MRL of 0.01 mg/kg had been established by the PACC by 1987. Such a value would be consistent with pre-emergence use or use on young plants. The oilseed category includes peanuts, rape, safflower, soybean, and sunflower. A cottonseed oil MRL has already been discussed and recommendations made. Apart from the cottonseed oil data already considered, no Australian oilseed data were available for evaluation.

The Australian use patterns can be divided into at sowing/early growth applications and applications at later stages of growth. Specific harvest withholding periods for oilseeds have not been identified. There is a 2 day grazing or feeding for stockfood restraint specified for oil seeds (including cotton). Bait applications are allowed but these are not expected to result in significant residues in the oil seeds. Early season use patterns allow for up to 750 g chlorpyrifos/ha for soil applications while seed dressing permits 40 g chlorpyrifos/100 kg seed while other uses allow up to 250 g/ha. Applications later in the season allow for uses of chlorpyrifos at 150-250 g/ha.

The DowElanco use pattern tables stated that oil seed crops would have up to three applications depending on pest pressure with applications at any crop stage (including seed dressing or pre-planting). Control of *orthopterans* (locust and grasshopper) generally requires one application (but this is dependent on the swarm size) which can be any time during the crop's development.

A French study showed that chlorpyrifos applied to the soil pre-sowing at rates of 5 or 7.5 kg chlorpyrifos/ha gave chlorpyrifos residues of <0.01 ppm in sunflower seed harvested 129-173 days after application. In a US study, chlorpyrifos was applied as a soil application at sowing followed by 3 or 5 further foliar treatments at various growth stages. Final applications were at early seed head development or a week after the early bloom period. Sunflower seeds were harvested at maturity (59-75 days for the four treatment and 44-46 days for the six treatment studies). Residues were 0.02-0.17 ppm at 44-46 days and ≤0.05 ppm at 59-75 days. The US residue tolerance for sunflower seeds is 0.25 ppm (and includes the 3,5,6-trichloro-2-pyridinol metabolite). US cottonseed and peanut tolerances are both 0.2 ppm and do not include the pyridinol metabolite.

On the basis of the information available, retention of the present oilseeds MRL of 0.01 appears reasonable for early season applications but perhaps not for later applications. It is recommended that the present MRL be amended to cover late season applications and given a temporary status while Australian residue data for the relevant use patterns are generated along with appropriate harvest/grazing withholding periods. A temporary MRL of 0.05 mg/kg is suggested. This flows from the decision to set the cotton seed MRL at that value and the expectation that residues seen in cotton seed could mirror those expected in oilseeds in general. Moreover, 0.05 mg/kg had been the initial value set for the oilseeds MRL in 1976. The MRL entry should also be amended to show that cotton seed has its own MRL of 0.05 mg/kg.

Passion fruit - this MRL was set by the PACC in 1989 as 0.05 mg/kg and is for bait use at 60 g chlorpyrifos/30L applied to a strip or patch on the tree (WP formulations). Contact with the fruit is not allowed and there is a label 14 day harvest withholding period. Multiple applications are permitted with 7-10 day intervals between applications. This use pattern should not involve fruit contact and consequently should not be significant with regard to residues.

The DowElanco use pattern tables stated that chlorpyrifos as baits could be used every 7 to 10 days during fruiting.

Results were presented from Australian studies in which passionfruit vines were treated according to the use pattern with between 1 and 10 applications of chlorpyrifos at 200 and 400 g/100L (1x and 2x label rates) with the fruit harvested at 0 to 7 days after last treatment. Residues were in all cases either not detected at the 1x level or <0.05 mg/kg at the 2x rate.

These results support retention of the present passionfruit MRL of *0.05 mg/kg for bait application.

Pig, Edible offal of and **Pig meat [in the fat]-** In 1974 the PACC established an MRL of 0.1 mg/kg for the fat of meat of pigs to cover a direct animal application. No further reference to this entry has been found in the PACC records. By 1992 however the MRL had been amended to individual pig meat (in the fat) and pig, edible offal of entries, each of 0.1 mg/kg. This situation is not dissimilar to that already noted for cattle meat and offal. With there being no known direct application to pigs, the MRL established needs to cover exposure caused by eating chlorpyrifos treated fodder and forage and by adventitious exposure such as by entry of the pigs into chlorpyrifos treated animal quarters.

A swine feeding study showed that the current pig, edible offal and pig meat, in the fat, MRLs (each 0.1 mg/kg) would be met provided the dietary intake of chlorpyrifos did not exceed 3 ppm. This is expected to be a realistic maximum intake based on the existing fodder/forage MRLs and the absence of cotton fodder and trash in the diet of pigs. Feeding at 10 ppm chlorpyrifos in the diet would result in pig meat (in the fat) residues of about 0.2-0.3 mg/kg. While exposure of such a level to pigs is unlikely, the recommendation is made that the current pig meat [in the fat] MRL of 0.1 mg/kg be replaced by a meat, mammalian (in the fat) MRL of 0.5 mg/kg and that the pig, edible offal MRL of 0.1 mg/kg be replaced by an edible offal, mammalian MRL of 0.1 mg/kg. Both recommended MRLs are to be of temporary status until sufficient details of chlorpyrifos residues in animal forage and fodder have been obtained through the chlorpyrifos ECRP process and the matter reviewed for final decision.

Such action does not increase the exposure of pigs to chlorpyrifos and there is no expectation that residues in pig meat will increase. The establishment of a single mammalian meat (in the fat) MRL is considered justified on the basis of the cattle, pig, and sheep residue situations outlined in this report.

Pineapple - the present MRL of 0.5 mg/kg was set by the PACC in 1981 on the basis of extrapolation from the citrus MRL of 0.5 mg/kg. There are two Australian use patterns for 500 EC formulations: One is a pre-planting spray at 2.5 kg chlorpyrifos/ha, which would not be expected to give residues in the harvested fruit. The second is a 50 g chlorpyrifos/100L or 2500 g chlorpyrifos/ha regime, which can be repeated at 90 day intervals. One label specified a 14 day harvest withholding period while another did not.

The DowElanco use pattern tables stated that pineapples would have one to two applications per year at any crop stage, including pre-planting, using ground-rig application.

In the absence of any residue data and because the citrus fruit MRL has been given a temporary status (because of lack of supporting data), it is recommended that the pineapple MRL of 0.5 mg/kg also be given a temporary status. Residue data or appropriate argument are needed to justify continuation of this MRL.

Pome fruits - the pome fruit MRL of 0.2 mg/kg was set by the PACC in 1973 with a 14 day harvest withholding period.

The present use patterns are for apples, pears, and pome fruit. Apples can be given multiple treatments at 50 or 25 g chlorpyrifos/100L or 250 g chlorpyrifos/ha (dependent on pest) with spraying taking place over the season and up until 2 or 3 weeks before harvest. A 14 day harvest withholding period is established.

The use patterns for pears allow multiple applications at about 2 weekly intervals at 25 or 50 g chlorpyrifos/100L or 250 g chlorpyrifos/ha (dependent on pest) with a 14 day harvest withholding period. Applications up until 2 or 3 weeks before harvest are allowed.

There are pome fruit use patterns, which allow 25 g chlorpyrifos/100L or 250 g chlorpyrifos/ha for grasshopper control with a 14 day harvest withholding period. There is also a bait application to trees with 200 g chlorpyrifos/100L bait mixture plus a requirement that the product not be allowed to contact the fruit.

The DowElanco use pattern tables stated that apples and pears would generally have one application (with a subsequent application for heavy infestations) at any crop stage or alternatively, usually up to three applications after petal fall for control of Light brown apple moth. One or two applications up until end of flowering were also used. High or low volume spray applications are used.

Australian residue data were from Tasmanian and Victorian apple trials conducted in 1972 with 25 g chlorpyrifos/100L (7 or 8 high volume applications). Residues at the withholding period of 14 days were between 0.07 and 0.16 mg/kg (the original report noted that a residue level of 0.41 mg/kg at the 14 day withholding period had been discarded as it was considered too high compared to other replicates (0.41, 0.068, and

0.14 mg/kg)). No Australian residue data on treatments at 50 g chlorpyrifos/100L were presented.

US data using multiple applications (4-12) of a 50W formulation at 60 g chlorpyrifos/100L (high volume spraying) on apples showed that at a 14 day pre-harvest interval, chlorpyrifos residues were between 0.02 and 1.9 ppm. Low volume applications gave chlorpyrifos residues of 0.14-3.5 ppm. A US pear study using 36-90 g chlorpyrifos/hl gave chlorpyrifos residues of 0.77 ppm for a high, and 2 ppm for low volume treatments (7 applications).

The draft ECRP chlorpyrifos trade report has noted that a New South Wales Agriculture Flemington Market Survey in 1997 found residues of 0.26 (2 instances) and 0.25 mg/kg in sampled apples. This indicates that excursions above the present pome fruit MRL have occurred on occasion and that review of the 0.2 mg/kg MRL is needed.

The Australian residue data package is insufficient to confidently set a revised MRL at this time. However the distribution of results reported in the Australian apple trials indicates that a temporary MRL of 0.5 mg/kg should be satisfactory to monitor and control chlorpyrifos use on pome fruit for the present time.

Potato - In 1988 PACC recommended the present potato MRL of 0.05 mg/kg.
The present use patterns on potato are soil applications at about planting or final hilling up (up to 3 kg chlorpyrifos/ha) or for grasshopper control at 250 g chlorpyrifos/ha or 25 g chlorpyrifos/100L. In neither case is a withholding period set.

The DowElanco use pattern tables stated that potatoes would normally be given 1 applications at pre-plant followed by one application at the “hilling-up” stage.

Australian potato residue data showed that when treated at 1.5 or 3 kg chlorpyrifos/ha at planting and about 0.5 kg/ha at hilling up, chlorpyrifos residues in the harvested potatoes were ≤0.01 mg/kg. Overseas data from potatoes given single or multiple foliar treatments at rates of 500 to 1920 g chlorpyrifos/ha showed that chlorpyrifos residues in the harvested tubers were between <0.01 and 0.04 mg/kg for harvest intervals of 1 to 127 days.

The combined data package has been taken to indicate support for retention without amendment of the current potato MRL using either soil or foliar applications. Specification of a harvest withholding period does not appear warranted on the basis of the data provided.

Poultry, Edible offal of and **Poultry meat [in the fat] -** both of these commodities have an MRL of 0.1 mg/kg. Poultry and sheep tissue and by-product chlorpyrifos MRLs to cover adventitious residues from the use of chlorpyrifos formulations as termiticides in and around farm buildings were set by PACC in 1983. The MRL was 0.1 mg/kg for “Fat of meat of sheep and poultry”. By 1992, this had been redrafted to be “Poultry, edible offal of” and “Poultry meat [in the fat]”, with each being given a value of 0.1 mg/kg. A similar process occurred for the pig meat situation.

In a poultry feeding study, laying hens were fed between 0.3 and 10 ppm chlorpyrifos in the diet for 30 days and chlorpyrifos residues in the tissues determined. One group of birds fed at 10 ppm for 30 days were placed on a chlorpyrifos free diet and killed 7 days later. Chlorpyrifos residues in muscle, liver, and kidney in birds fed at 10 ppm were all reported as no greater than in the control samples (taken to mean not quantifiable) while residues in the fat at the 10 ppm feeding level were between 0.02 and 0.06 ppm. Seven days after removal of the chlorpyrifos from the diet, there was no difference between the level of residues in the fat of the treated and control birds.

Because poultry are not expected to be exposed to chlorpyrifos residues in the feed of greater than 3 ppm, the present poultry MRLs at 0.1 mg/kg are supported by the study.

Sheep, Edible offal of and **Sheep meat [in the fat] -** As already noted these MRLs are both 0.1 mg/kg and were based on a PACC decision in 1983 to allow for adventitious chlorpyrifos contamination. The original MRL was for “fat of meat of sheep” which by 1992 had been developed to the present sheep offal and meat entries.

No sheep feeding studies were presented for review. A study in which sheep were given a single spot chlorpyrifos treatment at 19 mg chlorpyrifos/kg body weight showed that over a 6 week post-treatment period, chlorpyrifos residues in muscle, liver, and kidney were all ≤0.02 ppm. In omental fat, maximum residues were seen at week 3 post-treatment at 0.21 ppm with residues depleting to <0.003-0.042 ppm after 6 weeks. It seems reasonable to assume that inadvertent exposure to chlorpyrifos by sheep would not be at levels associated with spot on treatments and consequently, the present MRLs of 0.1 mg/kg should still be complied with.

Exposure to chlorpyrifos by grazing of treated pasture is possible and the low occurrence of residues in sheep meat reported by the National Residue Survey may be from such exposure, rather than contamination from treated buildings.

The original sheep product MRLs did not appear to consider exposure through grazing. The National Residue Survey has reported the occurrence of a chlorpyrifos concentration of 0.2 mg/kg in sheep fat (it is recognised that the survey showed negligible residues in the vast majority of the sheep fat analysed). Consequently, it is recommended that, based on argument presented in the “Meat, mammalian” entry of this Appraisal, that the current sheep meat [in the fat] MRL of 0.1 mg/kg be replaced by a meat, mammalian (in the fat) MRL of 0.5 mg/kg. Similarly, the sheep, edible offal MRL of 0.1 mg/kg is replaced by an edible offal, mammalian MRL of 0.1 mg/kg.

The raising of the meat, in the fat MRL value will not be expected to result in an increase of sheep fat residues as the use patterns and exposure remain unchanged. Rather the increase allows legitimate grazing by sheep without the fear of causing inadvertent and unnecessary residue violations.

Both recommended MRLs are of temporary status until sufficient details of chlorpyrifos residues in animal forage and fodder have been obtained through the chlorpyrifos ECRP process and the matter reviewed for final decision.

Sorghum - the present MRL of 3 mg/kg was set by the PACC in 1974 for control of spur throated locust in sorghum.

The sorghum specific use patterns are for furrow treatments, baits, and foliar applications.

Furrow and early season applications are not expected to result in significant residues in the harvested crop. For early season applications, there is probably too little crop to eat, and residue levels in the crop and animal intake may well be negligible at this stage. Consequently, there does not seem to be a demonstrated need to establish grazing withholding periods or to set restraints on the cutting for stock feed for sorghum given early season chlorpyrifos treatments.

Repeat foliar applications to control pests such as grasshoppers, locusts, midges, etc. are permitted. Harvest withholding periods of 10 and 2 days are referred to in some labels along with a grazing restraint of 2 days. Locust control allows up to 750 g chlorpyrifos/ha while other uses involve concentrations of 175-450 g chlorpyrifos/ha.

The DowElanco use pattern tables stated that sorghum would have up to three applications depending on pest pressure with applications at any crop stage (including seed dressing). Control of *orthopterans* (locust and grasshopper) generally requires one application (but this is dependent on the swarm size) which can be any time during the crop’s development.

Results from an Australian sorghum residue trial conducted at 70 and 140 g chlorpyrifos/ha in 1974 and a preliminary investigation study conducted in the same year were presented. The results were:

Treatment rate (g chlorpyrifos/ha)	**Number of applications**	**Withholding period (days)**	**Chlorpyrifos residues (mg/kg)**
70	1	1	0.94
		7	0.12
140	1	1	1.2
		7	0.18
60	2	100	0.02
125	2	100	0.02

This is a very small data base and it does not cover the locust use or uses such as armyworm (350 or 450 g chlorpyrifos/ha), cut worm (450 g chlorpyrifos/ha), or midge control (250 g chlorpyrifos/ha).

While fodder or forage results were not presented with these trials, it seems reasonable to believe that at the treatment rate of 750 g chlorpyrifos/ha, measurable residues would be present for at least several days after treatment.

In a 1994 US study conducted at two sites, sorghum was treated with Lorsban 4E and harvested at respective withholding periods of 30 or 60 days after two or three treatments respectively of chlorpyrifos at 560 or 1120 g chlorpyrifos/ha. Chlorpyrifos residues (mg/kg) were:

Harvest interval (days) & rate	**Grain**	**Green forage**	**Fodder**
30 (3x560 g chlorpyrifos/ha)	0.03 and 0.23	0.04 and 0.17	0.20 and 1.5
60 (560 then 1120 g chlorpyrifos/ha)	<0.002 and <0.01	0.01 and 0.05	0.09 and 0.40

The US label for Lorsban 4E (4 lb. chlorpyrifos/gallon, approximately 0.48 kg/litre), sets a 30 day restriction on the use of the crop when the treatment rate is 1 pint/acre (560 g chlorpyrifos/ha) and 60 days for applications greater than 1 pint/acre). Maximum usage was reported as 3 pints/acre/season.

An earlier US sorghum study had been reported in 1991, also at two US sites. Sorghum was treated with multiple applications of chlorpyrifos at 560 or 1120 g chlorpyrifos/ha and grain and fodder harvested at 29 or 30 and 60 days. The ranges of chlorpyrifos residues (mg/kg) reported were:

Harvest interval (days) & rate	**Grain**	**Fodder**
29 or 30 (3x560 g chlorpyrifos/ha)	0.03-0.05 and 0.22-0.29	0.01 and 0.28-0.39
60 (560 then 1120 g chlorpyrifos/ha)	0.01-0.03 and 0.09-0.22	0.01-0.02 and 0.04-0.15

In both the US study sets, results from one location were significantly higher than results from the other location. There is a US Administrative Guideline which specifies that sorghum forage shall have no more than 1ppm chlorpyrifos and sorghum fodder, no more than 4 ppm chlorpyrifos.

A Brazilian study reported chlorpyrifos grain levels of 0.07 and 0.17 ppm respectively after a 21 day pre-harvest interval and 3 treatments at 360 or 720 g chlorpyrifos/ha.

The data package does not provide good justification for the present MRL of 3 mg/kg with respect to the critical Australian good agricultural practice of control of spur throated locust using 625-750 g chlorpyrifos/ha which can be applied when areas of crop are infested. Nor does the package cover other permitted use rates. The Australian data package is also seen as deficient with respect to what residues would be after a 2 day grazing or feeding withholding period.

It is recommended that the present sorghum MRL be given a temporary status and appropriate supporting residue data obtained from Australian trials. In the generation of such data, data on residues in fodder and forage also need to be gathered and presented to the NRA. Setting a lengthy withholding period, while perhaps technically justifiable, is not supported by data or any historical evidence. Asking that the issue of forage and fodder residues be addressed when the sorghum MRL is verified was considered reasonable in this light.

Stone fruits – the present MRL of 1 mg/kg was set by the PACC in 1983 apparently on the basis of New Zealand residue data from use of Lorsban 25W. A 14 day withholding period was set for the use patterns of 25 g chlorpyrifos/100L with multiple applications at 1-2 weekly intervals.

The present use patterns allow for bait use, which is not expected to result in residues when there is no contact with the fruit, and multiple foliar sprays at 25 or 50 g chlorpyrifos/100L (or 1000 g chlorpyrifos/ha) with a 14 day withholding period.

The DowElanco use pattern tables stated that stone fruit would generally have one either high or low volume treatment, usually at blooming or flowering, and also at dormancy with a subsequent application in spring for scale control. Control of Light brown apple moth would usually require up to 3 applications starting after petal fall.

Australian stone fruit residue data were not presented for evaluation. Extensive US data on apricots, nectarines, peaches, plums, prunes, sour cherries, and sweet cherries were evaluated.

In trials conducted in the US in 1984, day 14 residues (maxima) from 7 or 8 high volume sprayings at 36-61 g chlorpyrifos/100L were – apricots: 0.14 & 0.23 ppm; nectarines: 0.07-0.25 ppm; peaches: 0.46-1.1 ppm; plums: 0.17-0.38 ppm. Prunes were treated at 1.7 kg chlorpyrifos/ha with a high volume treatment giving 0.04 ppm chlorpyrifos after a 14 day withholding interval. Sour and sweet cherries were treated at 1.7 kg chlorpyrifos/ha with 5-8 applications. Residues after a 14 day withholding interval were: sour cherries: 0.1 and 0.16 ppm; and sweet cherries: 0.18 and 0.66 ppm.

In the same series of trials, low volume applications at 1.7 kg chlorpyrifos/ha gave the following day 14 residue results – apricots: not detected-0.92 ppm; nectarines: 0.14-0.19 ppm; peaches: 0.16-0.51 ppm; plums: 0.03-0.37 ppm, prunes: not determined and 0.14 ppm, sour cherries: 0.07 ppm, and sweet cherries: 0.1-0.43 ppm.

Bait applications on peach trees at 360 g chlorpyrifos/hl gave no measurable chlorpyrifos residues at 14 day withholding periods.

The US results indicate the Australian stone fruit MRL is most probably adequate, but in the absence of Australian data, it is recommended that the MRL of 1 mg/kg be given a temporary status pending conduct of Australian stone fruit trials and evaluation of the residue data generated.

Strawberry – the current MRL of 0.05 mg/kg was set by the PACC in 1990. At that time it was recognised that the use pattern was a bait application and that there was an expectation of residues being negligible because translocation from the soil to the crop was unlikely. There were however no residue data from this use pattern to show this. The PACC decided that a finite MRL (0.05 mg/kg) be set on the basis of there being no relevant residue data but with the expectation residues would probably be negligible. A harvest withholding period was not considered necessary.

The current use patterns are still for baits and use 50 g chlorpyrifos/10 kg bait. One 500 EC product states that no withholding period is applicable, while another product sets a 14 day withholding period. The PACC decision pointed to the absence of any need to set a harvest withholding period and the 14 day entry may be an oversight.

The DowElanco use pattern tables stated that strawberries would generally have one application or as needed at any crop stage with the product not directly applied to the crop.

Results from single foliar applications of chlorpyrifos at 710 g/ha to strawberries in the United Kingdom showed that residues were of the order of 0.02-0.08 ppm over 3 to 14 day harvest withholding periods. These results tend to confirm the original PACC decision that provided the bait pattern only is used, residues would be expected to comply with the present 0.05 mg/kg MRL. The Market Basket Survey reports have reported on occasion that the current strawberries MRL of 0.05 mg/kg was exceeded. Should such findings continue to occur, this would point to the need to reconsider both the use pattern and the present MRL.

At this time no change to the current strawberry chlorpyrifos MRL of 0.05 mg/kg is recommended.

Sugar cane – in 1976 PACC established the present sugar cane MRL of 0.1 mg/kg.
The present use patterns are for granular application to the soil or use of an EC formulation either at planting or setting or for pest control (e.g. locusts)later in the growing season. Based on chlorpyrifos not translocating through the soil, the soil and sett applications are not expected to give residues exceeding the present MRL even though treatment levels can be up to 4 kg chlorpyrifos/ha. This is supported by the lengthy time between treatment and harvest and the non-systemic nature of chlorpyrifos. No harvest withholding period would be considered appropriate for such situations.

Where there are late season foliar applications (175 to 750 g chlorpyrifos/ha permitted), the residue situation may be different and this is reflected in the 500EC formulation use patterns specifying a 7 day harvest withholding period and a 2 day grazing restraint.

The DowElanco use pattern tables state that control of *orthopterans* (locust and grasshopper) generally requires one application (but this is dependent on the swarm size) which can be any time during the crop's development. Other use patterns, usually one application, occur at planting or ratoon stage. Control of *lepidopterans* can have up to 3 applications at any crop stage with applications by boom spray or air.

Granular applications to sugarcane grown in Australia at rates of 2 to 7.2 kg chlorpyrifos/ha with sugarcane harvested at 250 to 600 days after showed that in sugar cane juice no chlorpyrifos residues were detected (<0.001 ppm). These results have been taken as giving indirect evidence that the current sugar cane MRL would not be exceeded by soil or sett applications. Residue data submitted for soil application of controlled release granular product at planting of sugarcane show that this use pattern does not lead to residues above the existing MRL for sugarcane.

Trial data from foliar applications were not presented.

Because of the absence of foliar application data, it is recommended that residue data for such uses be generated to allow reconsideration of the appropriateness of the present MRL. If such data can not be provided, restriction of chlorpyrifos use in sugarcane to soil and sett applications only could be considered. Because of this concern over foliar uses, the current MRL of 0.1 mg/kg should be given a temporary status.

Tomato – the current MRL for this commodity is 0.5 mg/kg. This was set by the PACC in 1976 with a 3 day withholding period. The Codex Alimentarius MRL is also 0.5 mg/kg. Present use patterns are either at planting or at the base of the plant (up to 150 g chlorpyrifos/100L as a drench or 2.5 kg chlorpyrifos/ha as a soil application) or foliar treatment throughout the season (up to 100 g chlorpyrifos/100L or 1000 g chlorpyrifos/ha). The 3 day withholding period is consistent with foliar, late season use.

The DowElanco use pattern tables stated that, depending on the pest, tomatoes can be given up to 4 applications at any stage after flowering or when pests such as aphids are present or pre-planting for pests such as grubs or wireworms. Wingless grasshopper control would generally require one or two applications at any crop stage. Seedling or transplant stage treatments generally use only one application.

No data on residues in tomatoes were presented for review. In the absence of such data and because of the 3 day withholding period, it is recommended that the present tomato MRL be given a temporary status with the intention of re-evaluating it on the presentation of residue data from foliar applications. At this stage it is considered acceptable to believe that early season applications or applications to the base of the plant should not result in chlorpyrifos residues greater than 0.5 mg/kg in the harvested tomatoes.

Tree nuts – The current MRL of 0.2 mg/kg was set by the PACC in 1990. There are no known label uses for chlorpyrifos on tree nuts but in 1996 the NRA granted an off-label permit for the use of Lorsban 500EC on walnut trees for codling moth and walnut scale control. A withholding period of 14 days was recommended for the permit which has now expired.

Although there are not known to be any registered uses for chlorpyrifos on tree nuts, deletion at this time is not considered necessary. Instead it is recommended that the MRL of 0.2 mg/kg for tree nuts be given a temporary status while appropriate residue data are generated (if required in the industry).

Vegetables [except asparagus; brassica vegetables; cassava; celery, potato; tomato] – the present MRL is *0.01 mg/kg was set by PACC in 1976. The value set implies that no quantifiable residues are expected as a result of the present use patterns. The vegetable use patterns permits rates of 25 and 35 g chlorpyrifos/100L and between 250 and 400 g chlorpyrifos/ha. Specific withholding periods are set for some crops, e.g. cole crops (5 days), and asparagus (14 days). Where a specific harvest withholding period is not set, a zero days withholding period would apply.
Another use pattern for vegetables is as a bait for crickets and this use pattern would not be expected to result in significant residues and to most likely meet the *0.01 mg/kg MRL.

It is generally considered that entries such as "Vegetables" are too broad and should be replaced wherever possible by specific group or commodity MRLs. However in the present situation, it was recognised that the MRL set was equivalent to a no-measurable residue situation.

In the DowElanco "Use Pattern Tables", vegetables, as a group, were said to usually be given one high volume spray at seedling or transplant stages. Wingless grasshopper control would require one or two applications at any crop stage. Carrots were said to be given rarely more than 2 sprays (per season) at any stage after foliage formation. Application was generally by high volume spraying. Cucurbits were stated to be generally given one spray with repeat applications as needed at any growth stage. Silverbeet was generally given a single application at any growth stage, but generally at the earlier periods of development. Chlorpyrifos baits generally were used only once in a season, but could be used more frequently if required, such use however should have negligible residue consequences..

The "Use Pattern Tables" indicated that control of cutworm was at the seedling or transplant stage. In such situations, it is expected that residues would not be of consequence (but see comments on lettuce below). Consequently the uses most likely to give residues of consequence may be wingless grasshopper and vegetable weevil control.

There was a limited amount of overseas data on various vegetable crops using use rates similar to those allowed under the Australian use pattern. These indicated that in root and bulb vegetables (carrots, potatoes, and onions), residues were generally ≤0.1 mg/kg for withholding periods of about 7 or longer days – the highest residues were in carrots given 4 applications of chlorpyrifos at 720 g/ha (approximately twice the maximum permitted label rate) where residues were 0.33 ppm at 1 and 0.05 ppm at 7 days withholding periods. At approximately the maximum rate, residues over the same period were ≤0.1 ppm.

In a series of US studies lettuce were treated at 1120 g chlorpyrifos/ha (5-9 treatments). After 7 day withholding periods, residues were frequently greater than 0.1 mg/kg. However, the use rate was considered excessive with respect to those permitted in Australia. The draft ECRP trade report did note that a South Australian survey in 1997 had found lettuce samples exceeding the current MRL. In the 9 violations referred to, five were related to use on lettuce seedlings, two to spray drift, and two to either or both ground application and soil spraying before planting. If this occurrence is repeated, the traditional logic that uses at planting should not result in residues of significance in the harvested product will have to be reviewed for at least lettuce.

In South African trials, beans and peas treated once with 240 g chlorpyrifos/ha had pod chlorpyrifos residues of 0.16 and 0.03 ppm respectively at a 1 day preharvest interval. By day 7, residues had decreased to <0.01 ppm in both cases. Shelled peas had chlorpyrifos residues <0.01 ppm on all occasions.

Establishment of group MRLs remains desirable as a way of allowing use of chlorpyrifos on a wide range of vegetables without having to generate specific data for each vegetable crop (extrapolation of data from the key members of the group would allow the group MRL to be set). However, there were insufficient data to do this. Additionally there was insufficient information to clearly identify which vegetable groups used chlorpyrifos treatments. The draft efficacy report stated chlorpyrifos was important for most vegetable crops against specific cricket and weevil pests and that many vegetable crops required protection against cutworm at the seedling or transplant stage. The draft report also stated that the State departments of agriculture/primary industries had nominated chlorpyrifos use on “Vegetables, including potatoes, corn, crucifers, cucurbits, tomatoes” as essential.

With the lack of knowledge about which specific vegetables were treated, establisment of specific group MRL could result in use on various vegetables being prohibited because no appropriate group MRLs were set. Given the likelihood that such uses may probably not be extensive, there would then be little possibility of relevant residue data being generated. This would unnecessarily stop the use of chlorpyrifos on specific vegetables and is not seen as desirable.

One 500 EC product label did however list specific vegetable entries, e.g. lettuce, silver beet, beans, peas, beetroot etc. Such entries were listed with a “nil” withholding period and would be taken to fall under the “Vegetables” MRL of *0.01 mg/kg. Such entries need to be supported by either residue data or relevant argument to show that the use will not result in measurable residues.

The current MRL for vegetables represents a “nil residue” situation most probably associated with treatments at planting/transplanting or baiting. With the apparent absence of any clear concerns over residue violations (apart from lettuce), it is recommended that the current entry “Vegetables [except asparagus; brassica vegetables; cassava; celery; potato; tomato] of *0.01 mg/kg be retained as a temporary value. This will allow opportunity for data to be generated for any vegetable treatments which result in measurable residues and which may need establishment of specific MRLs. Specific residue data on lettuce should be generated if use on that crop is to be retained.

Provided any late season uses are supported by the relevant residue data, it would be expected that the temporary *0.01 mg/kg MRL for early season use on vegetables could be given a permanent status as an outcome of the ECRP review.

Table 4 entries (Animal feed MRLs)

Cotton fodder, dry - 30 mg/kg and Cotton meal and hulls - 0.05 mg/kg - these MRLs were set by the NRA in 1996 on the basis of Australian cotton trials conducted with a 300 g chlorpyrifos/L ULV formulation (the trials are considered under "Cotton seed"). At the maximum label rate of 1500 g chlorpyrifos/ha with a single repeat treatment after 7 days, residues in the fodder were 479-722 mg/kg at day 0 and after 28 days, 2-14 mg/kg. For a single application only, day 0 residues were 375 and 642 mg/kg and day 28 residues, 1.4 and 0.8 mg/kg with all residue concentrations corrected for average control and average recovery.

With a 28 day grazing and feeding restraint for cotton fodder, the data support the current cotton fodder, dry MRL of 30 mg/kg (equivalent to a total dietary intake of 3 ppm when cotton fodder makes up 10% of the total diet). Feeding of higher percentages of cotton fodder (>10%) containing chlorpyrifos at the 30 mg/kg level would need to be monitored to ensure total dietary intakes of chlorpyrifos did not become excessive with respect to result in residues in animal commodities. It also needs to be recognised that "cotton fodder" refer to stubble etc. and not to cotton trash.

In US studies cotton seed was given multiple chlorpyrifos treatments at 1.12 kg chlorpyrifos/ha. The harvested seed was processed and chlorpyrifos residues in the fractions determined. The seed was sampled at 15 and 18 days after last treatment, compared to the 28 days grazing/feeding restraint set for the 300 g/l ULV product in Australia. Seed, meal, and hull residues were: 0.06, not detected, and not detected in one study and 0.11, 0.09, and not detected in another. Assuming decline of residues continued over time, it would be reasonable to expect that cottonseed with chlorpyrifos residues of 0.05 mg/kg or less would have residues of ≤0.05 mg/kg in the meal and hulls when a 28 day grazing/feeding restraint was observed.

The review of the cotton meal and hull data supported the current MRL of 0.05 mg/kg for those commodities and no change to that value is recommended.

Cereal, forage, and other crops such as pasture, lucerne, or forage crops used for animal fodder/forage – such uses are permitted by the current chlorpyrifos labels at various rates (e.g. 450 or 750 g chlorpyrifos/ha to control armyworm or locust pests). Ten day harvest and or 2 day grazing withholding periods are set in some product labels.

There are no Table 4 entries for such crops in the MRL Standard.

The DowElanco use pattern tables stated that lucerne, pasture, and forage crops would have up to three applications (per annum specified in some cases) depending on pest pressure with applications at any crop stage. Control of *orthopterans* (locust and grasshopper) generally requires one application (but this is dependent on the swarm size) which can be any time during the crop's development.

Apart from the already discussed cotton fodder and forage situation, no Australian fodder/forage data were presented. Alfalfa, pasture, and grass residue results from trials conducted overseas were presented.

In US alfalfa trials conducted with 1 to 4 treatments with final rates of 280 or 560 g chlorpyrifos/ha, chlorpyrifos residues in the green fodder 7 days after the last treatment were between 0.68 and 4.4 ppm. Fourteen days after last treatment, residues of 0.87 and 3.2 ppm were reported. Residues in alfalfa hay from these trials were 1.0-18 ppm for harvest withholding periods of 7-22 days.

Trials conducted on grasses in Germany with single applications at 720 g chlorpyrifos/ha showed that within one day of treatment, residues were between 3.2 and 30 ppm. Fourteen days after treatment, residues had declined to <0.02 to 3.7 ppm. Hay in the German trials was made from grass cut at 28-35 days after treatment and chlorpyrifos concentrations were between 0.06 and 0.94 ppm. A US report on chlorpyrifos residues in grasses after bait treatment at 2.24 kg/ha found chlorpyrifos residues of up to 0.27 ppm at a zero withholding period. After 7 days these had dropped to a maximum 0.07 ppm and to a maximum of 0.05 ppm after 14 days. Hay made from these grasses had maxima of 0.72, 0.28, and 0.36 ppm chlorpyrifos at 0, 7, and 14 day withholding periods.

In a Belgian trial on pasture, chlorpyrifos was applied twice at 350 g/ha and samples taken from 0 (+1 hour after last treatment) to 57 days afterwards. At zero time, there was 19 mg/kg chlorpyrifos which had fallen to 0.53 mg/kg after 15 days and 0.06 mg/kg by 29 days.

These results show that significant chlorpyrifos residues could be expected on occasion shortly after treatment and that the 2 day grazing withholding period set in many instances may not always be appropriate and could be in need of revision.

In the absence of residue data on the levels of chlorpyrifos in such crops, it is not possible to know what chlorpyrifos levels occur or when grazing/feeding of the crops could be allowed while ensuring animal commodity MRLs would be complied with. There is however the expectation that chlorpyrifos residues on forage and fodder will readily breakdown. Thus there is the belief, that while initial forage levels may be high, they will not persist, becoming, instead, of little significance within a relatively short time.

As it is not acceptable for labels to bear a residue restraint prohibiting grazing or feeding of major animal feeds, data are required on major animal feeds, e.g. cereal grains, legume animal feeds, grasses, grass-like plants, and pastures. Argument as to why certain animal feeds would not need MRLs/withholding periods or why setting an appropriate grazing restraint would ensure animals were not exposed to unacceptable chlorpyrifos levels could also be submitted.

For non-major crops, a label restraint is recommended in respect to grazing/feeding of animals in the absence of relevant residue data and MRL proposals.

Other issues

Crops which are listed on labels but for which there are no MRLs

In the examination of the product labels instances were found in which certain commodities (e.g. coffee, hops, and custard apple) were listed on some product labels without having appropriate MRLs set.

Residue data (or argument) to support retention of such entries on the label and to address the MRL situation appear necessary.

Fate of residues in storage and processing – Processing studies on apples, oranges, sugar cane, soybeans and cotton showed that chlorpyrifos residues tended to be associated with the surface or outer layers of the treated produce. Concentration factors were generally not large, indicative of minimal residue concentration during processing.

Laboratory processing studies with apples harvested immediately after the last of multiple chlorpyrifos treatments showed that chlorpyrifos residues peels contained the majority of the residue and that concentration factors were: peeled apples 0.1, peels 6.1, wet pomace 1.8 and 2.7, dry pomace 7.9 and juice 0.1 and 0.2.

In oranges given a single chlorpyrifos treatment, and analysed after a 14 day post harvest interval (PHI), a 1 to 2 fold concentration of chlorpyrifos residues was seen in the peel and pulp compared to the whole orange. Chlorpyrifos residues did not transfer to the orange juice in any significant amount. In a second orange study, oranges were harvested with PHIs of 24 to 251 days. The rind was identified as the site of major residue deposition with no significant (>0.01 mg/kg) chlorpyrifos residues in the flesh. The rind/fruit concentration factors over the entire sampling period were between 3 and 3.6.

When sugar cane was aerially treated once with chlorpyrifos, residues of chlorpyrifos remained essentially in the bagasse (0.08-1.77 ppm), residues in raw sugar, juice, and syrup, were all <0.05 ppm and generally <0.01 ppm.

Soybeans sprayed with chlorpyrifos were harvested after a 14 day PHI and processed to give hulls, meal, crude and refined soybean oil, and soap stock. Residues in the beans and hulls were low (<0.05 ppm) and no significant concentration was seen in the meal, oils, or soapstock.

Cotton given multiple treatments with chlorpyrifos and harvested after 15 days was processed into seed, trash, hulls, linters, meal, and crude and refined cottonseed oils. Residues were highest in the trash without significant concentration seen in the hulls, the linters, meal, or oils. Other studies confirmed that residues did not concentrate significantly in the cotton seed oil. These indicated that when chlorpyrifos residues in oilseed were low or even non-measurable, there was a persistent identification of low but measurable concentrations of chlorpyrifos in the crude oil.

Results from the processing studies did not identify processed products made from chlorpyrifos treated agricultural commodities as likely to result in residue violations in animal commodities as a result of livestock being fed processed by-products.

Environmental fate in soil – chlorpyrifos is adsorbed by soil and is expected to be immobile. Chlorpyrifos did not readily leach from examined soils.

Environmental fate via volatilization – radiolabelled studies have shown that on corn leaves, about 80% of the applied radioactivity (as carbon 14 chlorpyrifos) had volatilized into the air. Volatility loss is probably the major mechanism of chlorpyrifos dissipation from the surface of corn and possibly from other plants as well.

Fat solubility – Residue data examined in the evaluation and animal metabolism data identify chlorpyrifos as a fat soluble pesticide. This conclusion has also been taken by the Codex Alimentarius which defines chlorpyrifos as “Chlorpyrifos (fat-soluble).

Farm animal metabolism studies showed that chlorpyrifos residues in milk reached plateau values and, it would be expected, also in tissues. While residue concentration was seen in fat, the attainment of plateau values, animal transfer studies, depletion of residues when exposure ceased, and actual survey data on chlorpyrifos residue levels in animal commodities do not identify this area as being of significant concern. This is especially the case with livestock where the dietary intake of chlorpyrifos on a daily basis is not expected to be either high or frequent.

Residues in food in commerce or at consumption - The National Residue Survey (NRS) conducts an organophosphate screen on grain, animal commodities and other foods which allows detection and determination of chlorpyrifos residues.

Analyses for chlorpyrifos residues in grains over recent years showed that measurable chlorpyrifos residues occur infrequently and that most residues are less than the relevant MRL. The following results come from the period between July 1994 and June 1997. In 347 wheat bran samples, 2 had results between the MRL of 0.1 mg/kg and twice that value and 4 had residues between half the MRL and the MRL. Measurable residues were not found in the other samples. Only one of 8327 wheat samples had a measurable chlorpyrifos residue and that was less than one fifth of the MRL of 0.1 mg/kg).

No chlorpyrifos residues were reported in 263 onion samples. In 1995/1996, 4 of 32 nut samples had chlorpyrifos residues at between half the MRL of 0.02 mg/kg and the MRL value. In 1996/1997, no chlorpyrifos residues were reported in 116 nut samples.

In animal commodities, no chlorpyrifos residues were reported as found in whole eggs, goat, porcine, horse or poultry fats. A low frequency of residues below the relevant MRLs (except two sheep fat samples from a total of approximately 9000 analysed samples) were found in beef and ovine fat and whole milk. The survey results did not highlight any problem of significance in this area.

The Australian Market Basket Survey has regularly analysed for chlorpyrifos residues in foods in a table ready state. The Survey was conducted originally through the Commonwealth Department of Health and the National Health and Medical Research Council and now by the Australian New Zealand Food Authority.

Results for recent surveys showed that residues of chlorpyrifos in food were generally within relevant ANZFA MRLs and also generally not found as a high proportion of the foods analysed. While maximum values reported did show relevant MRLs on occasion were exceeded in a variety of the foods, celery, grapes, and strawberries were identified as frequently containing chlorpyrifos residues above relevant MRLs. This has resulted in changes to the ANZFA MRLs (grapes) or recommendations from the NRA that the celery MRLs be appropriately altered. The surveys have also shown that maximum bran results are often at the current cereal MRL of 0.1 mg/kg. This is not unexpected given chlorpyrifos's fat solubility.

Dietary intake calculations for infants, children, young adults and adults conducted in the Market Basket surveys have consistently shown the calculated intakes of all these groups is less than 10% of the chlorpyrifos ADI. This latter finding is consistent with the statement in the 1995 report of the FAO/WHO Joint Meeting on Pesticide Residues that dietary intakes of chlorpyrifos in Belgium and Finland were less than the then current Codex ADI.

Estimated daily intake – Results from the Australian market basket survey have consistently shown dietary intakes of chlorpyrifos are well below the chlorpyrifos acceptable daily intake value of 3.0 µg/kg body wt/day. The 1994 survey reported dietary intakes for a 95th percentile energy intake were between 1.4% (adult males) to 5.3% (2 year old child) of the ADI of 3.0 µg/kg body wt/day.

Labels – the residue evaluation identified a number of issues with current labels which indicate that a thorough review would be of value. A review could address relationships between rates expressed as g chlorpyrifos/hl and g chlorpyrifos/ha, the number of applications allowed, the intervals between applications, the consistency and appropriateness of harvest and grazing period withholding intervals and animal re-entry periods after chlorpyrifos treatments and the presence of commodities in the labels for which no MRLs have been set. All registered and proposed use patterns should be examined by product owners to update and align their product labels.

Non-food uses – chlorpyrifos can be used in a variety of applications such as termite control, insect control in buildings (domestic and commercial, including food processing plants), use on turf and golf greens, *Macrocarpa* hedges etc. Provided the label instructions are followed, such situations are not expected to result in any significant transfer of chlorpyrifos into food commodities. There are other related or similar uses where animal exposure might be possible, e.g. treatment of animal housing or mosquito control. Adherence to the label instructions in such cases is again expected to result in negligible residues in food commodities.

4.3 Recommendations

Changes to the MRL Standard

The following changes to the chlorpyrifos entries in Table 1 of the MRL Standard are recommended

Codex Classification	Commodity	NRA MRL
Chlorpyrifos		
DELETE:		
VS0621	Asparagus	0.5
FI0327	Banana	*0.1
VB0040	Brassica (cole or cabbage) vegetables, Head cabbages, Flowerhead brassicas	0.5
MO0812	Cattle, Edible offal of	2
MM0812	Cattle meat [in the fat]	2
GC0080	Cereal grains [except sorghum]	0.1
FC0001	Citrus fruits	0.5
DF0167	Dried fruits	2
FB0269	Grapes	1
SO0088	Oilseed	0.01
MO0888	Pig, Edible offal of	0.1
MM0888	Pig meat [in the fat]	0.1
FI0353	Pineapple	0.5
FP0009	Pome fruits	0.2
MO0822	Sheep, Edible offal of	0.1
MM0822	Sheep meat [in the fat]	0.1
GC0651	Sorghum	3
FS0012	Stone fruits	1
GS0659	Sugar cane	0.1
VO0448	Tomato	0.5
TN0085	Tree nuts	0.2
	Vegetables [except asparagus; brassica Vegetables; cassava; celery; potato; tomato	*0.01
ADD:		
VS0621	Asparagus	T0.5
FI0327	Banana	T0.5
VB0040	Brassica (cole or cabbage) vegetables,	

	Head cabbages, Flowerhead brassicas	T0.5
GC0080	Cereal grains [except sorghum]	T0.1
FC0001	Citrus fruits	T0.5
DF0167	Dried grapes (currants, raisins, and sultanas)	2
MO0105	Edible offal (mammalian)	T0.1
FB0269	Grapes	T1
MM0095	Meat [mammalian] [in the fat]	T0.5
SO0088	Oilseed (except cottonseed)	T0.05
FI0353	Pineapple	T0.5
FP0009	Pome fruits	T0.5
GC0651	Sorghum	T3
FS0012	Stone fruits	T1
GS0659	Sugar cane	T0.1
VO0448	Tomato	T0.5
TN0085	Tree nuts	T0.2
	Vegetables [except asparagus; brassica Vegetables; cassava; celery; potato; tomato	T*0.01

Notes: The residue definition for all chlorpyrifos MRLs remains unchanged as "Chlorpyrifos". The banana MRL is an NRA Chemistry and Residue Evaluation group recommendation made in October 1997.

Retention of temporary MRLs will depend on supply of relevant and appropriate, preferably Australian, residue data or argument.

Temporary MRLs are recommended to expire on the 31st December 2001 or at a date to be decided by the NRA.

It is recommended that the following MRLs in the NRA's MRL Standard remain unchanged:

Table 1 entries:	**Table 1 entries (continued):**
Avocado (0.5 mg/kg)	Milks [in the fat] (0.2 mg/kg)
Cassava (*0.02 mg/kg)	Passionfruit (*0.05 mg/kg)
Celery (T5 mg/kg)	Potato (0.05 mg/kg)
Cottonseed (0.05 mg/kg)	Poultry, Edible offal of (0.1 mg/kg)
Cottonseed oil, crude (0.2 mg/kg)	Poultry meat [in the fat] (0.1 mg/kg)
Eggs (*0.01 mg/kg)	Strawberry (0.05 mg/kg)
Ginger, root (*0.01 mg/kg)	**Table 4 entries:**
Kiwifruit (2 mg/kg)	Cotton fodder, dry (30 mg/kg)
Mango (*0.05 mg/kg)	Cotton meal and hulls (0.05 mg/kg)

Other recommendations

-To ensure compliance with animal and poultry commodity MRLs, cattle should not be consistently exposed to more than 30 ppm chlorpyrifos in the feed, and sheep, pigs and poultry to not more than 10 ppm chlorpyrifos in the feed. In the event of such exposure, withholding from slaughter intervals need to be observed to allow any tissue residues to deplete to acceptable levels.

- The prohibition on some labels for the use of chlorpyrifos treated grapevine leaves for human consumption should be removed. This is in the expectation that consumption of grape leaves is not significant and that chlorpyrifos residues which might be on the leaves are either negligible or do not result in adverse effects,

- As it is not acceptable for labels to bear a residue restraint prohibiting grazing or feeding of major animal feeds, data are required on cereal grains, legume animal feeds, grasses, grass-like plants, and pastures. Alternatively the possibility of setting grazing restraints which would result in chlorpyrifos residues in these feeds being negligible or of little consequence could be considered. This latter alternative has clear advantages.

- For non-major crops which can be used as animal fodder or forage, a label restraint is recommended in respect to grazing/feeding of animals in the absence of relevant residue data or argument.

- It is recommended that where commodities identified on a label use pattern have no MRL entry, argument or residue data must be supplied to allow retention of the use and establishment of an MRL. Coffee, hops, custard apple, and loquats have been identified as such commodities.

- It is recommended that all product labels be updated to address issues such as relationships between rates expressed on a g/hl and g/ha basis, the number of applications allowed and the intervals between applications, and consistency and appropriateness of harvest and grazing period withholding intervals and animal re-entry periods after chlorpyrifos treatments.

- It is recommended that all cotton uses have a 28 day harvest withholding period and a 28 day cotton fodder/grazing period after treatment established as recommended by the Residues Evaluation Section of the NRA in October 1996.

4.4 Issues

During the evaluation of the data presented, several issues were identified as needing further comment via the ECRP progress. In most instances the issue has arisen because of either lack of appropriate data or because of doubt about the current use pattern. The issues, plus some background, are:

Animal grazing and feeding withholding periods

Numerous instances were noted where label grazing withholding periods of 2 days were set. No data to justify this situation were presented and use patterns such as locust control could be expected to result in substantial residues for a period of at least several days after treatment. US information indicated grazing withholding periods of several weeks or more have been established or recommended.

While the 2 day grazing withholding period is not known to have resulted in unacceptable residue situations, it has not been justified at this time.
A permanent residue restraint on the grazing/feeding of major animal feeds is unlikely to be adhered to and is not a viable option

A key question is “What is the level of chlorpyrifos residues in forage after chlorpyrifos treatment?” as this allows the decision to be made as to which feeding level should be used to set the animal commodity MRLs.

There is no Australian data base giving a comprehensive picture of chlorpyrifos residue levels in animal forage crops after treatments and cotton forage data have required a 28 day grazing withholding period being set. Overseas data from grass, pasture, and wheat using use rates similar to those used in Australia show that residues at day 0 or 1 were 3.2-30 ppm (grasses), and 30-50 ppm (pasture).

While this data base is small it does indicate that day 2 residue values would probably be distributed over a range of perhaps 3 to 50 ppm and declining with time. It is not possible at this time to recommend with complete confidence that a 2 day grazing withholding period is appropriate to ensure compliance with the proposed meat mammalian, in the fat MRL of 0.5 mg/kg. Balanced against this however is the realisation that the surveys conducted in Australia show that chlorpyrifos residue violations in livestock appear to be of no major concern.

It is necessary that data be generated to allow appropriate grazing withholding periods to be set for the relevant chlorpyrifos use patterns.

Such periods can be realistically set. Cattle feeding studies showed that levels of chlorpyrifos in the feed of up to 30 ppm could be tolerated via setting of specific cattle meat and offal MRLs. Exposure to higher levels of chlorpyrifos in the feed are not thought likely to occur frequently and can be controlled by appropriate feeding periods with chlorpyrifos free feed.

The major controlling factor apart from good agricultural practice, could well be the need to ensure that residues in exported cattle meat commodities complied with the relevant tolerances or MRLs of the importing countries. Again, use of appropriate withholding from slaughter intervals should allow this to be achieved. Appropriate “decline” feeding studies could be needed for this to be confirmed when sensitive markets were concerned.

Withholding from slaughter intervals

While the recommended animal commodity MRLs are expected to be complied with under the present use patterns, there is always a possibility that livestock could be exposed to chlorpyrifos residues at concentrations greater than expected and which result in the animal commodity MRLs possibly being exceeded. There is also the situation where tolerances set in overseas markets for chlorpyrifos are less than those recommended in Australia. Because chlorpyrifos is metabolised in animal tissues, setting of appropriate withholding from slaughter intervals would allow both these situations to be resolved.

Depletion studies for cattle showed that when exposed to chlorpyrifos for 30 days at 100 ppm (this is an excessive exposure and unlikely to be met in either feed lots or grazing situations) and then placed on a chlorpyrifos free diet, omental fat residues went from 2.3-2.9 ppm to 0.15-0.7 ppm in 14 days and to 0.02-0.2 ppm in 28 days. In milk, depletion appeared more rapid, cream chlorpyrifos residues of 0.1 mg/kg from feeding at 30 ppm for 14 days went to <0.1 mg/kg within 3 days of stopping chlorpyrifos exposure. Rapid residue depletion from fat in pigs feed chlorpyrifos at 10 ppm for 30 days was also reported. Residues in the fat depleted from 0.2 ppm to ≤0.03 ppm in 7 days of feeding on chlorpyrifos free feed.

Consequently a withholding from slaughter interval of 28 days would be expected to allow satisfactory residue depletion in most likely situations. The important fact being that chlorpyrifos residues should deplete to low, even non-quantifiable concentrations, within realistic times once exposure to the chlorpyrifos ceases.

Vegetables - current general entry

There is presently a general "Vegetable" entry for chlorpyrifos (with some specified exclusions) with an MRL of *0.01 mg/kg. Given the wide range of products chlorpyrifos can be used on, the presence of such an MRL can be understood, especially as it requires chlorpyrifos residues to be "non-measurable". However limited supporting data were presented to support the MRL. Furthermore, there is a general belief that large, unqualified entries such as "vegetables" are no longer acceptable because of: the desirability of preventing overuse of the pesticide and the preference for specific commodities having their own MRLs. Additionally, group entries can on occasion lead to artificially high dietary intake calculations. These can cause unnecessary health concerns, although data from dietary surveys can and do ameliorate these estimates.

The residue evaluation has recommended the current vegetables MRL be retained with a temporary status as the MRL of *0.01 mg/kg is equivalent to a nil measurable residue situation. This will allow continuation of many minor uses as long as the use results in residues complying with the MRL. Given that use of chlorpyrifos was seen as essential by state agricultural authorities, such an action seems appropriate.

As the use pattern associated with this MRL is for seedling/transplant treatment or bait use, the value of *0.01 mg/kg remains appropriate. Should evidence show that such use does not result in negligible residues, residue data would be needed to allow appropriate vegetable or vegetable group MRLs to be set.

Where there is later season use on vegetables, and an accompanying possibility of measurable residues at harvest, the force of the temporary status will be to cause generation of appropriate residue data to support the particular uses. This has already been done for asparagus, brassica vegetables, cassava, celery, potato, and tomatoes and appropriate MRLs set on the basis of residue data or argument

Current use patterns

Examination of the registered labels for chlorpyrifos formulations showed that frequently there was little information on the number of applications and intervals between applications and that there were also sometimes minor differences between use rates for different formulations. Additionally some of the labels were lengthy, reflecting the wide number of uses of chlorpyrifos. Given the long registration history of this active, such a situation is not unexpected. It is also worth noting that the review of the residue data showed the depletion of chlorpyrifos continued over time with a rapid reduction in residue concentrations often seen in the first few days after application. While measurable residues were frequently found for 7 or more days after final treatment, chlorpyrifos is not seen as a persistent chemical.

DowElanco provided up-to-date information on the use of the Lorsban 500 EC and 500 WP formulations. This showed there is current information on the number of applications and use patterns available.

With the relatively lengthy age of many of the current chlorpyrifos labels, opportunity should be taken to revise all labels so that they reflect current good agricultural practice.

Consumption of grapevine leaves

The labels of several chlorpyrifos formulations bear a restraint on the use of chlorpyrifos treated grapevine leaves as human food. The chlorpyrifos residue review has recommended that there are reasonable reasons for deleting this prohibition. Such a deletion is on the basis of argument rather than data. While the risk to consumers is considered negligible, it needs to be decided if the removal of a prohibition designed to specifically protect public health is acceptable on such a basis.

Tomatoes

No Australian or overseas residue data were presented and the recommendation made that the present MRL (0.5 mg/kg, the Codex Alimentarius MRL value), be given a temporary status while relevant residue data are generated. The current label harvest withholding period for tomatoes is 3 days.

Because a short withholding period for tomatoes may be needed, there is a need to confirm that the 3 day withholding period is still appropriate.

Mosquito control

Mosquito control use could have a potential for residues in animals allowed to graze or feed on treated areas. Label requirements that animals are not allowed into the treated areas for at least 24 hours or until the spray deposit is dried are clearly designed to minimise residue uptake and need to be adhered to.

In the absence of data on the residue levels at zero or 24 hours time, it is not possible to know which, if either, of these times is appropriate.

4.5 Australian Use Patterns

A consolidated use pattern summary is listed as an Attachment to this evaluation. The summary comes from examination of the labels provided with the ECRP submissions or which were available to the NRA. The use pattern summary also made use of the chemical industry surveys and use pattern tables in the "Chemical Industry Surveys" volume submitted in DowElanco's ECRP submission.

Crops in which chlorpyrifos use patterns have been identified are:

<u>Fruits and vegetables</u> - apples, avocado, bananas, carrots, cassava, citrus, cole crops or brassica vegetables (including cabbage, cauliflower, brussels sprouts and broccoli), capsicum, cucurbits, custard apple, egg plant, ginger, grape vines, kiwifruit, leafy crucifers, loquat, mango, passionfruit, pears, pineapple, pome fruit, potatoes, silver beet, stone fruit, strawberries, tomatoes, and vegetables (includes specific vegetable entries found on some labels). Seed dressings are also specified for some commodities.

<u>Field crops and pasture</u> - barley, broad beans, cereals, chickpeas, clover seed crops, coffee (non bearing), cotton, establishing perennial pastures, field peas, forage crops, hops, improved annual pastures, lucerne, lucerne pastures seed crops, lupins, maize, millet, oats, oilseeds, pasture, rice, rye, sorghum, sugarcane, tobacco, triticale, wheat, and young plants of oil seeds. Seed dressings are allowed for cereal and oil seeds.

<u>Miscellaneous uses</u> - animal hides and skins, container plants, insect control in agricultural, domestic, commercial, and industrial areas, mosquito control in vegetation and polluted water impoundments, protection of existing buildings and reticulation systems against termites, soil treatments as termite protection, termite protection of buildings (houses, factories, industrial and commercial buildings public premises, and farm buildings) under construction, macrocarpa hedges, turf and lawn insect protection

Applications can be foliar, soil applied, bait, or seed dressing.

Comments on specific uses or products

Frequency of applications and intervals between applications

The examination of the labels showed that frequently the number of applications and intervals between applications were not always given. Any revision of the chlorpyrifos labels should reconsider and address as appropriate such matters.

This matter has already been noted with the NRA's 1996 recommendation that the chlorpyrifos MRL for celery be amended from *0.05 mg/kg (as a vegetables entry) to a temporary MRL of 5 mg/kg following use of Lorsban 500EC. The review stated the product label be amended to include the maximum number of applications and retreatment intervals. A similar issue was identified in the NRA's 1996 recommendation that the chlorpyrifos grape MRL be amended from *0.01 mg/kg to 1 mg/kg.

Direct animal applications

National Health and Medical Research Council records show that chlorpyrifos (as Dursban 250E) was used as a cattle dip and lice spray (1 December 1987. Correspondence from the Secretary, Pesticides and Agricultural Chemicals Committee to the Secretary, Technical Committee on Veterinary Drugs.) and that in 1970, a tolerance of 2 mg/kg for chlorpyrifos in the fat of meat of cattle was established. Dow Chemical correspondence from the same period stated that the product label contained a 3 day slaughter interval after tick treatment and a 21 day slaughter interval when the product was used for lice control. A 0.2 mg/kg MRL for milk (fat basis) was added in 1973 and in 1974, an MRL of 0.1 mg/kg for fat of meat of pigs was established (Pesticides and Agricultural Chemicals Committee meeting, Aug 1974, item 22. Details not provided as to the use pattern.)

An MRL of 0.1 mg/kg for fat of meat of sheep and poultry was set in 1983 to cover use of chlorpyrifos as a termiticide in and around farm buildings (Pesticides and Agricultural Chemicals Committee meeting Feb 83, item 7.14). An MRL of *0.01 mg/kg for chlorpyrifos in eggs was set at the same time. An MRL of 0.1 mg/kg for chlorpyrifos in edible sheep and poultry offal has also been established but details about these were not found.

Examination of the NRA's registered product database indicated there were no chlorpyrifos products currently registered for direct use on cattle, sheep, or pigs. Consequently, it is expected that the only animal exposure to chlorpyrifos will be by grazing or feeding of treated crops or by uptake through being housed in chlorpyrifos treated animal quarters or the like. Spray drift contamination of crops could also be a source of animal exposure. In this case, which is a misuse situation, such exposure should be intermittent and of short duration. This could lead to transient increases above relevant MRLs. However these should be of minimal residue impact.

Current label requirements for termite control in existing buildings and for treatment of areas where animals live state that livestock are not allowed into treated areas for at least 24 hours or until the spray deposit has dried. Both situations would have the opportunity to allow a transient residue transfer to livestock. It would be desirable if a single re-entry period could be agreed on.

Chlorpyrifos products registered for use on household pets are not expected to result in residues in agricultural commodities and are not considered further in this evaluation

Termiticide and turf and grass uses

Termiticide use patterns and use on turf or grasses where appropriate animal feeding restraints are established are not considered likely to result directly in significant chlorpyrifos residues in food. Consequently such uses were not considered to any great extent in this evaluation. As label reregistration takes place, it should be ensured that the appropriate animal feeding and exposure restraints are included in all labels.

Uses in non-food situations

Current labels permit a number of non-food uses of chlorpyrifos. These include domestic or public places uses, commercial and industrial area uses, uses on hides/skins and for mosquito control on vegetation and polluted water impoundments. Provided the label restraints prohibiting use on and exposure of food or food utensils are complied with, residues in foods from uses in such places should be negligible and of low concern. Use on hides and skins is not expected to be a food residue issue.

Mosquito control use could have a potential for residues in animals allowed to graze or feed on treated areas. Label requirements that animals are not allowed into the treated areas for at least 24 hours or until the spray deposit is dried are clearly designed to minimise residue uptake and need to be adhered to. In the absence of evidence to show which of the two restrictions leads to lower residues or that the use leads to unacceptable residue levels, no change to either of these restrictions has been recommended at this time

Household use

Cockroach baits containing chlorpyrifos are available for household use. The baits are contained and the label directs that food contact is not allowed. Similarly chlorpyrifos impregnated paper is registered for control of moths and other pests in household cupboards, drawers, etc.

Provided the label instructions are observed, such use patterns are not expected to result in residues of significance in food. Consequently these types of products are not considered further.

LORSBAN* 500 W INSECTICIDE

Information contained in the Use Pattern table material supplied by DowElanco for the 500W product indicated the 500W formulation was also used as a seed dressing. This use does not appear to be referred to on the 500W label examined.

Permits

A trial permit has been issued for use of chlorpyrifos on bananas and, according to the chlorpyrifos efficacy report, permits have also been issued for use of chlorpyrifos in black currents, capsicums (young plants only), compost heaps near orchards, cucumber, grape, lettuce (seedling stage), onions (seedling stage), ornamentals, pine and eucalyptus plantations, railway wagons for transporting rice, rice, silverbeet, stonefruit, tomato, and turf.

Uses on capsicums as young plants, compost heaps, and onions at the seedling stage, pine and eucalyptus plantations, and on ornamentals would not be expected to have residue consequences. However, information in the draft trade report noted that excessive chlorpyrifos residues had been found in lettuce treated at seedling and earlier stages. If this is found to be a common occurrence with early vegetable treatments, the entire issue of vegetable MRLs for that use pattern would need to be revisited. The Appraisal section of this report has recommended that relevant data on chlorpyrifos residues in lettuce be generated.

Provided treated turf or clippings from treated turf were not used as animal feeds, that use would also be expected to have no commodity residue impact. Although data were not presented, such uses could be retained as residues arising from them are expected to be negligible.

Retention of other uses (for which no appropriate MRLs are set) would be dependent, in the first instance, on the supply of residue data or argument to support or establish the appropriate MRLs.

4.6 National Registration Authority MRL's

The present Table 1 entries for chlorpyrifos in the MRL Standard are (Codex commodity classification, commodity, MRL (mg/kg) as follow:

Codex Classification	Commodity	NRA MRL
VS0621	Asparagus	0.5
FI0326	Avocado	0.5
FI0327	Banana	T0.5
VB0040	Brassica (cole or cabbage) vegetables, Head cabbages, Flowerhead brassicas	0.5
VR0463	Cassava	*0.02
MO0812	Cattle, Edible offal of	2
MM0812	Cattle meat [in the fat]	2
VS0624	Celery	T5
GC0080	Cereal grains [except sorghum]	0.1
FC0001	Citrus fruits	0.5
SO0691	Cotton seed	0.05
OC0691	Cotton seed oil, crude	0.2
DF0167	Dried fruits	2
PE0112	Eggs	*0.01
HS0784	Ginger, root	*0.01
FB0269	Grapes	1
FI0341	Kiwifruit	2

FI0345	Mango	*0.05
ML0106	Milks [in the fat]	0.2
SO0088	Oilseed	0.01
FI0351	Passion fruit	*0.05
MO0818	Pig, Edible offal of	0.1
MM0818	Pig meat [in the fat]	0.1
FI0353	Pineapple	0.5
FP0009	Pome fruits	0.2
VR0589	Potato	0.05
PO0111	Poultry, Edible offal of	0.1
PM0110	Poultry meat [in the fat]	0.1
MO0822	Sheep, Edible offal of	0.1
MM0822	Sheep meat [in the fat]	0.1
GC0651	Sorghum	3
FS0012	Stone fruits	1
FB0275	Strawberry	0.05
GS0659	Sugar cane	0.1
VO0448	Tomato	0.5
TN0085	Tree nuts	0.2
	Vegetables [excepting asparagus; brassica vegetables; cassava; celery, potato; tomato	*0.01

These MRL values are the same as Australian legal MRLs set by the Australian New Zealand Food Authority (ANZFA) except in a small number of cases that are being or will be addressed through the normal processes established between ANZFA and the NRA.

The banana MRL is an NRA Chemistry and Residue Evaluation group recommendation made in October 1997. The celery MRL is an NRA recommended change made in 1996 as a result of chlorpyrifos residue data results.

The MRL Standards Table 4 entry (animal feed commodities) is:

AM0691	Cotton fodder, dry	30
	Cotton meal and hulls	0.05

The residue definition for chlorpyrifos is: Chlorpyrifos.

4.7 Metabolism Trials

4.7.1 Animal metabolism

Rats

Wistar strain white rats (approximately 200 g) were given a single dose (stomach tube) of chlorpyrifos labelled in the 3 and 5 positions with chlorine 36 at a rate of 10 mg chlorpyrifos/animal (ref.1). The rats were then killed at intervals over 480 hours and tissues examined for radioactivity. Four hours after treatment radioactivity was found in all tissues with high concentrations in liver, kidney, lungs and fat. After 72 hours, radioactivity had declined in all tissues with the highest amount at that time in the fat (at approximately 1/10th of the value at 4 hours). Residue depletion continued in all tissues over the remainder of the study. Approximately 90% of the radioactivity was eliminated in the urine, and about 10% in the faeces with the majority eliminated within the first 42 hours. Calculated tissue half-lives were: liver about 10 hours, kidney about 12 hours, muscle about 16 hours and fat about 62 hours. These results showed that fat was a site of residue deposition and that metabolism there was relatively slow compared to metabolism in other sites.

Two male rats (Sprague-Dawley, about 200g) were given single oral doses of chlorpyrifos (3.8 mg, carbon 14 labelled in the 2 and 6 ring positions) and 3,5,6-trichloro-2-pyridinol (1.4 mg, carbon 14 label assumed to be in the equivalent ring positions) (ref. 2). The dimethyl ester was also administered to rats but its fate is not considered further other than to note it behaved similarly to chlorpyrifos. Blood, faeces, and urine were collected over 72 hours when the rats were killed and tissue samples taken for analysis. Expired air was also monitored for carbon 14 activity.

Peak blood activity occurred at about 1 and 3 hours (3,5,6-trichloro-2-pyridinol and chlorpyrifos respectively). Of the chlorpyrifos, 83-87% (68-70% in urine, 14-15% in the faeces, and 0.14-0.89% in the respired carbon dioxide) was eliminated by 72 hours. For the 3,5,6-trichloro-2-pyridinol, 77-81% (73-76% (urine), 6-7% (faeces), and 0.3-0.6% (respired air)) was eliminated by that time. The 3,5,6-trichloro-2-pyridinol was identified as the major metabolite. Tissue residue levels at 72 hours were (chlorpyrifos, 3,5,6-trichloro-2-pyridinol, ppm): Liver 0.15-0.19, 0.12-0.14; kidneys 0.11, 0.07-0.08; muscle 0.11-0.12, 0.12-0.25; and fat 0.71-0.81 (3,5,6-trichloro-2-pyridinol in fat not determined). The individual chlorpyrifos values found in the tissues/organs of the two rats were given in a separate report (ref. 3). These results indicate chlorpyrifos as the residue of concern and fat as the site of maximum residues.

Lactating goats

^{14}C-chlorpyrifos (labelled in the 2 and 6 ring positions) in gelatin capsules was administered to two lactating goats twice a day after milking for 10 days (ref. 4 and ref. 5). Average feed consumptions were 2 and 1.56 kg/day to give dose rate equivalents of 16 and 21 ppm in the feed. During acclimation, each goat consumed about 2000 g/day. The feed consumption of goat 1 was consistent during the treatment phase, while that of goat 2, showed some variation (700-2000 g/day). .Milk, urine, and faeces were collected over the dosing period. The goats were killed 24 hours after the last dose and tissues taken for analysis.

Total recoveries of carbon 14 in each goat as a % of the dose given were: milk 0.14 and 0.05%, urine 75.5 and 85.1%, faeces 3.5 and 3.7%, tissues and gut contents 1.9 and 1.4% for total recoveries of 81 and 90.2%. No significant losses of carbon 14 as $^{14}CO_2$ were recorded.

Total carbon 14 residues in urine reached a plateau of about 15-18 ppm (approximately 2-6% of the total dose) after 116 hours. Residues in the faeces reached plateau values of about 1 ppm (approximately 0.1-0.5% of the total dose) after 93 hours. The major portion of the excreted ^{14}C-labelled material was 3,5,6-trichloro-2-pyridinol and its β-glucuronide conjugate.

The identity of tissue residues was (% of total activity, ppm for each animal):

Residue	**Fat (composite)**		**Liver**		**Kidney**	
Chlorpyrifos	74%, 0.06	79%, 0.14	3.5%, <0.01	0.2%, <0.01	0.7%, <0.01	1.1%, <0.01
3,5,6-trichloro-2-pyridinol	23%, 0.01	19%, 0.02	85%, 0.07	82%, 0.10	92%, 0.11	92%, 0.15

a. Other residues (unknowns, ether extractables after hydrolysis, and non-extractables) were all £0.02 ppm (0.4-9.6%) and considered to be of minor importance.

In milk the following distributions of radiolabelled material were seen:

Day and time	**Goat 1 (16 ppm in the feed)**		**Goat 2 (21 ppm in the feed)**	
(am or pm)	**ppm**	**% of total dose**	**ppm**	**% of total dose**
1 pm	0.004	0.001	0.002	0.000
2 am	0.013	0.008	0.015	0.003
2 pm	0.018	0.005	0.021	0.001
3 am	0.015	0.008	0.020	0.003
3 pm	0.019	0.005	0.025	0.002
4 am	0.017	0.009	0.020	0.003
4 pm	0.016	0.005	0.022	0.002
5 am	0.016	0.009	0.015	0.002
5 pm	0.016	0.004	0.024	0.002
6 am	0.015	0.007	0.018	0.003
6 pm	0.014	0.005	0.018	0.002
7 am	0.023	0.011	0.028	0.004
7 pm	0.019	0.008	0.022	0.001
8 am	0.021	0.009	0.029	0.001
8 pm	0.024	0.008	0.046	0.002
9 am	0.017	0.009	0.031	0.004
9 pm	0.019	0.005	0.033	0.003
10 am	0.017	0.009	0.020	0.003
10 pm	0.020	0.005	0.029	0.002
11 am	0.013	0.008	0.026	0.004
11 pm	0.010	0.003	0.015	0.001
	Total	0.14%	**Total**	0.05%

Carbon 14 residues in the milk show that plateau values were reached during the feeding period:

Identification of the milk residues was reported separately (ref. 6) with the following results reported on residues extracted from the milks sampled (as % total activity, ppm).

	Goat 2	**Goat 1**	**Goat 2**	**Goat 2**
Treatment day	**3**	**7**	**7**	**10**
Chlorpyrifos[a]	67%, 0.017	66%, 0.015	74%, 0.021	71%, 0.021
3,5,6-trichloro-2-pyridinol[a]	20%, 0.003	15%, 0.002	13%, 0.002	16%, 0.003
Non-extractable	13%, 0.003	17%, 0.004	13%, 0.004	11%, 0.003
Total hydrolysable to 3,5,6-trichloro-2-pyridinol[b]	-	>92%, 0.012	>94%, 0.015	

Total carbon 14 extracted from the milk using four extraction procedures were:

	Goat 2	**Goat 1**	**Goat 2**	**Goat 2**
Treatment day	3	7	7	10
% of ^{14}C extracted by:				
benzene/alkaline	67	65	72	70
alkaline/hydrolysis	-	97	96	-
hexane/neutral(ACR 80.5)	-	55	63	-
benzene/acid (ACR 71.2)	87	83	87	89

Overall, these milk results showed that in goats fed for 10 days with chlorpyrifos at 16 or 21 ppm in the feed, residues plateaued in milk (from approximately 3 days after the first dose). The chlorpyrifos concentrations in the tissues are not considered excessive based on the levels fed. The study also identified chlorpyrifos was the residue of importance in milk and fat.

In a literature report (ref. 7), radiolabelled chlorpyrifos (carbon 14 in the 2 and 6 ring positions) was applied dermally behind the shaven right shoulder of each of two goats. This gave a dose rate of 22 mg chlorpyrifos/kg of body weight (goats were approximately 15-18 kg in weight at start of acclimitation period). The animals were killed approximately 18 hours after dosing when the blood radioactivity levels at 16 hours post dose had declined from the maximum blood levels seen at 12 hours post-dose in both animals. Blood, tissue, and non-extractable solids were analysed.

Chlorpyrifos equivalents reported were (ppm): liver 0.6 and 0.36; kidney 0.73 and 0.44; heart 0.48 and 0.25; omental fat 0.83 and 0.40; and skeletal muscle 0.09 and 0.05. Of this radioactivity, 80-96% was extractable. Chlorpyrifos and chlorpyridinol were identified as the major carbon 14 residues. Levels reported were (as ppm chlorpyrifos equivalents and percentage of the total carbon 14 residue):

Matrix	Chlorpyrifos	Chlorpyridinol	Unidentified
Liver	Not detected	0.33 ppm, 54%	0.03 ppm, 3.9%
Kidney	0.06 ppm, 8.7%	0.44, 60%	0.02 ppm, 2.6%
Heart	0.25 ppm, 53%	0.1 ppm, 22%	0.01 ppm, 2.9%
Fat	0.65 ppm, 78%	0.08 ppm, 9%	Not detected
Muscle	0.02 ppm, 22%	0.03 ppm, 32%	0.02 ppm, 19%

These results were stated to be consistent with similar studies seen in poultry and cattle following oral treatments and confirmed the fat solubility of chlorpyrifos.

Lactating cow

A literature report (ref. 8) presented stated that a Holstein cow was fed chlorpyrifos at 5 ppm in the feed for 4 days (daily feed ration 50 pounds). Milk was taken before, during, and for four days after the feeding period. Urine and faeces were similarly collected.

No residues of chlorpyrifos were reported detected in the milk or urine (<0.04 ppm chlorpyrifos). Chlorpyrifos residues were detected in faeces taken from the latter period of the trial. Approximately 63% of the chlorpyrifos fed was accounted for in urine as diethyl thiophosphate and diethyl phosphate.

The results indicated that the presence of chlorpyrifos in the forage at levels below 5 ppm should not result in measurable milk residues and that the cow was able to metabolise and excrete ingested chlorpyrifos.

4.7.2 Plant metabolism

Apples

In a draft description/evaluation of a DowElanco study (ref. 9), the following observations were recorded. Chlorpyrifos labelled with carbon 14 in the 2,6 ring position was formulated as a Lorsban 50W product and sprayed twice on to an apple tree with 9 days between applications. The concentration of radiolabelled chlorpyrifos was 180 mg/300 ml of water. The tree had received 7 applications of unlabelled chlorpyrifos previously according to GAP. Fruit was harvested 14 days after the last treatment. Four apples were analysed separately and homogenates of 14, 12, and 25 apples prepared and analysed. Peel, flesh, seed, and whole apple results were reported. The actual trial report was not submitted with the DowElanco ECRP submission.

The distribution of radioactivity in the apples was reported as follows:

Distribution of carbon 14 activity in apple samples 14 days after two applications of a carbon 14 chlorpyrifos containing LORSBAN 50W solution, given with a 9 day interval between the applications.

No. of apples		**^{14}C activity, ppm chlorpyrifos equivalents**		
	Peel	**Flesh**	**Seed**	**Apple**
1	0.60	0.001	0.001	n/a
1	1.34	0.005	0.001	n/a
1	1.86	0.003	0.002	n/a
1	0.76	0.005	0.0005	n/a
14	0.72	n/a	n/a	0.09
12	0.86	n/a	n/a	0.09
25	n/a	n/a	n/a	0.14

n/a not available

Acetone extraction of the peel was reported to release 57.3% of the carbon 14 residue and methanol extraction, 59.8%. Alkaline hydrolysis released a further 38.5 and 38.6% of the carbon 14 residue respectively. Chlorpyrifos was identified as the major residue with 36% of the total radioactivity extracted (0.05 ppm). 3,5,6-Trichloro-2-pyridinol was present in free and bound forms at a concentration of <0.01 ppm. Other metabolites were present at concentrations of <0.01 ppm and 95% of the radioactivity was in the peels of the apples.

In an unreferenced, summary paper (ref. 10), apples were reported to have been treated once with chlorpyrifos at a rate of 0.2% in water (0.96 kg chlorpyrifos/acre). Apples were sampled at 7 and 14 days after application. Chlorpyrifos residues on the surface of the apples after a 7 day PHI were 0.29-0.80 ppm (3 samples) while the concentration of chlorpyrifos from extraction of the apples after extraction (surface washing) was between 0.016 and 0.02 ppm (3 samples). After a 14 day PHI, residues on the apple surface were 0.15-0.32 ppm and 0.004-0.019 ppm after extraction from the washed apples, (3 samples in both cases). These results indicated that chlorpyrifos residues were mainly on the surface of the treated fruit. The actual residue values were considered high as the apples analysed were less than normal commercial size.

The apple metabolism studies indicate that translocation of chlorpyrifos to the apple pulp was negligible.

Cranberry beans

were grown in a nutrient solution containing [^{36}Cl] chlorpyrifos (labelled in the 3 and 5 ring position chlorines) or [^{14}C] chlorpyrifos (carbon 14 label in the 2 and 6 ring positions) (ref. 11 and ref. 12). After 72 hours only about 0.1% of the radioactivity from the radiolabelled chlorine material had entered the plant while about 30% of the radioactivity had plated out on the surface of the roots. With the carbon 14 chlorpyrifos, about 0.07% of the applied dose was in the top of the plant after 72 hours. The carbon 14 work showed that in the plants the majority of the acetone soluble radioactivity was in the roots (76%) while water soluble radioactivity was greatest in the top of the plants (54% of the total radioactivity in the plant). 3,5,6-trichloro-2-pyridinol was the major component in the plant tops (95-97% of the total radioactivity) while in the roots, chlorpyrifos (49% of the total radioactivity extracted), chlorpyrifos monoethyl ester (27%) and 3,5,6-trichloro-2-pyridyl phosphate (11%) were the major compounds identified. In **corn** plants grown in soil or sand containing [^{36}Cl] chlorpyrifos or [^{36}Cl] 3,5,6-trichloro-2-pyridinol, uptake of the pyridinol was faster than the chlorpyrifos. Amounts present in the plants were low and compound identification was difficult. The study indicated that once absorbed into plants, chlorpyrifos was converted to 3,5,6-trichloro-2-pyridinol.

Conclusions of the papers were that root and leaf absorption of chlorpyrifos was insignificant and in foliar treatment, much of the applied radioactivity was lost by volatilisation from the leaf (approximately 80% of the activity had disappeared within 3 days of treatment). It was also concluded there was little practical translocation of chlorpyrifos in the plants.

Seed treatment of snap beans and field corn.

Snap beans were slurried in a commercial formulation without chlorpyrifos and then ^{14}C-chlorpyrifos was applied to individual seeds at a rate of 2 oz chlorpyrifos/100 lb of seed (125 g chlorpyrifos/100 kg seed) (ref. 13). The beans were sown and aerial parts sampled at 2, 4, and 6 weeks. Field corn seed were similarly treated with 14C-chlorpyrifos at a rate of 2 oz/56 lb of seed (223 g chlorpyrifos/100 kg of seed), sown and aerial parts of the plants sampled at the same intervals as beans. The chlorpyrifos was labelled in the 2,6 ring positions and the bean variety was Northrup-King round pod bush green beans and the corn, Northrup-King PX446(T*) Hybrid seed corn. The treated seeds were grown in a greenhouse. Total carbon 14 was determined and expressed as ppm chlorpyrifos. Summary results are given in the next table.

The report concluded that residual radioactivity (as chlorpyrifos) was greater than 0.01 ppm in the growing plants. The identity of the radiolabelled material was not pursued in the study. The study did indicate that residues in plants after four and six weeks were not excessive and it would seem reasonable to conclude that the actual chlorpyrifos residue concentrations would be well below the total residual levels reported in this study. The study also indicates that chlorpyrifos residues in harvested produce would be negligible which supports the belief that chlorpyrifos seed treatments should result in negligible residues in harvested produce.

Carbon 14 levels found in parts of bean plants, expressed as ppm chlorpyrifos				**Carbon 14 levels found in parts of corn plants, expressed as ppm chlorpyrifos**			
Portion	**2 Weeks**	**4 Weeks [a]**	**6 Weeks [b]**	**Portion**	**2 Weeks**	**4 Weeks [c]**	**6 Weeks [d]**
Cotyledons	72-258			First leaf	0.2-1.4	0.5	4
Lower stem	2-4	2	2	Second leaf	0.05-0.4	0.3	2
Main stem	0.8-1.5	0.3	0.3	Third leaf	0.04-0.3	0.1	0.1
Leaf base	0.6-1	0.1	0.06	Fourth leaf	0.02-0.4	0.04	0.08
Leaf tip	0.7-5	0.1	0.01	Fifth leaf	0.05-0.07	0.02-0.04	0.01

a lower stem = below primary leaves, main stem = above primary leaves, leaf base = primary leaves, leaf tip = trifoliate leaves.
b lower stem = below primary leaves, main stem = stems above primary leaves, leaf base = trifoliate leaves, leaf tip = beans.
c first leaf = lowest leaf, fifth leaf = all leaves above 4th leaves. d. fifth leaf = 9th leaf, top and any parts of 10th leaf.
All results wet weight basis.

Soybeans were sprayed in mid-season with Lorsban* 4E insecticide containing carbon 14 labelled chlorpyrifos (2,6-ring positions) at a rate of 1 lb chlorpyrifos/acre (1.12 kg chlorpyrifos/ha) (ref. 14). A forage sample taken 14 days after treatment, mature beans, and final field trash were taken for metabolite analysis. The total carbon 14 activity in these samples was:

Total carbon 14 activity in soybean plants after mid-season treatment with carbon 14 chlorpyrifos at 1.12 kg chlorpyrifos/ha.		
Plant	**^{14}C activity as ppm chlorpyrifos equivalents**	
Sample	**As harvested**	**Dry basis**
14 days forage, whole homogenate	5.09	25.9
14 days, plants sectioned into		
leaves, top, middle, lower	-	112, 46, 25
stem-petiole top, middle, lower	-	12, 11, 6
Seeds-pods	-	4
52 days beans	-	0.5
52 days, field trash	-	4

The distribution of metabolites in these fractions was:

Residue	Bean	Plant sample Forage	Field trash
Total carbon 14 , ppm chlorpyrifos equivalents	0.50	5.09	4.15
Chlorpyrifos %	2.6%	36.4%	28.8%
Chlorpyrifos ppm (calculated)	0.01 ppm	1.8 ppm	1.2 ppm
Free 3,5,6-trichloro-2-pyridinol %	8.8%	5.7%	6.0%
Alkali liberated 3,5,6-trichloro-2-pyridinol %	0.0%	18.1%	25.1%
Next most abundant metabolite%	6.8%	6.6%	4.6%
Incorporated carbon 14 activity %	66%		

These results indicate that there were negligible chlorpyrifos residues in the beans (incorporated radioactivity was found instead) with about 2 ppm chlorpyrifos residues in the forage and trash. This value is less than the 10 ppm chlorpyrifos in feed concentration which has been shown to allow compliance with the proposed livestock commodity MRLs recommended in this report (see 9.3 Animal transfer studies). However the study does point to the need to consider chlorpyrifos intake from forage and fodder sources.

Field corn was treated with carbon 14 chlorpyrifos labelled in the 2,6 ring positions as a soil treatment at planting (233 mg chlorpyrifos/metre of row, using a granular formulation simulating a commercial product) and or once at mid season (47 days after planting) at 1.6 kg chlorpyrifos/ha, again with a formulation simulating a commercial product (ref. 15). Samples of green forage taken 96 days after planting and of dry fodder and grain sampled at maturity (139 days after planting) were analysed for radioactivity. The total carbon 14 activity reported was:

Total carbon 14 activity in field corn samples from four field plots after application of chlorpyrifos to the soil (233 mg/metre) at planting and/or foliage (1.6 kg chlorpyrifos/ha)

Treatment	Total carbon 14 activity, ppm chlorpyrifos equivalents		
	Green forage[a]	Dry fodder[b]	Grain[b]
Soil treatment	0.08	0.46	0.09
Soil and foliar treatments	1.62	4.16	0.13
Soil and foliar treatments	1.61	4.12	0.13

Foliar treatment	2.4	4.04	0.04

a. Sampled 96 days after planting. b. Sampled 139 days after planting.

Chlorpyrifos in the green forage from one of the plots, which received both treatments, was about 3% of the total carbon 14 present, equivalent to 0.05 ppm. Pyridinol was present at about 0.02 ppm. When the green forage was subject to alkaline hydrolysis, approximately 30% of the residue was identified as 3,5,6-trichloro-2-pyridinol (≈0.48 ppm). In the dry fodder, again from a plot receiving both applications, chlorpyrifos was present at about 2% (approximately 0.08 ppm) and 3,5,6-trichloro-2-pyridinol at 3% (approximately 0.12 ppm) of the total carbon 14 content. In grain from plots, which had received both treatments, 1.6% of the carbon 14 was organosoluble, indicating the grain contained no significant chlorpyrifos or 3,5,6-trichloro-2-pyridinol residues.

Corn, soybean, and sugar beet

Corn plants had carbon 14 chlorpyrifos (2,6 ring label) applied to their leaves using concentrations of 1000 to 6000 ppm and the carbon 14 on the treated leaves was measured over time (ref. 16). A greenhouse volatility experiment showed that 1 day after treatment, approximately 70% of the applied radioactivity had volatilised with 19% remaining as leaf rinse and 13% remaining in the treated segment. After 8 days, 0.9% of the applied radioactivity was in the leaf rinse, 4% in the treated leaf segment and 95% had volatilised. Translocation studies were reported to show that 1.6% of the applied radiolabel translocated outside the treated leaf area. The corn leaf study also showed that 1 day after application, about 11% of the applied chlorpyrifos was in the corn leaf and this gradually decreased to 2% after 16 days. Insoluble carbon 14 activity increased from 0.5% of the applied carbon 14 at day 4 to 1.6% at day 28 (equivalent to 5.5% of the leaf content at day 4 and 25.6% at day 28.

When corn, soybeans, and sugar beet were each treated with 200 μg of carbon 14 chlorpyrifos formulated at 1000 ppm and samples taken at 8 and 16 days, the percent of applied carbon 14 activity in the surface rinse, leaf extract, and as chlorpyrifos (by HPLC) after 8 days were: respectively 0.3-1.1%, 5.9-9.2%, and 1.7-4.1%. After 16 days, the percentages were: 0.2-0.7%, 4.8-6%, and 0.1-1.5%.

Polar fractions in the 16 day corn, soybean, and sugar beet material contained approximately 50% 3,5,6-trichloro-2-pyridinol after basic hydrolysis.

The study indicated that most of the applied chlorpyrifos is lost through volatilisation and that chlorpyrifos on plant surfaces is readily metabolised to polar products. Translocation of chlorpyrifos is minimal.

4.7.3 Fish metabolism

In a literature report (ref. 17), goldfish were raised in tap water initially containing 50 ppb carbon 14 chlorpyrifos (labelled in the 2,6 ring positions) and the radioactivity in the fish over time measured (static flow system). In one series of studies, radioactivity in the fish was observed to increase over a 48 hour period but after 144 hours, total radioactivity in the fish was at or approaching the levels initially seen at about an hour after the exposure started. Other results showed that radioactivity in the viscera of the fish peaked at an hour after exposure and then steadily declined over the next 8 hours. Other studies in the report indicated that levels of radioactivity in fish tended to have reached plateau levels by about 10 hours after exposure. Four metabolites and chlorpyrifos were reported identified in the fish tissues with 3,5,6-trichloro-2-pyridinol the major product considered to be accumulating over time.

This study, although dated, indicates that in fish, chlorpyrifos residues are taken up into the tissues but with plateau values being reached along with metabolism/degradation of the chlorpyrifos.

4.8 Methods of Residue Analysis

4.8.1 Analytical methods

Examination of the available data demonstrated that chlorpyrifos was adequately determined in a variety of plant and animal commodity matrices using solvent extraction and gas liquid chromatography (GLC). Recoveries were typically high with a limit of determination of 0.01 mg/kg being achievable. A summary of the analytical methodology is provided in the Attachments to this report.

Analysis of 3,5,6-trichloro-2-pyridinol was also readily achieved. Extraction with heated methanolic sodium hydroxide allowed determination of total pyridinol as chlorpyrifos and 3,5,6-trichloro-2-pyridinol are both converted to the sodium salt of the pyridinol. After derivatisation, the pyridinol is determined by gas chromatography. The difference between the total pyridinol found and the pyridinol equivalents from the chlorpyrifos then determines the 3,5,6-trichloro-2-pyridinol. The method designation for this determination was ACR 71.19R (and modifications) (ref. 18). Because 3,5,6-trichloro-2-pyridinol was determined to be of no residue concern, methods of analysis for its determination in crops were not considered further.

3,5,6-Trichloro-2-pyridinol was also readily determined in animal and poultry tissues, milk, cream, and eggs. As the decision was taken that 3,5,6-trichloro-2-pyridinol was not essential for the residue definition and monitoring of good agricultural practice, methodology to measure 3,5,6-trichloro-2-pyridinol residues in animal commodities was not evaluated.

4.8.2 Stability of residues in stored analytical samples

Examination of the relevant available data showed acceptable storage stability was demonstrated in alfalfa, apples, orange juice, orange peel and pulp, oranges, and sweet corn. Such results point to the acceptable storage stability of chlorpyrifos residues in various commodity matrices. Relevant results were:

Substrate	% Residue remaining and reference[a]
Alfalfa	Chlorpyrifos and 3,5,6-trichloro-2-pyridinol were added to alfalfa green forage and hay at 1 ppm (as chlorpyrifos) and

Substrate	% Residue remaining and reference[a]
	stored -18^{o}C for 327-346 days (ref. 19). At those time, remaining chlorpyrifos made up 97-110% of the initial chlorpyrifos levels and 3,5,6-trichloro-2-pyridinol 65-80%.
Apples	In apples stored at -18^{o}C and initially fortified at 0.1 ppm chlorpyrifos, 90-93% was recovered after 172 and 271 days (ref. 20). In apples fortified at 1 ppm chlorpyrifos and stored at -18^{o}C, 80-90% of the chlorpyrifos was recovered after 3.7-4.2 years.
Orange juice	79% chlorpyrifos remained after 162 days storage at -18^{o}C. Fortification level 0.1 ppm. Reference as for oranges.
Orange peel and pulp	103% chlorpyrifos remained after 162 days storage at -18^{o}C. Fortification level 0.1 ppm. Reference as for oranges.
Oranges	78 and 79% chlorpyrifos remained after 162 and 172 days storage at -18^{o}C (ref. 21). Fortification level 0.1 ppm.
Sweet corn	Green plant, kernels, kernels and cobs, cobs, and husks were fortified at 0.1 ppm chlorpyrifos and stored at -32^{0}C and stored for 5 months (ref. 22). Residues remaining after 1 and 5 months storage were present at 76-96% of the original chlorpyrifos in all fractions. Equivalent storage stability was demonstrated when plant, stalks, grain, and cobs were fortified at 0.1 and 1.0 ppm and stored at -32^{0}C for up to 27 months (ref. 23).

a. References either given here or refer the designated analytical method reference.

4.9 Residue Definition

The metabolism data and analytical methodology support retention of the present residue definition, which measures chlorpyrifos as “chlorpyrifos”. The Codex Alimentarius residue definition of “chlorpyrifos (fat-soluble)” is equivalent to the Australian residue definition and identifies chlorpyrifos as a fat soluble chemical. The US residue definition is either “chlorpyrifos or metabolite (3,5,6-trichloro-2-pyridinol)” or “chlorpyrifos” with indications that the recognition of 3,5,6-trichloro-2-pyridinol’s not having toxicological concerns might result in a move to the residue definition being solely “chlorpyrifos”. (in CHLORPYRIFOS Shaughnessy No. 059101 Case No. 0100 (CBRS No. 13024, DP Barcode D198040) TASK 2B Reregistration Eligibility Document: Residue Chemistry Considerations September 14, 1994 (in DowElanco ECRP submission Section B and C - Residues and Trade, reference 3)).

Metabolite residues - 3,5,6-trichloro-2-pyridinol

Because 3,5,6-trichloro-2-pyridinol is a significant metabolite of chlorpyrifos, the question arose as to whether the pyridinol should be included in the residue definition.

Residue studies clearly demonstrated that quantifiable 3,5,6-trichloro-2-pyridinol could be present on occasion. However the pyridinol, which was not previously included in the present Australian residue definition, is understood to be of no toxicological concern and compliance with good agricultural practice can be monitored by measurement of the chlorpyrifos alone. For these reasons the inclusion of the 3,5,6-trichloro-2-pyridinol in the residue definition is not considered necessary.

This decision is consistent with the Codex residue definition for chlorpyrifos and, according to the US reregistration draft report supplied by DowElanco, also consistent with the US approach. The report stated “TOX Branch has determined that TCP [3,5,6-trichloro-2-pyridinol] is not of toxicological concern and concluded that TCP can be excluded from the tolerance expression ...” (CHLORPYRIFOS Shaughnessy No. 059101). The report went on to note that the tolerances recommended were for chlorpyrifos *per se* as the residue of concern. In 1993, the US EPA was stated as having concluded that 3,5,6-trichloro-2-pyridinol was not of toxicological concern (FR Vol. 58, No 70/Wednesday, April 14, 1993) (quoted from DowElanco ECRP submission, Section 5-Residues, Addendum 1, Reference 25).

As a consequence of this decision, 3,5,6-trichloro-2-pyridinol specific residue studies were not evaluated.

Metabolite residues - Chlorpyrifos oxygen analogue
Sufficient experimental data were generated to indicate that residues of the chlorpyrifos oxygen analogue are not expected to be quantifiable. Consequently, there was considered to be no need to include this metabolite in the residue definition.

4.10 Residues Resulting from Supervised Trials

Australian residue data

Australian crop residue data

Residue data on apples, avocados, bananas, celery, cottonseed, grapes, maize, mangos, passionfruit, potatoes, sorghum, sugarcane, and wheat were reviewed. In summary the residue situation was as shown below. Results were used in the development of the report’s “Appraisal” section and are presented in summary form as an attachment to this report.

Commodity	Label WHP (days)	Label treatment rate as gram chlorpyrifos /hl or ha[a]	Residues (mg/kg) at withholding period and treatment rate	Current MRL
Apples	14	25 or 50 g/hl, 250 g/ha	0.14, 0.07, 0.16, 0.15, 14 days, 25 g/hl	0.2
Avocado	7	25 or 50 g/hl, 0.5-1 kg/ha	0.37 and 0.22, 7 days, 1 kg/ha	0.5
Bananas	14	1000 g/ha (aerial)	nd, 800 g/ha	*0.1
		Off label dusting use	0.07-0.1, 70-120 days,	*0.1
Celery	14	400 g/ha	0.11 and 1.48, 15 & 19 days, 350 and 241 g chlorpyrifos/ha.	T5
Cotton(seed)	not set and 28	1500 g/ha ULV and EC and up to 750 g/ha	Nd-0.04, 750-1500 g chlorpyrifos/ha, 0-28	0.05

Commodity	Label WHP (days)	Label treatment rate as gram chlorpyrifos /hl or ha[a]	Residues (mg/kg) at withholding period and treatment rate	Current MRL
	days	for EC formulation use.	days	
Grapes	14	25 g/hl[b] or 250 g/ha	<0.01-0.3, 25 g/hl, 14 and 15 days	1
Maize	10	150-450 g/ha	<0.01, 500 g/ha, ca. 6 months	0.1
Mango	21	50 g/hl[c]	0.04, 100 g/hl; 0.07, 200 g/hl, 21 days	*0.05
Passionfruit	14	60 g/30 L (bait)	<0.05 ppm, 200 & 400 g/hl, 0-7 days	*0.05
Potatoes	-[d]	0.45-3 kg/ha or 35 g/hl	≤0.01, 0.45-5 kg/ha, 81-136 days	0.05
Sorghum	2 or 10	175-750 g/ha	0.9, 70 g/ha; 1.18, 140 g/ha, 1 day	3
Sugarcane	7	175-1000 g/ha	2-7.2 kg/ha, 200-600 days	0.1
Wheat	10	35 to 750 g/ha	No data	0.1
	nil as a seed dressing	60 g/100 kg seed	<0.01, 200 g/100 kg seed, about 140 days	0.1

a. Label WHP and treatment rate as given in the Lorsban 500EC label. B. 50 g/hl allowed by one company label. Some wine and dried fruit residue results also submitted. C. 100 g/hl allowed for green tree ant control by one label.
4. Use pattern such that a harvest withholding period is not needed.

Australian livestock residue data

No Australian livestock trials were available for review. Given the NRA's records indicate there is no registered product for treatment of livestock, the absence of such studies was not unexpected and livestock exposure is expected to come essentially from consumption of treated feeds or from exposure to chlorpyrifos in treated animal quarters. Animal transfer studies to evaluate the oral exposure route were supplied and were considered adequate to reach decisions on the setting of mammalian meat and edible offal MRLs.

4.9.2 Overseas residue data

Commercial crops such as fruits, cereals, and vegetables

Overseas residue results for a variety of commodity crops were evaluated. The majority of the data came from the United States. The US data were extensive and comprehensive and routinely made up of a series of trials conducted in different US states. The overseas results were used where appropriate to aid in the development of this report's Appraisal and Recommendations. Details of the overseas data are provided in the attachments to this evaluation.

Livestock

Sheep Residue results were available from a trial conducted in the USA in 1979 (Ref. 24) in which 19 sheep were treated with Dursban® 44 Insecticide (43.2% chlorpyrifos) at a rate of 1 ml/50 lb (19 mg/kg) of body weight as a pour-on application to control a sheep ked. Three control animals were included in the trial and killed at 1, 3, and 5 weeks after treatment of the treated animals. The pour-on was applied to a shorn area on the backline (posterior to the shoulder blade and neck) with a 1" wool length. Three treated animals were killed at each of 1, 2, 3, 4, and 5 weeks; and four were killed at 6 weeks post-treatment. Omental fat, muscle, liver, and kidney were analysed for chlorpyrifos and 3,5,6-trichloro-2-pyridinol by gas chromatography. The methodology has recoveries of chlorpyrifos of 79-95% for the tissues analysed over the range of 0.1 to 5.0 µg of added chlorpyrifos and a limit of detection of 0.003 ppm (3,5,6-trichloro-2-pyridinol, 0.01 ppm).

The control animal killed at the 3 week post-treatment slaughter interval had chlorpyrifos residues of 0.55 ppm in the fat, 0.014 ppm in the muscle, 0.046 ppm in the liver, and 0.003 ppm in the kidney. The report stated this animal was obviously not a control and that there was no explanation as to how or why the animal had been treated and possibly received a double treatment. The results presented below do not include the values from this animal.

Results were:

<u>**Chlorpyrifos**</u>

Residues of chlorpyrifos in sheep tissues after a single spot-on treatment with chlorpyrifos at 19 mg chlorpyrifos/kg of body weight. Results uncorrected for recoveries in the range 79-95%

Tissue	**Time (weeks) post-treatment slaughter, chlorpyrifos residues as ppm**					
	1 week	**2 weeks**	**3 weeks**	**4 weeks**	**5 weeks**	**6 weeks**
Omental fat	0.007-0.36	0.008-0.021	0.003-0.21	0.003-0.11	0.008-0.042	<0.003-0.042
Muscle	<0.003-0.02	<0.003	<0.003-0.005	<0.003	<0.003	<0.003
Liver	<0.003	<0.003	<0.003	<0.003		
Kidney	<0.003-0.005	<0.003	<0.003	<0.003		

Blank values occur when the tissue was not analysed.

<u>**3,5,6-trichloro-2-pyridinol**</u>

Residues of 3,5,6-trichloro-2-pyridinol in sheep tissues after a single spot-on treatment with chlorpyrifos at 19 mg chlorpyrifos/kg of body weight. Results uncorrected for recoveries in the range 79-95%

Tissue	Time (weeks) post-treatment slaughter, 3,5,6-trichloro-2-pyridinol residues as ppm					
	1 week	**2 weeks**	**3 weeks**	**4 weeks**	**5 weeks**	**6 weeks**
Omental fat	<0.01-0.013	<0.01-0.022	<0.01	<0.01	<0.01	
Muscle	<0.01-0.011	<0.01	<0.01-0.01	<0.01	<0.01	
Liver	0.01-0.048	0.011-0.033	0.01-0.03	<0.01-0.014	0.01-0.011	<0.01-0.01
Kidney	0.01-0.083	0.020-0.038	0.013-0.045	0.021-0.035	0.021-0.023	<0.01-0.012

Blank values occur when the tissue was not analysed.

Cattle A literature report on chlorpyrifos levels in cattle wearing chlorpyrifos impregnated plastic ear bands was also reviewed (ref. 25). Nine Hereford yearlings of mixed sex had 10% chlorpyrifos-impregnated plastic bands placed around both ears and the animals were biopsied over a 15 weeks schedule and then killed. Three control animals were biopsied over the same period and then killed. Omental and renal fat, muscle, liver, and kidney were analysed for chlorpyrifos and 3,5,6-trichloro-2-pyridinol by gas chromatography. The methodology had reported recoveries of chlorpyrifos of 80-97% for the tissues analysed over the range of 0.3 to 1 μg of added chlorpyrifos. A limit of detection for chlorpyrifos was set at 0.003 ppm.

In fat biopsy samples, the following residue levels were reported.

Residues (averages of duplicate analyses) of chlorpyrifos and 3,5,6-trichloro-2-pyridinol in biopsy omental fat samples from cattle wearing 10% chlorpyrifos-impregnated chlorpyrifos plastic ear bands. Residues expressed as ppm.

Post-treatment time weeks	Chlorpyrifos	3,5,6-trichloro-2-pyridinol
1	0.009, 0.016	<0.01
2	0.007, 0.091	<0.01, 0.029
3	0.031, 0.068	0.012, 0.014
4	0.018, 0.026	<0.01, 0.011
6	0.010, 0.037	<0.01, 0.012
7	0.014, 0.038	<0.01, 0.013
8	0.010, 0.007	<0.01
9	0.006	<0.01
11	0.008	<0.01
14	<0.003	<0.01

Control animal biopsy samples at 1 and 7 weeks both had no detectable chlorpyrifos or 3,5,6-trichloro-2-pyridinol residues.

In the tissues of the animals killed at 5, 10, and 15 week post-treatment slaughter times, residues were as shown in the next table:

Residues (averages of duplicate analyses, expressed as a range in ppm) of chlorpyrifos (Chlorpyr.) and 3,5,6-trichloro-2-pyridinol (3,5,6) in tissues of cattle wearing 10% chlorpyrifos-impregnated ear bands.

Omental fat		**Renal fat**		**Liver**		**Kidney**	
Chlorpyr.	**3,5,6**	**Chlorpyr.**	**3,5,6**	**Chlorpyr.**	**3,5,6**	**Chlorpyr.**	**3,5,6**
5 Week post-treatment slaughter results							
0.040-0.084	0.018-0.028	0.032-0.042	0.012-0.030	<0.003	0.026-0.032	<0.003	0.034-0.037
10 Week post-treatment slaughter results							
0.006-0.025	<0.01-0.010	<0..003-0.03	<0.01	<0.003	0.017-0.026	<0.003	0.014-0.022
15 Week post-treatment slaughter results							
<0.003-0.015	<0.01	<0.003-0.013	<0.01	<0.003	<0.01-0.012	<0.003	<0.01-0.014

The animal with the 0.091 ppm biopsy result for chlorpyrifos at 2 weeks had the 0.015 ppm chlorpyrifos result at the 15 week post-treatment slaughter.

At the 5 week post-treatment slaughter, one muscle sample was reported to have 0.01 ppm of chlorpyrifos. Two heart samples contained 3,5,6-trichloro-2-pyridinol each at 0.01 ppm. Neither compound was detected in these tissues again.

4.9.3 Animal transfer studies

Cattle tissue residues

Eighteen Hereford crossbred heifers (347 and 524 lbs) were fed chlorpyrifos for a 30 day period at 0, 3, 10, 30, or 100 ppm in the diet on a daily, dried-matter basis (ref. 26). The cattle were in six groups of 3 heifers each, one group for each level through to 30 ppm and two groups at 100 ppm. Chlorpyrifos was administered in gelatin capsules administered orally. All cattle fed 0, 3, 10, and 30 ppm and one group fed 100 ppm were killed at the end of the 30 day period and tissue samples taken for analysis. The second group fed at 100 ppm were placed on a chlorpyrifos free diet and omental fat samples collected from the animals by surgical biopsy at weekly intervals for 5 weeks.

Chlorpyrifos residues after 30 days feeding were:

Chlorpyrifos rate fed, ppm	Chlorpyrifos found, ppm Muscle	Liver	Kidney	Omental fat	Renal fat	Subcutaneous fat
0	0.00	0.00	0.00	0.00	0.00	0.00
3	<0.01	<0.01	<0.01	<0.01-0.05	0.01-0.03	<0.01-0.03
10	<0.01-0.02	<0.01-0.02	<0.01	0.08-0.11	0.10-0.16	0.07-0.16
30	<0.01-0.02	<0.01-0.02	<0.01	0.35-0.85	0.46-1.09	0.29-0.59
100	0.14-0.34	<0.01-0.03	<0.01-0.03	2.28-2.89	2.62-4.70	2.92-4.37

. Results are the range from 3 individual cows/feeding level.
. Results are those found after feeding the cattle for 30 days at the stated levels of chlorpyrifos in the feed.

Fats were identified as the site of maximum residue deposition with chlorpyrifos residues in all types of fat similar at each feeding level. Feeding at 3 ppm in the diet would be expected to result in chlorpyrifos residues in the fat being <0.1 mg/kg. Feeding at 10 ppm in the diet should result in residues of <0.3 mg/kg in the fat. The results also give some indication that concentration is occurring in the fats as the feeding levels increase.

The results of depletion studies on the second group of animals fed at 100 ppm are shown in the next table.

Depletion of chlorpyrifos from omental fat took place steadily over the 5 week chlorpyrifos-free feeding period. A 4 weeks depletion appeared appropriate to allow residues to be fall below the 0.5 ppm level. A longer than 5 weeks run out time could be needed to allow residues to be non-quantifiable if starting residues were in the order of those seen in the 100 ppm feeding study.

Chlorpyrifos residues in omental fat (biopsy samples) from cattle after feeding with 100 ppm chlorpyrifos in the diet for 30 days and then placed on chlorpyrifos-free feed - Withdrawal data

Days of withdrawal	Chlorpyrifos found ppm
7	0.66-1.15
14	0.15-0.67
21	0.09-0.58
28	0.02-0.15

Chlorpyrifos residues in omental fat (biopsy samples) from cattle after feeding with 100 ppm chlorpyrifos in the diet for 30 days and then placed on chlorpyrifos-free feed - Withdrawal data

Days of withdrawal	Chlorpyrifos found ppm
35	<0.01, 0.04

. Results are the range from 3 individual cows/feeding level except for the day 35 results where only 2 results were reported..

No residue of the oxygen analogue was reported detected in any tissue at any feeding level. The 3,5,6-trichloro-2-pyridinol was found predominantly in the liver and kidney. In animals fed 3 ppm, the pyridinol residues in those tissues were 0.09-0.23 ppm, and <0.05 ppm in all other tissues. At 100 ppm, 3,5,6-trichloro-2-pyridinol was present in the liver at 2.16-2.61 ppm and in the kidney at 1.46-1.95 ppm. In the muscle and fats, 3,5,6-trichloro-2-pyridinol residues at the 100 ppm feeding were all between 0.12-0.17 ppm in muscle and 0.22-0.36 ppm in the fats. In the withdrawal study, the 3,5,6-trichloro-2-pyridinol level in omental fat after 7 days was <0.05 ppm and not detectable after 35 days.

Cattle milk residues

Three of six Holstein dairy cattle (953-1228 lb) were fed basal rations containing 0.3, 1, 3, 10, or 30 ppm chlorpyrifos for approximately 14 consecutive days at each level (ref. 27). The remaining three cattle were used as control animals. At the end of this time, the cattle were placed on chlorpyrifos free basal ration for 14 days. The cows consumed about 36 lb (16.4 kg) of basal ration/day. Milk samples were obtained throughout by mixing morning and evening milks. Cream samples came from morning milks only. Feed consumption, body weight, and milk production were said not to have been depressed by the chlorpyrifos feeding. The study was a literature report and full trial details were not given. The chlorpyrifos results for the 3, 10, and 30 ppm feedings are reproduced in the next table.

Residues in milk and cream gave no evidence of accumulation and cream residues depleted readily when chlorpyrifos was withdrawn from the diet. Chlorpyrifos residues in cream were approximately tenfold those in milk, which is consistent with chlorpyrifos's fat solubility. Feeding at up to 30 ppm chlorpyrifos in the feed would be expected to result in chlorpyrifos residues in the milk of ≤0.01 mg/kg

Oxygen analogue residues were <0.01 ppm at all feeding levels in both milk and cream. 3,5,6-Trichloro-2-pyridinol residues in milk were <0.01 ppm for the 10 ppm feeding level and 0.01 ppm for the 30 ppm feeding level. After 3 days withdrawal the 3,5,6-trichloro-2-pyridinol levels had dropped to <0.01 ppm in the milk. In cream, 3,5,6-trichloro-2-pyridinol residues were <0.025 ppm at the 30 ppm feeding level after 10 days. After 4 days on chlorpyrifos free food, the cream residues were still <0.025 ppm.

The 3,5,6-trichloro-2-pyridinol residues did not increase in value over the exposure period.

Chlorpyrifos residues in cow milk and cream from cows given chlorpyrifos for 14 days at 3 to 30 ppm in the feed

Chlorpyrifos in the diet ppm	Days the level fed	Milk, chlorpyrifos ppm	Cream, chlorpyrifos ppm
3	10		<0.01
	11		<0.01
	12		<0.01
	13		<0.01
10	3	<0.01	
	6	<0.01	
	10	<0.01	0.03
	11	<0.01	0.03
	12	<0.01	0.03
	13	<0.01	0.03
30	3	0.01	
	6	0.01	
	10	0.01	(Continued)
30	11	0.01	0.10
	12	0.01	0.10
	13	0.01	0.09
		Withdrawal 30 ppm group	
0	1	<0.01	
	3	<0.01	<0.01
	4	<0.01	<0.01
	5	<0.01	<0.01

. Results are the means of samples from three cows per treatment level. Cream had about 45%
butter fat.

Laying hens

Laying hens (Hy-line) were divided into 8 treatment groups, each of 36 hens (ref. 28). The groups were fed dry feed containing chlorpyrifos at levels of 0 (2 groups), 0.3, 1.0, 3.0, and 10.0 (3 groups) ppm in the feed for 30 days. Feed was supplied *ad libitum*. After 30 days, 24 hens in each of the 0, 0.3, 1.0, 3.0 ppm feeding groups and one of the 10 ppm were killed without withdrawal from treated feed. The remaining two groups fed at 10 ppm were put on untreated food and one group each killed at 7 and 21 days withdrawal. Eggs were collected daily for each group for 30 days. Twelve hens were continued on treated feeds for an additional 15 days and the total egg production collected. Feed consumption for all groups was between 0.19 and 0.26 lb/hen/day. Weights/bird were initially between 3.3 and 3.6 lb and finally between 3.4 and 3.7 lb.

Tissue and egg samples were analysed starting with samples from the highest feeding levels and analyses were stopped when all samples from hens within a given level were less than the sensitivity of the respective methods. Chlorpyrifos in the tissues and whole eggs was analysed by method ACR 72.3 with 88-110% recovery for eggs and 74-109% for the other tissues at fortification levels of 0.01 to 1.0 ppm. The validated lower limit of sensitivity was 0.01 mg/kg for chlorpyrifos.

Chlorpyrifos consumption did not depress feed consumption, body weight or egg production. The levels of chlorpyrifos and 3,5,6-trichloro-2-pyridinol found are summarised in the following table.

The egg results came from eggs sampled from days 7 to 45 of the feeding regimes. Residues over that time were between nd and <0.01 ppm and indicate that accumulation of chlorpyrifos did not occur in eggs.

Residues of chlorpyrifos and 3,5,6-trichloro-2-pyridinol in tissues and eggs of hens fed chlorpyrifos for 30 days

Chlor-pyrifos fed ppm	**Range of chlorpyrifos and 3,5,6-trichloro-2-pyridinol residues found (ppm)**									
	Chlorpyrifos ppm					**3,5,6-trichloro-2-pyridinol ppm**				
	Muscle	**Liver**	**Kidney**	**Fat**	**Eggs**	**Muscle**	**Liver**	**Kidney**	**Fat**	**Eggs**
0	0.002	0.002	0	0	0	0.000	0	0	0	0
0.3	-	-	-	-	-	-	nd	nd-<0.05	-	-
1.0	-	-	-	nd	-	-	nd-<0.05	nd-0.11	-	-
3.0	-	-	-	nd-0.02	-	-	nd-0.06	0.06-0.24	-	-
10.0	nd	nd	nd	0.02-0.06	nd-<0.01	nd	nd-0.25	nd-0.84	nd	nd-<0.05
10.0*	-	-	-	nd		-	nd	nd	-	-

. A dash indicates no result was presented and interpreted as equivalent to a "not measurable". "nd" meant no detectable difference between the control and treated samples.
. 0 ppm results are averages.
. Fat was described as "peritoneal fat".
. Eggs collected from hens on treated feed for 7-45 days. No withdrawal period.
. Second 10 ppm (10 ppm*) feeding level results were after a 7 day withdrawal period.
. Results corrected for average recovery.

The results also show that chlorpyrifos residues are not expected in muscle or offal of poultry fed at up to 10 ppm chlorpyrifos in the diet. At levels of 3 or 10 chlorpyrifos ppm in the diet, low but quantifiable residues are expected in the fat. The values found are less than the current poultry meat, in the fat and offal MRLs of 0.1 mg/kg. After a 7 day withdrawal from chlorpyrifos treated feed, fat residues were not detectable.

Swine

Eighteen weaned Landrace pigs weighing about 50 lbs each were divided into 6 treatment groups (2 males and 1 female/group) and each group fed a basal ration containing 0, 1, 3, or 10 ppm chlorpyrifos (3 groups were fed at 10 ppm) for 30 days (ref. 29). Groups fed at 0, 1, 3, and one of the 10 ppm levels were killed at this time without withdrawal from treated feed. The remaining 2 groups fed at the 10 ppm level were put on untreated feed and 1 group each was killed at 7 and 21 days withdrawal. Samples of muscle, liver, kidney, omental fat, renal fat, and subcutaneous fat were collected and analysed for chlorpyrifos (ACR 72.1, recoveries acceptable over the range 75-118% for 0.01(0.05 ppm for liver and kidney) to 1.0 added chlorpyrifos and 3,5,6-trichloro-2-pyridinol. Chlorpyrifos feeding did not depress feed consumption (4.1-4.7 lb/day/pig on average) or body weight (initially 48-50 kg/pig, with final weights of 93-104 kg/pig). A summary of results is presented in the following tables.

The muscle results showed that at up to 3 ppm in the feed, no chlorpyrifos residues in muscle are expected. At 10 ppm in the feed, quantifiable, but low (0.03 ppm) residues occurred in muscle which depleted to non-measurable levels after a 7 day withdrawal from chlorpyrifos containing feed.

Chlorpyrifos residues in liver and kidney were not significant.

:Residues of chlorpyrifos and 3,5,6-trichloro-2-pyridinol as ppm in muscle, liver and kidney in swine fed chlorpyrifos in the feed for 30 days

Chlorpyrifos fed at ppm	**Chlorpyrifos**			**3,5,6-trichloro-2-pyridinol**		
	Muscle	**Liver**	**Kidney**	**Muscle**	**Liver**	**Kidney**
0	-	-	-	-	-	-
1	-	-	-	-	nd-<0.05	nd-<0.05
3	nd	nd	-	nd	0.06-0.08	nd-<0.05
10	0.02-0.03	nd-<0.01	nd	nd	0.18-0.32	0.10-0.16
10*	nd	nd	-	nd	nd	nd
10**	-	-	-	-	-	-

. A dash indicates no result was presented and interpreted as equivalent to "not measured".
. Results corrected for average recovery.
. 10* = results from a seven day withdrawal of treated food before slaughter.
. 10 = results from a 21 day withdrawal of treated food before slaughter not determined.**

Residues in the fats are shown in the next table.

Chlorpyrifos residues in the three types of fat analysed were similar with quantifiable residues present from feeding at 1 ppm in the diet. Chlorpyrifos residue levels in the fats increased as the concentration of chlorpyrifos in the feed increased. After a 7 day withdrawal from feed after feeding at 10 ppm, chlorpyrifos residues were still quantifiable but less than 0.05 ppm. No fat residues were detected after a 21 day withdrawal of feed containing 10 ppm chlorpyrifos.

Residues of chlorpyrifos and 3,5,6-trichloro-2-pyridinol as ppm in fats of swine fed chlorpyrifos for 30 days

Chlorpyrifos fed at ppm	**Chlorpyrifos ppm**			**3,5,6-trichloro-2-pyridinol ppm**		
	Omental	**Renal**	**Subcutaneous**	**Omental**	**Renal**	**Subcutaneous**
0	-	-	-	-	-	-
1	nd-<0.01	nd-0.02	nd-<0.01	-	-	-
3	nd-0.03	<0.01-0.04	0.01-0.04	nd	nd	nd
10	0.05-0.22	0.14-0.22	0.14-0.22	0.05-0.07	<0.05	nd-<0.05
10*	nd	nd-0.02	<0.01-0.03	nd	nd	nd
10**	nd	nd	nd	-	-	-

. A dash indicates no result was presented and interpreted as equivalent to "not measured".
. Results corrected for average recovery.
. 10* = results from a seven day withdrawal of treated food before slaughter.
. 10 = results from a 21 day withdrawal of treated food before slaughter.**

Feeding at 10 ppm chlorpyrifos in the diet would be expected to result in fat residues greater than the current MRL of 0.1 mg/kg. At 3 ppm in the diet, the MRL should be met. Persistent, direct exposure to chlorpyrifos treated feed is thought unlikely for swine and grain feeding would expose the animals to a maximum of 3 ppm in the diet if sorghum was the sole food supply. Such exposure should not result in the present MRLs being exceeded.

4.9.4 Rotational crop studies

In 1976 a rotational crop study was reported (ref. 30) in which Lorsban formulations (a granular formulation containing 10% chlorpyrifos and an emulsifiable formulation containing 2 lb chlorpyrifos/gallon) were applied broadcast at the rate of 6.7 kg chlorpyrifos/ha during the springs of 1971 and 1972 for a test plot for soybeans and 3 times during the springs of 1971, 1972, and 1973, all also at 6.7 kg chlorpyrifos/ha, for a sugar beet test plot. Soybean variety was Beeson and sugar beet variety, No. 400237No.2. The granular formulation was applied by a spreader and the emulsifiable formulation by spraying at 280 l/ha. Soybeans and sugarbeet were planted in the treated plots one year after the final applications. Soybean green plant, silage, straw, and grain and sugarbeet leaf and root were harvested and analysed for chlorpyrifos and 3,5,6-trichloro-2-pyridinol residues using standard chlorpyrifos and 3,5,6-trichloro-2-pyridinol analytical methods which gave acceptable recoveries of 77-94% over the range of 0.005 to 2.0 ppm for chlorpyrifos and 74-91% over the range of 0.05 to 0.2 ppm for 3,5,6-trichloro-2-pyridinol.

No quantifiable residues of chlorpyrifos (0.01 ppm) or 3,5,6-trichloro-2-pyridinol (0.05-0.08 ppm) were found in soybean green plant, silage, straw, or grain nor in sugar beet leaf or root. The rate of chlorpyrifos applied was stated to be 3x to 6x times the recommended pest control rates for crops. The study results indicated that chlorpyrifos residues will not occur in crops, which may be rotated with chlorpyrifos treated crops according to good agricultural practice.

4.9.5 Residue depletion/stability

The chlorpyrifos use patterns allow for repeat applications in a number of cases which leads the need to consider the rate at which chlorpyrifos residues deplete and the possible effect of multiple chlorpyrifos applications on the final residue concentration.

Examination of the residue data shows that frequently the loss of chlorpyrifos over time was steady with chlorpyrifos residues at 7 and more days after the last application still being measurable as a significant percentage of the original concentration. On occasion this was not of consequence as the initial residue concentrations were not particularly high and would not result in unacceptable concentrations at the withholding period even though the percentage decrease may not have been large. An instance of notably rapid residue depletion was seen in Australian cotton trials conducted in 1996 where chlorpyrifos residues in green forage of the order of 375-730 mg/kg at day 0 had reduced to 19-51 mg/kg in 4 of 5 trials and 116 mg/kg in the other after 7 days (equivalent to 4-7% or 24% chlorpyrifos remaining after 7 days).

The depletion of chlorpyrifos was considered to be steady over time, with residues frequently measurable for 7 or more days after final treatment and continuing to deplete as the preharvest interval increased. On this basis, residue studies should be conducted with at least two applications at the recommended interval when the use pattern is such that more than one application is permitted and there is only a relatively short time between the two applications.

4.11 Animal Feeds

Use of chlorpyrifos on crops, which could be fed to animals

Many of the crops which chlorpyrifos can be used on can also be used as animal fodder and forage. Examples are cereals, legume animal feeds, oilseeds, pasture, and forage crops. Processed produce such as apple and citrus pomaces and residual plant material from grape pressings are also occasional feed items for farm animals.

Such uses could expose animals fed the treated forage and fodder to chlorpyrifos residues and result in quantifiable residues in the animal commodities. This has been recognised by label statements of some EC formulations specifying that cereals, pastures, and forage crops are not to be grazed or cut for stock food for 2 days after application. Oilseeds are included in the listing of one such product but not specifically mentioned in the DowElanco 500 EC formulation.

Grazing restraints were not seen on the labels of WP formulations examined or on the label of the 300 EC ULV DowElanco formulation used to treat cotton. In this latter case, the NRA, in an evaluation of a change to the use pattern of this product for cotton, recommended that there be a 28 day period after treatment before use as cotton fodder or grazing was allowed.

Data justifying the 2 day grazing/feed restraint were not presented and a reconsideration of this restraint will be made on the basis of forage residue data presented as an outcome of the chlorpyrifos ECRP.

In situations where the chlorpyrifos is applied either at planting (including seed dressing) or in the early growth stages of the crops, it might be expected that residues at harvest in the forage or fodder would be negligible.

Where the application is made to crops, which could be grazed, or fed to livestock, data to show the decline of residues in plants so treated are needed. These would demonstrate to what extent grazing or feeding withholding periods are required.

Residues in animal forage and fodder

Forage and or fodder chlorpyrifos residue data from alfalfa, barley, beans, corn, grass, oats, pasture, peas, sorghum, soybean, sunflowers, and wheat were presented with the overseas residue studies. Residues from processing of apples, oranges, sugar cane, soybeans, cotton etc. from processing are considered in the following section, “Fate of Residues in Storage and Processing”. Australian residue data on cotton fodder were evaluated and confirmed the cotton fodder (dry) MRL of 30 mg/kg.

While fuller trial details are given in the attachments to this report, the following summary gives an indication of the levels of chlorpyrifos seen in treated animal forage or fodder and shows that in some cases there would have been measurable residues present after a 2 day grazing withholding period, sometimes at levels which if the animals consumed for a period of time might result in the animal commodity MRLs being equaled or exceeded – this is however considered an unlikely event as the residues steadily decline over time and the exposure would be more likely transient, rather than prolonged

Examples of chlorpyrifos residues found in animal feed commodities (Overseas data)

Commodity	Grazing WHP (days)	Label & study rate treatment rates as gram chlorpyrifos /hl or ha	Residues (mg/kg or ppm) and harvest interval		
Alfalfa	**2 (label)**	**100-350 g/ha (label)**			
		280 g/ha (trial)	Green forage	1.4	7 day PHI
			hay	2.9	
		280 g/ha (trial)	Green forage	0.68	7 day PHI
			hay	1.8	9 day PHI
		560 g/ha (trial)	Green forage	0.87	14 day PHI
			hay	1.0	22 day PHI
		560 g/ha (trial)	Green forage	2.6	7 day PHI
			hay	18	12 day PHI
		1120 g/ha (trial)	Green forage	5-16	7 day PHI
			hay	5.8-58	
		1120 g/ha (trial)	Green forage	0.86	21 day PHI
			hay	0.7	22 day PHI
		1120 g/ha (trial)	Green forage	122	0 day PHI
			green forage	12	7 day PHI
			hay	13	16-22 day PHI
Barley	**2 (label)**	**35-750 g/ha (label)**			
		420-576 g/ha (trials)	Straw	0.51	27-29 days PHI
Corn	**2 or not set for early use**	**35-1000 g/ha (label)**			
		3.4 kg/ha (trials)	Green forage	nd	27 plus days PHI (trials at planting)
		1120 g/ha (trial)	Green forage	nd	44 days PHI
Grass	**2 (label)**	**35-750 g/ha (label)**			
		2.24 kg/ha (bait, trial)	Grass	0.27	0 days PHI
			hay	0.72	0 days PHI
		720 g/ha (trials)	Grass	3.2-30	0 or 1 day PHI
				<0.02-3.7	14 days PHI
Oats	**2 (label)**	**35-750 g/ha (label)**			
		420-576 g/ha (trials)	Green forage	~2.5	5 days PHI
				~0.1	17-19 days

Examples of chlorpyrifos residues found in animal feed commodities (Overseas data)					
Commodity	**Grazing WHP (days)**	**Label & study rate treatment rates as gram chlorpyrifos /hl or ha**	**Residues (mg/kg or ppm) and harvest interval**		
					PHI
			Straw	0.24	19 days PHI
				0.02-0.15,	27-34 days PHI
Pasture	**2 (label)**	**35-750 g/ha (label)**			
		~730 g/ha (trials)	Pasture	30-50 32-35 1.0-1.1	0 day PHI 1 day PHI 15 days PHI
Soybeans	**2 (label)**	**250-450 g/ha (label)**			
		1120 g/ha (trials)	Green forage	50-70 8.7-13	0 and 1 day PHI 14 days PHI
			Straw	0.60-14	28-51 days PHI
Sunflower	**2 (label)**	**250-450 g/ha (label)**			
		560 g/ha (trials)	Forage	2.4-4.4	13 and 27 days PHI
Wheat	**2 (label)**	**35-750 g/ha (label)**			
		240 g/ha (trial)	Plant straw	1.4 ~0.1-0.2,	1 days PHI; 30-46 days PHI
		576 g/ha (trials)	Straw	0.54-0.60	27-33 days PHI

Note: Bolded WHP and label rates relate to Australian use patterns.

The grass and pasture results, and the cotton fodder results presented with the Australian residue data indicate that a fodder/forage chlorpyrifos concentration of about 30 ppm might be expected in grass and pasture after a 2 day grazing withholding period and in cotton fodder after a 28 day grazing withholding period.

4.12 Fate of Residues in Storing and Processing

Apples

Apple processing

Apples treated with Lorsban 50W foliar applications (60 g ai/100L, the Australian use patterns have rates of 25-50 g chlorpyrifos/100L) and sampled after 7 high volume sprayings with Lorsban 50W were processed to give peeled apples, peels, pomace, and juice (ref. 31) (PHI = 0 days). Processing was laboratory scale. Results were:

Processed fraction	Treatment rate	Chlorpyrifos mg/kg minima	maxima	3,5,6 mg/kg Minima	maxima
Unwashed apples	2240 g ai/ha	2.2	4.6	Nd	0.22
Washed apples	3738 l/ha =	3.0	4.2	Nd	nd
Peeled apples	60 g ai/100L	0.22	0.55	Nd	0.09
Peels		13	20	Nd	0.43
Pomace (moist)		8.0	9.4	Nd	nd
Juice		0.23	0.40	Nd	nd

Average and median chlorpyrifos residue values and concentration factors were:

Fraction/ Residue level	Unwashed apples	Washed apples	Peeled apples	Peels	Pomace wet	Juice
Average mg/kg	3.3	3.6	0.38	18	8.6	0.3
Median mg/kg	3.2	3.6	0.37	19.5	8.6	0.35
Concentration factor		1.1	0.1	6.1	2.7	0.1

These results show that a concentration of chlorpyrifos occurred in the peels and to a lesser extent, the pomace. While actual residues in commercially harvested fruit should be much lower, peels would still be expected to have the major residue concentration.

A second apple processing study was also submitted (ref. 32). McIntosh apples were given 12 high volume applications of Lorsban 50W (2-32 days between applications with 32 day period between the last and second last treatments) and harvested at a 0 day PHI. The spray concentration was 60 g ai/100L. The processing was on a laboratory scale. Results were:

Fraction/ Residue level	Whole apples	Wet pomace	Dry apple pomace	Juice
Average mg/kg	0.52	0.92	4.1	0.11
Concentration factor		1.8	7.9	0.2

These results confirm that some residue concentration is expected in pomace but not in the juice fraction.

Residues in apple pomaces

Apple pomace is considered to make up no more that 20% (dry weight basis) of the diet of cattle in the Australian scene.

Based on a concentration factor of 8 (7.9 rounded up, dry pomace) and a (temporary) MRL of 0.5 mg/kg, chlorpyrifos residues in the dry apple pomace would be 4 mg/kg. At 20% of the total diet, this represents a chlorpyrifos concentration in the total daily diet of about 1 ppm or less. Based on the cattle transfer studies (*q.v.*), this amount of chlorpyrifos would not be expected to result in residues exceeding the proposed temporary animal commodity MRLs of 0.5 mg/kg for mammalian meat (in the fat) and 0.1 mg/kg for edible mammalian offal, or the present 0.2 mg/kg in the fat of milks.

US data states that apple pomace is either not used or is a minor (<10%) component of the diet of poultry or swine (from the FAO Manual on the Submission and Evaluation of Pesticide Residue Data for the Estimation of Maximum Residue Levels in Food and Feed", Food and Agricultural Organization of the United Nations, Rome, 1997. Appendix IX Maximum proportion of agricultural commodities in animal feed). This is assumed correct for Australia and the actual intake of chlorpyrifos from pomace is not expected to be of significance.

Oranges

Orange processing

The fate of residues in oranges treated with chlorpyrifos was reported by Wetters in 1977 (ref. 33). Valencia oranges were given a single chlorpyrifos treatment with Lorsban 4E and harvested 14 days later. Results from 3 trials were submitted. In one study samples were taken at 0, 3, 14, and 30 days. Residues were determined in the whole oranges and in the orange juice and orange peel and pulp obtained from the oranges (non-commercial scale operation was indicated). The following results were reported:

Processed fraction	Treatment rate		Chlorpyrifos mg/kg minima	maxima	3,5,6 mg/kg minima	Maxima
Whole oranges	12040 g ai/ha 935 l/ha and	Low volume	1.18	1.46	nd	0.58
			0.27	0.94	nd	0.13
			0.80	3.78	nd	0.62
			0.78*	1.01*		
	13412 l/ha = 90 g ai/100L	High volume	0.41	0.63	nd	0.10
			0.89	0.99	0.09	0.45
			0.43	0.60	nd	0.08
			0.15*	0.23*		
Orange juice		Low volume	0.02	0.08	nd	Nd
			nd	nd	nd	Nd
			0.07	0.19	nd	Nd
			0.03*	0.06*		
		High volume	nd	<0.01	nd	Nd
			nd	<0.01	nd	Nd
			0.01	0.01	nd	Nd
			0.01*	0.02*		
Peel and pulp		Low volume	1.47	1.80	<0.05	0.27
			0.65	0.94	0.06	0.20
			2.18	5.43	0.13	0.15
			0.75*	1.56*		
		High volume	0.53	0.59	0.13	0.17
			1.68	1.84	0.25	0.31
			0.76	0.98	0.13	0.16
			0.43*	0.44*		

. 3,5, 6 = 3,5,6-trichloro-2-pyridinol

. Residues are corrected for recovery and control values.

. Each data row comes from an individual residue trial (3 trials in total) and represent residues found after a 14 day PHI (except in the third data set where day 30 results are also given and marked with an "*". These data come from the same trial as the day 14 data immediately above them in the table).

Average chlorpyrifos residues reported in the study are presented in the next table. A 1 to 2 fold concentration of chlorpyrifos residues in the peel and pulp compared to the whole oranges is indicated by these results. Residues do not transfer to the juice in any significant amount.

Chlorpyrifos residues found in whole oranges and processing fractions and calculated concentration factors

Fraction	High volume mg/kg (average values)	Conc. factor	Low volume mg/kg (average values)	Concentration Factor
Whole oranges	0.52		1.22	

Peel and pulp	0.57	1.1	1.63	1.3
Juice	nd		0.04	
Whole oranges	0.94		0.60	
Peel and pulp	1.75	1.9	0.73	1.2
Juice	nd		nd	
Whole oranges	0.56		not reported	
Peel and pulp	0.87	1.5		
Juice	0.01			

A second study on oranges was conducted in South Africa in 1975 (ref. 34). The fruit were given a single application (two applications in one case, material with a 212 day PHI) with Dursban 4 at 0.048 or 0.096% chlorpyrifos and harvested at intervals of 24-251 days. Residues of chlorpyrifos in the whole orange, flesh, and rind were reported.

	Residues mg/kg						
PHI days	**24**	**55**	**139**		**212**	**214**	**251**
Whole fruit	0.11	0.05	0.26	0.16	0.17	0.28	0.01
Rind	0.40	0.15	0.94	0.58	0.60	0.95	0.03
Flesh	0.01	0.01	<0.01	<0.01	0.01	0.01	0.01
Concen-tration factors for rind/fruit	3.6	3	3.6	3.6	3.5	3.4	3

The rind was clearly the site of maximum residues and the fruit/rind concentration factor was relatively constant over the study period.

Residues in animal feeds prepared from processed citrus

US data (*op.cit.*) states that dried citrus pulp can make up 20% of the diet of beef and dairy cattle but is either not used or is a minor (<10%) component of the diet of poultry or swine. If it is assumed these values are valid for the Australian situation, then using a concentration factor of 3.6 and the MRL of 0.5 mg/kg for citrus, the concentration of chlorpyrifos in the pulp/rind would be 1.8 mg/kg. At 20% of the diet, the presence of the chlorpyrifos in the pulp/rind would result in a chlorpyrifos concentration in the feed of about 0.4 ppm. Based on the animal transfer studies (*q.v.*), this amount of chlorpyrifos would not be expected to result in residues exceeding the proposed animal commodity MRLs of 0.5 mg/kg for mammalian meat (in the fat) and 0.1 mg/kg for edible mammalian offal, or the present 0.2 mg/kg in the fat of milks.

Sugar cane

Sugar cane Processing

Sugarcane growing in Queensland was given a single low volume aerial application of Lorsban 50EC at rates of 560, 1120, and 1680 g chlorpyrifos/ha (ref. 35). The cane was harvested at 1 day, 1 week, 2 weeks, and 4 weeks after spraying and samples processed in a pilot plant. Samples were put through rollers to give bagasse and first roller juice. The bagasse was macerated with water to give “maseration juice”. Concentration of the roller juice gave syrup, which gave raw sugar after crystallisation. Washing of the raw sugar gave affined raw sugar and affination water. Chlorpyrifos residues in these fractions were then determined.

Chlorpyrifos residues were:

Rate and Time of sampling	**Fractions & residues (ppm)**						
	Bagasse	**1st roller juice**	**Syrup**	**Raw sugar**	**Affination water**	**Affined sugar**	**Masera-tion water**
560 g ai/ha							
1 day	0.31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1 week	0.19	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2 weeks	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4 weeks	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1120 g ai/ha							
1 day	0.94	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1 week	0.97	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2 weeks	0.53	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02
4 weeks	0.47	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1680 g ai/ha							
1 day	1.77	0.014	<0.01	<0.01	<0.01	<0.01	0.02
1 week	1.26	0.033	<0.01	<0.01	<0.01	<0.01	0.04
2 weeks	1.16	0.011	<0.01	<0.01	<0.01	<0.01	0.03
4 weeks	1.30	0.010	<0.01	<0.01	<0.01	<0.01	0.02

Extraction of the bagasse was shown to be essentially completed by the first extraction process with residues from a second extraction all <0.01 ppm for the 560 and 1120 g/ha treatments and all <0.03 ppm for the 1680 g/ha treatment.

The study showed that the chlorpyrifos residues remained essentially with the bagasse.

Residues in animal feeds made from processed sugar cane
Bagasse is understood to be a minor animal feed (it can be used as a fuel in the sugar processing plant and it is not identified as a major sugarcane feedstuff in US animal feeding data (*op. cit.*)). Consequently chlorpyrifos residues in processed sugar cane waste is not expected to be of significance with respect to animal feeds.

Soybeans

Soybean processing
Lorsban 4E was applied broadcast in a US study conducted in Michigan to Hark variety soybeans at crop emergence at a rate of 4.48 kg/ha (ref. 36). Four further foliar applications were made at 29, 21, 22, and 20 day intervals. The crop was harvested 14 days later (PHI = 14 days). The foliar application rates were 1.12, 1.12, 2.24, and 2.24 kg/ha with a spray volume of 280 l/ha (low volume). The harvested soybeans were

processed into various fractions (laboratory scale indicated) and chlorpyrifos and 3,5,6-trichloro-2-pyridinol residues determined. Recoveries of chlorpyrifos and 3,5,6-trichloro-2-pyridinol from the process fractions were acceptable (80-100%, 0.01-0.05 ppm fortification levels). Residues were as shown in the next table.

The results show that residues in the beans were low and that residues in the hulls, meal, and oil fractions were even lower. No concentration of residues in the processed fractions was shown by the study.

Chlorpyrifos residues in soybeans and processed soybean fractions

Process fraction/substrate	Chlorpyrifos mg/kg	3,5,6-trichloro-2-pyridinol mg/kg
Soybeans	0.04	0.10
Hulls	0.02	0.08
Extracted meal	nd	0.13
Crude soybean oil	0.01	nd
Refined soybean oil	0.02	nd
Refined, bleached soybean oil	0.02	nd
Soap stock	nd	<0.05

. Residues corrected for control and recovery
. nd = not detected

Residues in animal feeds made from processed soy products
Based on the soybean processing study, soybean processing is not expected to result in significant concentration of chlorpyrifos residues. Consequently feeding of meal, etc. to livestock should not result in any significant animal commodity chlorpyrifos residues.

Cotton

Cotton processing
In a US 1974 study (ref. 37) conducted in Wayside, Mississippi, cotton (var. Stoneville 213) was treated twice with Lorsban* 4E (4 lb chlorpyrifos/gal) at 26 and 19 days after planting using ground application (93 l/ha) at 0.25 lb/ac (280 g chlorpyrifos/ha) and then at 1 lb/ac (1120 g chlorpyrifos/ha) 12 times at intervals of 4 to 14 days. Cottonseed was harvested 15 days after the last application. The cotton was ginned in a small plot gin to give seeds and trash. The seeds (50 lb samples) were processed into linter, hull, solvent extracted meal, crude and refined-bleached oil fractions and chlorpyrifos residues in them determined. In the same study results from a second residue and processing trial, conducted in Texas, were also reported. Cotton was treated 4 times with aerial applications of Lorsban* 4E at 0.25 lb/ha (280 g chlorpyrifos/ha) with 9-32 days between applications followed by 12 applications at 1 lb/ac (1120 g chlorpyrifos/ha) at intervals of 2-14 days. Cottonseed was harvested at 18 days after the last treatment. The harvested cotton was processed as before. In both studies, the cotton was treated from shortly after planting up until the noted pre-harvest interval.

In an Australian study reported in 1986 (ref. 38), cotton was treated with Predator 300 (300 g chlorpyrifos/L) with single aerial applications at 750 g ai/ha or with four applications 7 days apart at 750 or 1500 g chlorpyrifos/ha. Cottonseed from the first treatment was sampled at PHIs of 0 to 21 days and seed from the multiple treatments at 14 days. The seed was ground to separate hull and lint from the meat and the meats then sieved, cooked, ground and washed with hexane to allow separation of cotton seed oil. Chlorpyrifos was determined in both the seed and the oil.

An Australian residue study conducted in 1996 also provided data on the level of chlorpyrifos in cottonseed oil (ref. 39). Predator 300 was applied as a single application or as two applications (7 day intervals) at 5 L/ha (corresponding to the approved use pattern) or 10 L/ha. These rates are equivalent to 1500 or 3000 g chlorpyrifos/ha. Cotton seed was sampled at the withholding period of 28 days and crude cotton seed oil extracted. Chlorpyrifos residues in the seed and oil were determined.

Results of all the studies are summarised as follows:

Trial details	**Form-ulation used**	**No. of applns.**	**Time between applns.**	**Rate of chlor-pyrifos**	**Fracn.**	**Chpfos. ppm**	**3,5,6 ppm or as stated**	**Other details**
Cotton seed, ground application United States, Mississippi, 1975	Lorsban 4E	2 at 0.28 kg/ha, 12 at 1.12 kg/ha	19 days for 1st 2 then 4-14 days for rest	280 g/ha x 2 then 1120 g ai/ha x 12 93 l/ha	Seed Trash Hulls Linters Meal Crude Refin-ed oil	0.06 2.0 nd 0.04 nd 0.01 nd	0.05 2.5 nd nd <0.05 nd nd	Stoneville 213 var. Applied as a broadcast foliar spray. Trash results are uncorrected values. PHI = 15 days
Cotton seed, aerial application United States, Texas, 1975	Lorsban 4E	4 at 0.28 kg/ha & 12 at 1.12 kg/ha	32, 12, & 9 days then 2-14 days	4 at 280 g/ha then 1120 g ai/ha x 12 19 l/ha	Seed Trash Hulls Linters Meal Crude Refin-ed oil	0.11 0.24 0.09 0.51 nd 0.17 nd	0.11 3.8 0.09 1.2 <0.05 nd 0.07	Stoneville 213 var. Applied as an aerial spray. PHI = 18 days
Cotton seed, aerial application, Australia, 1986	Predator 300	1	na	750 g ai/ha	**PHI** 0 1 3 5 7 10 14 21	**Seed** <0.025 <0.025 <0.025 nd nd nd <0.025 nd	**Oil** 0.34 0.34 0.16 0.054 0.047 <0.025 <0.025 <0.025	DP 90 var. Applied as an aerial spray. PHI in days

Trial details	Form-ulation used	No. of applns.	Time between applns.	Rate of chlor-pyrifos	Fracn.	Chpfos. ppm	3,5,6 ppm or as stated	Other details
Cotton seed, aerial application, Australia, 1986	Predator 300	4	7 days	750 g ai/ha	14	**Seed** <0.025	**Oil** 0.063	DP 90 var. Applied as an aerial spray.
Cotton seed, aerial application, Australia, 1986	Predator 300	4	7 days	1500 g ai/ha	14	**Seed** nd	**Oil** 0.14	DP 90 var. Applied as an aerial spray.
Cotton seed, Australia, NSW, 1996	Predator 300	1	na	1500 g ai/ha 3000 g ai/ha	28	**Seed** <0.01 ≤0.01	**Oil** 0.02 0.03	CS85 var. Broadcast application (ref. 40). Oil results re-ported as "corrected"
Cotton seed, Australia, NSW, 1996	Predator 300	2	7 days	1500 g ai/ha 3000 g ai/ha	28	**Seed** <0.01 ≤0.01	**Oil** 0.03 0.02, 0.02, & 0.06	CS85 var. Broadcast application. Oil results reported as "co-rrected". Ref. NRA.
Cotton seed, Australia, QLD, 1996	Predator 300	2	7 days	1500 g ai/ha 3000 g ai/ha	28	**Seed** 0.04 0.01	**Oil** *0.20 & 0.24* 0.85 & 0.89	SK14 var. Broadcast application. Oil results reported as "co-rrected". Ref. NRA.

Fracn. = Fraction analysed. Chpfos. = chlorpyrifos. 3,5,6 = 3,5,6-trichloro-2-pyridinol. nd = not detected.
In the Australian results, chlorpyrifos values are given in one column for the seed and in the second column for the oil. Australian studies did not measure 3,5,6-trichloro-2-pyridinol.

The US results indicate that after multiple treatments by either ground or air application, the maximum chlorpyrifos residues tended to be on the seed surface (hulls and linters) with lesser amounts in the meal and oil fractions. The crude oil fraction had residues of 0.01 and 0.17 ppm chlorpyrifos from seed containing 0.06 and 0.11 ppm respectively with concentration factors of 0.2 and 1.5. This is a wide variation.

The 1986 Australian results showed that even when no measurable chlorpyrifos was found in the cottonseed, measurable levels were present in the oil. Concentration factors can not be calculated from these results because of the uncertainty as to what the actual cotton seed levels were.

The 1996 cotton seed and cotton seed oil results present a similar picture - low, near unquantifiable residues in the seed but finite residues in the crude oil. These data were used to establish the NRA's recommended cotton seed oil, crude MRL of 0.2 mg/kg. The concentration factor for the 1500 g chlorpyrifos/ha treatment (Queensland, 2 applications according to the use pattern) was 5.5, a value greater than seen in the US studies.

With respect to concentration of chlorpyrifos in cotton seed oil, both the Codex Alimentarius Commission and the draft US chlorpyrifos reregistration document have recommended MRLs of *0.05 mg/kg for both cotton seed and cotton seed oil, crude. The draft reregistration chlorpyrifos report stating that in cottonseed, residues of chlorpyrifos are not likely to concentrate in processed fractions.

Based on the data seen, residues are not expected to significantly concentrate in cotton seed oil. The 1996 Australian data, while showing significant residue concentration did not occur in the crude oil, did show that residues exceeded 0.05 mg/kg. The Australian data showed that the current cotton seed oil, crude MRL of 0.2 mg/kg is expected to be adequate to cover this small but persistent identification of measurable chlorpyrifos residues in the crude cotton seed oil.

Residues in cotton meal and hulls

The cotton processing studies indicated that significant amounts of chlorpyrifos residues in cotton processed products are not expected. Consequently feeding of meal etc. to animals is not expected to cause residue issues. The data were also taken as supporting the NRA recommended cotton meal and hulls MRL of 0.05 mg/kg in the NRA's 1996 review of the use of chlorpyrifos as Predator 300 on cotton.

Assuming decline of residues continued over time, it would be reasonable to expect that cottonseed with chlorpyrifos residues of 0.05 mg/kg or less would have residues of ≤0.05 mg/kg in the meal and hulls when a 28 day grazing/feeding restraint was observed.

Feeding of cotton trash to livestock is understood to be not recommended in Australia and further consideration of this source of intake by animals is not considered necessary at this time.

4.13 Environmental Fate

Environmental fate in soil

A 1 ppm solution of chlorpyrifos, carbon 14 labelled in the 2,6 ring positions was added to soils and, after shaking overnight, the amount of carbon 14 remaining in solution was determined (ref. 41). The majority of the chlorpyrifos was sorbed and calculated K_{oc} values of 4690-7300 reported. These were taken as indicating chlorpyrifos would be immobile in the soil. In column leaching studies, the radiolabelled chlorpyrifos was added to soil columns at a rate equivalent to 0.5 kg/ha and then eluted with a dilute calcium sulphate solution. Greater than 95% of the radioactivity was found in the top 2 centimetres of the column. This indicated chlorpyrifos did not readily leach in to the soils examined (organic carbon contents of 0.68-2%).

Environmental fate via volatilisation

Corn plants (Jacques JX-21) raised in a greenhouse to a height of 35 cm were used in a volatility study (ref. 42). The corn leaves were treated with carbon 14 chlorpyrifos labelled in the 2,6 ring positions as a Lorsban 4E formulation (90 μg/leaf) and at designated times the amount of chlorpyrifos remaining was determined. The report noted that metabolism in the plant did not occur by day 4 (HPLC identified only chlorpyrifos). After 48 hours about 80% of the applied radioactivity had volatilised into the air. This was calculated to be equal to 400, 60, and 20 g/ha/day for the first three days after an application of 1.12 kg/hectare, assuming 50% of the spray struck the crop. Volatility loss was concluded to be the major mechanism of chlorpyrifos dissipation from the surface of corn and possibly from other plants as well. In contrast, on soil other mechanisms were said to act to make soil volatility loss of less significance.

Illustrative values of the volatilisation loss are that 24 hours after treatment, the percent of chlorpyrifos remaining on the corn leaf surface was 5.8% of the applied carbon 14 with 72% in the air. At that time there was 21.5% of the carbon 14 applied in the plant leaf. After 96 hours, there was 1.1% of the applied carbon 14 on the leaf, 10.6% in the leaf and 84.2% in the air. In soils at 24 hours after treatment with carbon 14 chlorpyrifos at a simulated rate of 1.12 kg/ha, 70-90% of the radioactivity was still associated with the soil. The report also reproduced a set of chlorpyrifos results from a study by McCall *et al.* (ref. 43) in which the rapid loss of chlorpyrifos from the corn is apparent.

Dissipation of chlorpyrifos from corn applied as Lorsban 4E in a field study conducted by McCall et al. in Illinois

Days after application	Chlorpyrifos on corn ppm[a]	Days after application	Chlorpyrifos on corn ppm[a]
0[b]	99,137	31 (0)[c]	126-171
4	2.8, 1.9	34 (4)	11-23
7	0.8, 1.5	46 (15)	0.4-7.1
21	0.03, 0.05	50 (19)	0.01-0.08
30	0.01, 0.01	63 (32)	0.01-0.03

a. Results of replicate analyses
b. Lorsban 4E applied broadcast at 1.7 kg chlorpyrifos/ha
c. Lorsban 4E applied broadcast at 1.7 kg chlorpyrifos/ha, second application.

Chlorpyrifos, labelled with chlorine 36 in the 3 and 5 ring positions was applied as a water emulsion formulation containing 22.6% chlorpyrifos or as an acetone solution containing 160 mg chlorpyrifos/100 ml to bare wood, painted wood, glass, paper and metal surfaces and the change in radioactivity measured over time (ref. 44). Unpainted wood lost 60 (acetone solution) and 46% (emulsion) of the applied chlorpyrifos after 1 day. Painted wood losses were of the order of 10-15% after 24 hours from either treatment. Metal surfaces retained the radioactivity for varying times (stainless steel after 12 days had 5% of the radioactivity retained, copper, in contrast, had 68%). Losses from glass were rapid while from paper, the rate depended on the treatment.

These results are of interest as chlorpyrifos can be used to treat animal quarters and the treated surfaces will, on these results, be expected to have chlorpyrifos residues for some time after treatment.

4.14 Fat Solubility

Residue data examined in the evaluation and animal metabolism data identify chlorpyrifos as a pesticide, which shows fat solubility. A similar conclusion has been reached by the Codex Alimentarius which defines chlorpyrifos as “Chlorpyrifos (fat-soluble).

Farm animal metabolism studies showed that chlorpyrifos residues in milk reached plateau values. The likely attainment of tissue plateau values (implied by the milk plateau formation), the depletion of residues when exposure ceased, and actual survey data on chlorpyrifos residue levels in animal commodities indicate that chlorpyrifos in animal, especially fat, tissues is not a major concern when the current use patterns are followed.

4.15 Residues in Food in Commerce or at Consumption

National Residue Survey

The National Residue Survey (NRS) has analysed for chlorpyrifos residues in grains and animal commodities over recent years.

The Survey results show that measurable chlorpyrifos residues have been found in wheat bran. Two out of 347 samples (0.6%) between the periods of July 1994 and June 1997 had results between the MRL of 0.1 mg/kg and twice that value. In that same period, four samples had chlorpyrifos residues between half the MRL and the MRL (1.2%). Quantifiable residues were not reported in the other samples.

One chlorpyrifos residue has been reported in wheat (1 sample out of 8327 samples over the July 1994 to June 1997 period, with the detected residue being less than one fifth of the MRL of 0.1 mg/kg).

In animal commodities, the NRS reported that beef fat contained residues in 2 samples out of 2269 in 1993/1994 (one at trace level and the other at <0.2x the MRL of 2.0 mg/kg, i.e. ≤0.4 mg/kg), in 1995/1996, beef fat analysed had residues in 1 of 3558 samples, (a trace value,), and in 1996/1997, 6 beef fat samples out of 3228 had residues (4 at trace levels and 2 at <0.2x the MRL of 2.0 mg/kg). In the 1994/1995 period, no chlorpyrifos residues were measured in 2922 beef fat samples. The recommended deletion of the cattle meat (in the fat) MRL and replacement by a meat mammalian (in the fat) MRL of 0.5 mg/kg indicates that those residues previously identified as <0.2x the MRL of 2 mg/kg would still fall under the lower MRL of 0.5 mg/kg.

Ovine fat samples very rarely contained measurable chlorpyrifos residues. In 1993/1994 in a total of 1701 samples, one sample had trace levels and one was between 1 and 2 times the MRL of 0.1 mg/kg. In 1996/1997 one sample was between 1 and 2 times the 0.1 mg/kg MRL from a total of 1880 samples. In the 1994/1995 and 1995/1996 periods, no measurable chlorpyrifos was reported in 3113 and 2429 ovine fat samples respectively.

In whole milk sampled in 1993/1994, no measurable chlorpyrifos was found in 118 samples. In 1994/1995, one out of 295 whole milk samples had chlorpyrifos residues at <0.2x the MRL of 0.2 mg/kg, i.e. ≤0.04 mg/kg. Milk was not reported as being analysed in the 1995/1996 and 1996/1997 periods.

No chlorpyrifos residues were reported as found in whole eggs, goat, porcine, horse or poultry fats.

Between 1993 and 1996, no chlorpyrifos residues were reported in 263 onions samples. In 1995/1996, 4 of 32 nut samples had chlorpyrifos residues at between half the MRL of 0.02 mg/kg and the MRL value. In 1996/1997, no chlorpyrifos residues were reported in 116 nut samples.

Market Basket Survey

The Australian Market Basket survey, conducted by the Australian New Zealand Food Authority, has regularly analysed foods in a table ready state for pesticide and contaminant residues. Chlorpyrifos has been included in those analyses and results from surveys conducted from 1985 to 1995 showed that residues of this chemical were regularly found in a wide range of crops and occasionally in meat samples. Residue concentrations were generally less than the relevant MRLs with the notable exceptions of celery and grapes where residues were sufficiently above the MRLs to result in the NRA reviewing these cases and recommending appropriately revised MRLs. Beef was not identified as a significant chlorpyrifos source and residues were at the “trace” level.

Dietary intakes of chlorpyrifos were reported in the 1986, 1990, 1992, and 1994 surveys. These intakes have consistently been less than 7% of the chlorpyrifos ADI of the time. In 1986 the calculated dietary intakes for infants, children, young adults, men, and women were between 0.2 (infant) and 0.5% (child) of the then ADI of 10 μg/kg body weight/day. In 1990, the dietary intakes for infants, etc. were between 0.01 (infants) and 0.14% (boy) of the same ADI value. In the 1992 survey, intakes based on 95th percentile energy intakes were between 3.8 (adult male) and 6.3% (2 year old of the again, same ADI. In the 1994 survey, dietary intakes for the 95th percentile energy intake ranged between 1.4% (adult males) to 5.3% (2 year old child) of the ADI of 0.003 µg/kg body weight/day.

The 1995 report of the FAO/WHO Joint Meeting on Pesticide Residues reported that dietary intakes of chlorpyrifos in Belgium and Finland were less than the then current Codex ADI. These results are consistent with the Australian Market Basket Survey results in relation to dietary intake of chlorpyrifos.

Victorian produce monitoring results

In the 1995/96 Victorian Department of Natural Resources and Environment residue monitoring program (Victorian Produce Monitoring   Results of residue testing 1995/96 March 1997. Department of Natural Resources and Environment, Victoria. ISSN 1039 3846, Subseries ISSN 1036-1227), it was reported that in 64 fruit samples analysed for chlorpyrifos, one had residues above the apple MRL (0.2 mg/kg, now recommended as a temporary value of 0.5 mg/kg) and two, residues above the grape MRL (0.01 mg/kg at that time, now recommended as 1 mg/kg). In 55 vegetable samples analysed, all were reported as having residues complying with the relevant MRL. These results show that chlorpyrifos residue complied with the relevant MRLs on the majority of occasions with the recommended increases in the pome fruit and grape MRLs further reducing the chance of residue violations.

Theoretical maximum daily intake (TMDI)

The Market Basket Survey has shown the dietary intake of chlorpyrifos was less than 0.5% of the then chlorpyrifos ADI for all age groups based upon average consumption figures and less than 6% of the chlorpyrifos ADI of 0.003 mg/kg body weight/day when based upon the 95th percentile energy intake. As a result calculation of a TMDI was not considered necessary for the residue evaluation. This was based on there being no increases to the current chlorpyrifos use patterns, no significant new MRLs, the recognised gross overestimates of intake produced by the TMDI calculation and retention of the present ADI of 0.003 mg/kg body weight/day.

4.16 International Residue Limits

The DowElanco ECRP submission for chlorpyrifos (Part: Schedule 1, volume 1 of 1, 26 May, 1997) contains a global registration information database listing country name, active ingredient (chlorpyrifos and on occasion other actives), concentration of chlorpyrifos, the brand name, the crop concerned, the use rate (as L or kg of product/ha) and MRL (as mg/kg). This listing appears to be most comprehensive and could be included in the ECRP report (with appropriate acknowledgment and provisos) if agreed to by DowElanco.

The Codex Alimentarius Commission has established chlorpyrifos MRLs with the latest listing known to the NRA being published in the Codex document CX/PR 97/9, February 1997. The values set (plus the NRA's present equivalent MRL) are:

Codex and equivalent NRA chlorpyrifos MRLs (as mg/kg)

Commodity	**Codex MRL**	**NRA MRL**	**Commodity**	**Codex MRL**	**NRA MRL**
Apple	1	0.2 (p)	Grapes	1	1
Cabbages, head	0.05*	0.5 (b)	Kale	1	ns
Carrot	0.5	*0.01 (v)	Kiwifruit	2	2
Cattle meat	2 (fat, V)	2 (fat)	Lettuce, head	0.1	*0.01 (v)
Cauliflower	0.05*	0.5 (b)	Milks	0.01* (V)	0.2 (fat)
Celery	0.05*	T5	Mushrooms	0.05*	*0.01 (v)
Chicken meat	0.1 (fat)	0.1 (pm&o)	Onion, bulb	0.05*	*0.01 (v)
Chinese cabbages	1	*0.01 (v)	Pear	0.5	0.2 (p)
Citrus fruits	0.3	0.5	Peppers	0.5	Tomato MRL
Citrus fruits	2	0.5	Potato	0.05*	0.05
Common bean	0.2	*0.01 (v)	Raspberries	0.2	ns
Cotton seed	0.05*	0.05	Rice	0.1	0.1 (cg)
Cotton seed oil, crude	0.05*	0.2	Sheep meat	0.2 (fat, V)	0.1 (m&o)
Dried grapes	2	2 (df)	Sugar beet	0.05*	ns
Egg plant	0.2	Tomato MRL	Tomato	0.5	0.5
Eggs	0.05*	*0.01	Turkey meat	0.2 (fat, V)	0.1 (pm&o)

p = pome fruit, b = brassica vegetables MRL, v = general vegetable MRL, pm&o = poultry meat and edible offal MRLs, df = dried fruits MRL, cg = cereal grains MRL, m&o = meat and edible offal MRLs, V = veterinary use, fat = fat soluble pesticide and measured in fat, ns = no specific equivalent to the Codex commodity.

Because of their importance to Australian meat exports, US animal commodity tolerances are given here. The draft US reregistration document (RED) for chlorpyrifos indicates no changes to these values are being recommended except for milk. In that situation, the whole milk tolerance is recommended for revocation, as residues are covered by the tolerance for milk fat which reflects the current whole milk tolerance of 0.01 ppm.

Proposed US animal commodity chlorpyrifos tolerances (as given in the draft US reregistration document for chlorpyrifos)

cattle fat 0.3 ppm
cattle meat 0.05 ppm

cattle meat, by-products 0.05 ppm
goats, hogs, and sheep fat each 0.2 ppm
goats, hogs, and sheep meat each 0.05 ppm
goats, hogs, and sheep meat byproducts each 0.05 ppm
horses fat 0.2 ppm
horses, meat 0.25 ppm
horses, meat by-products 0.25 ppm
milk fat 0.25 ppm
poultry, fat 0.1 ppm
poultry, meat 0.1 ppm
poultry, meat byproducts 0.1 ppm.

FAO/ WHO Joint Meeting on Pesticide Residues (JMPR)

Residue aspects of chlorpyrifos have been considered by the JMPR on a number of occasions since 1972 with the last evaluation being in 1995 when chlorpyrifos in citrus was looked at and the then current Codex MRL of 0.3 mg/kg raised to 2 mg/kg on the basis of residue data from the USA..

In the 1995 JMPR report it was noted that chlorpyrifos had been identified by the Codex as a compound listed for periodic review but no date had been scheduled at that time

ATTACHMENT A - Australian Use Patterns

Commodity/ site	Form- ulation [chlor- pyrifos]	Maximum application rate (chlor- pyrifos = ai)	Maximum number of applications	Minimum interval between applications	Other
Agricultural, do-mestic, commercial, and industrial areas	EC 500 g/l	1 L/100L (500 g ai/100L)			Ant control. Used as a spot spray.
Agricultural, dom- estic, commercial and industrial areas	EC 500 g/l	100 ml/10L (50 g ai/10L)			
Apples	WP 500 g/kg	100 g/100L (50 g ai/100L)	2 (50 g ai/100L)		Early season application or repeat spraying after petal fall (25 g ai/hl for repeat spraying program). 14 day WHP.
Apples	EC 500 g/l	100 ml/100L (50 g ai/100L) or 500 ml/ha (250 g ai/ha) or 50 ml/100L (25 g ai/100L).			Depending on pest, apply in mid-late November and later as necessary. Can be applied up to within 2-3 weeks of harvest. Per hectare and lower /hl rate for control of wingless grasshoppers. 14 day WHP.

Apples	WP 250 g/kg	200 g/100L (50 g ai/100L)	2		Apply at late pink and flowering stages. 14 day WHP
Apples	WP 250 g/kg	100 g/100L (25 g ai/100L)		2 weeks	Apply after petal fall. 14 day WHP.
Avocado	WP 500 g/kg	120 g/30L (60 g ai/30L)		7 days	Strip or patch low on tree. Avoid contact with fruit. Used with yeast hydrolysate. 7 day WHP.
Avocado	EC 500 g/l	100 ml/100L (50 g ai/100L) or 2 L/ha (1000 g ai/ha)			Apply and repeat as necessary. 7 day WHP.
Avocado	EC 500 g/l	400 ml/100L (200 g ai/100L) plus yeast hydrolysate		Every 7 days	Applied as bait on tree trunk. Avoid contact with fruit. 7 day WHP
Avocado	WP 250 g/kg	240 g/30L (60 g ai/30L)		7 days	Mixed with yeast hydrolysate as bait on tree trunks. Not allowed to contact fruit. 7 day WHP.

Banana	WP 500 g/kg	250 g/125L (125 g ai/125L) or 2 kg/ha (1 kg ai/ha) or 10 g/5L (5 g ai/5L)			Repeat as necessary from first appearance of flowers (moth control). 14 day WHP
Banana	EC 500 g/l	200 ml/100L (100 g ai/100L) or aerially 2 L/ha (1000 g ai/ha)			From flower bell, repeat as necessary until fingers are exposed. Control of moth. 14 day WHP.
Banana	EC 500 g/l	1.8 L/100L (900 g ai/100L)	Two	Sept/Nov and Feb/Apr in tropical areas	Borer control, applied to butt and soil. Withholding period not applicable or “Nil”.
Banana	WP 500 g/kg	500 g/100L (250 g ai/100L) or 500 g/4 kg of sand (250 g ai/4 kg of sand).	2 per season		Apply in spring and autumn to base of plant for borer control. 14 day WHP.
Banana	WP 250 g/kg	500 g/125L (124 g ai/125L) or 4 kg/ha (1000 g ai/ha) or 20 g/5L (5 g ai/5L)			Air-blast. Use between flower and finger exposure. Repeat as needed to control moth pests. 14 day WHP

Banana	WP 250 g/kg	1 kg/100L (250 g ai/100L) or 1 kg/4 kg sand (250 g ai/4 kg sand)	Two		Apply in October/Nov-ember and again at March/April for borer control. Applied to base of plant and around base. 14 day WHP
Beans	EC 500 g/l				See "Vegetables"
Beetroot	EC 500 g/l				"NIL" WHP. See "Vegetables".
Brassicae vegetables	EC 500 g/l	200 ml/100L (100 g ai/100L) or 2 L/ha (1 kg ai/ha)		Every 10-14 days	For *Helicoverpa* control. Use of wetting agent recommended. See also "Cole crops" or "Vegetables".
Cabbage	EC 500 g/l	300 ml/100L (150 g ai/100L) as drench or 2L/ha (1000 g ai/ha) as boom spray			Drench applied to base of plant. 5 day WHP.
Carrots	EC 500 g/l	700 ml/ha (350 g ai/ha)	Two		Apply when moths detected. Withholding period not applicable.
Carrots, beetroot, turnips, onions, shallots, radish	WP 250 g/kg	1 kg/10 kg seed (250 g ai/10 kg seed)			Seed dressing.

Carrots, beetroot, turnips, onions, shallots, radish	Dust	1 kg/10 kg seed (250 g ai/10 kg seed)			Seed dressing.
Cassava	EC 500 g/l	700 ml/ha (350 g ai/ha) or 70 ml/100L (35 g ai/100L)			Applied to seedlings. Withholding period not applicable or “NIL”.
Cauliflower	EC	300 ml/100L (150 g ai/100L) as drench or 2L/ha (1000 g ai/ha) as boom spray			Drench applied to base of plant. 5 day WHP.
Celery	500 EC	Up to 1 kg ai/ha as a foliar spray.	Not specified	Not specified	Temporary MRL of 5 mg/kg established with WHP of 14 days. Additional data requested by about 1999.
Cereals (all cereal entries include barley, maize, millet, oats, rice, rye, sorghum, triti-cale, & wheat	EC 500 g/l	900 ml/ha (450 g ai/ha)	See “Other”	See “Other”	Repeat when necessary. 10 day harvest WHP, 2 day grazing WHP.
Cereals	EC 500 g/l	120 ml/100 kg seed			Seed dressing. With-holding period not applicable.

Cereals	WP 250 g/kg	800 g/100 kg seed (200 g ai/100 kg seed)		Seed dressing.
Cereals	Dust	800 g/100 kg seed (200 g ai/100 kg seed)		Seed dressing.
Cereals, pasture, forage crops	EC 500 g/l	900 ml/ha (450 g ai/ha)		Spray as required by pest pressure. Pre-plant and post-emergence spraying allowed. Cereals WHP 10 days, grazing WHP 2 days.
Cereals, pasture, forage crops (oil seeds)	EC 500 g/l	1.5 L/ha (750 g ai/ha) (oil seeds, 500 ml/ha)		Locust, grasshopper control. Lower rates for other insects. Re-spray for mite and lucerne flea control allowed. WHP 10 days for cereals and 2 days for grazing.
Cereals, pasture, young plants of oil seeds, oil seeds	EC	900 ml/ha (450 g ai/ha)		Spray as required. Cutworm control. Follow-up treatments permitted. Cereals WHP 10 days, grazing WHP 2 days.

Citrus	WP 500 g/kg	120 g/30L (60 g ai/30L)		7-10 days	Strip or patch low on tree. Avoid contact with fruit. Used with yeast hydrolysate. 14 day WHP.
Citrus	EC 500 g/l	100 ml/100L (50 g ai/100L)	Two		Applied in November/ March for scale control. 14 day WHP.
Citrus	EC 500 g/l	50 ml/100L (25 g ai/100L) or 500 ml/ha (250 g ai/ha)			Grasshopper control. 14 day WHP.
Citrus	EC 500 g/l	2 L/ha (1 kg ai/ha) or 2 l/100L (1 kg ai/100L)			Ant control. Ground and butt applications, 1-2 times per year as needed.
Citrus	EC 500 g/l	200 ml plus yeast autolysate (100 g ai)		7-10 days	Bait on tree trunks. 14 day WHP set.
Citrus	WP 250 g/kg	240 g/30L (60 g ai/30L)		7 to 10 days	Mixed with yeast hydrolysate as a bait on tree trunks. Not allowed to contact fruit. 14 day WHP
Clover seed crops	EC 500 g/l	300 ml/ha (150 g ai/ha)	1		Apply just prior to seedling emergence. 2 day grazing WHP.
Cockroaches	Bait	5 g ai/kg			Household baits for cockroach control.

Coffee (non bearing)	EC 500 g/l	200 ml/hl (100 g ai/hl)	See “Other”		Apply as necessary to base of seedlings. Nil WHP.
Cole crops includ-ing cabbage, cauli-flower, brussels sprouts. broccoli	EC 500 g/l	200 ml/100L (100 g ai/100L) or 2 L/ha (1000 g ai/ha)		7-14 day intervals depending on pest	Non-ionic wetting agents can be used. 5 day WHP.
Commercial and industrial areas	EC 225 g/l	240 ml/10L (54 g ai/10L)			Pest control.
Container plants in soil or other growing media	WP 500 g/kg	250 g/25L (12.5 g ai/25L)			Tasmania only
Container plants in soil or other growing media	WP 250 g/kg	500 g/25L (125 g ai/25L)			Tasmania only.
Cotton	ULV 300 g/l	2.5 L/ha (750 g ai/ha) in label presented by DowElanco. In 1996 the NRA agreed to a revised rate of 1.5 kg/ha with no more than 2 applications per season.	As needed	See “Other”	5-10 day regular sprays for mite control. Repeat sprays for aphid control. 10 day WHP. Can be used as a preventative spray. In 1996 the NRA recommended a 28 day harvest withholding period and a 28 day grazing/feeding interval after treatment.

Cotton	ULV 300 g/l	25 ml/100m row (7.5 g ai/100 m row or 2.5L/ha (750 g ai/ha)			In furrow treatment at planting
Cotton	EC 500 g/l	1.5 L/ha (750 g ai/ha) or for in- furrow use: 15 ml/100 m row (7.5 g ai/100 m row) or 1.5 L/ha with a 1 metre row spacing			Re-spray permitted for some pests. Withholding period stated to be not applicable. Another product label states there is a 2 day grazing WHP.
Cotton (young plants)	EC 500 g/l	900 ml/100L/ha (450 g ai/100L)			Follow up treatments as required. Withholding period not stated (not applicable to use pattern)
Cotton, Lucerne, Maize, Sorghum, Sunflower	EC 500 g/l	90 or 250 ml product + cracked wheat or sorghum/ha (45 or 125 g ai/ha)			As baits.
Cucurbits	EC 500 g/l	100 ml/100L (50 g ai/100L)			Ant and mealy bug control. 5 day WHP.
Cucurbits	EC 500 g/l	50 ml/100L (25 g ai/100L)		10-14 days	Repeat treatments as needed. 5 day WHP.
Custard apple	EC 500 g/l	2 L/100 L (1 kg ai/100L)	1-2 per season		Use 1000 l spray/ha to trunk and ground below tree.

Domestic & public places. Commercial & industrial areas	EC 450 g/l 500 g/l	110 ml/10L (49.5 g ai/10L) or 100 ml/10L (50 g ai/10L)		Applied as spray to areas where pests can occur. Indoor and outdoor use. Outdoor use for where animals frequent.
Domestic, commercial and industrial areas	EC 500 g/l	1 l/100 L		Ant control
Field peas, broad beans, chickpeas, lupins, lucerne, lucerne pastures and clover seed crops. Rapeseed, linseed, safflower, wheat, oats, barley, rye, triticale. Improved annual pastures, establishing perennial pastures	EC 500 g/l	300 ml/ha 330 ml/ha (165 g ai/ha)		Spray prior to seedling emergence to control mites. A day 10 WHP for cereals and a 2 day grazing WHP are listed.
Ginger	WP 500 g/kg	900 g/ha (450 g ai/ha)		Apply when pest damage is seen on the primary shoot or first leaf

Ginger	EC 500 g/l	900 ml/ha (450 g ai/ha)			Apply when primary shoot or first leaf damaged by pest. Withholding period not applicable.
Ginger	WP 250 g/kg	1.8 kg/ha (450 g ai/ha)			Apply when there is damage to the primary shoot or first leaf.
Grape vines	EC 500 g/l	50 ml/100L (25 g ai/100L) or 500 ml/ha (250 g ai/ha)..			First spray after berry set, with later sprays as required. 14 day WHP.
Grape vines	EC 500 g/l	100 ml/100L (50 g ai/100L) for scale control or for mealybug control.	2 (mealybug control)	14	Scale control done as a dormant spray, post-pruning. No WHP applicable. Also for mealy bug control. Applied to bunches and lower part of vines before berries close (repeat after 14 days if necessary).
Grape vines	WP 500 g/kg	50 g/100L (25 g ai/100L) or 500 g/ha (250 g ai/ha)			From berry set onwards. Multiple sprays can be used. 14 day WHP.
Grape vines	WP 250 g/kg	100 g/100L (25 g ai/100L) or 1 kg/ha (250 g ai/ha)			Apply after berry set and then as required. 14 day WHP

Hides and skins	EC 450 g/l 500 g/l	220 ml/100L (99 g ai/100L) or 200 ml/100L (100 g ai/100L)		3 months	
Hops	EC 500 g/l	160 ml/100L (80 g ai/100L)	See “Other”		Apply as necessary. Nil WHP set.
Kiwi fruit	WP 500 g/kg	50 g/100L (25 g ai/100L) or 1 kg/ha (500 g ai/ha)		14 days between 1st and 2nd, then 21-28 days as required.	14 day WHP.
Kiwi fruit	WP 250 g/kg	100 g/100L (25 g ai/100L) or 2 kg/ha (500 g ai/ha)		14 days for the 1st and 2nd and then 21-28 days	From green-tip on. 14 day WHP
Kiwifruit	EC 500 g/l	50 ml/100L (25 g ai/100L) or 1 L/ha (500 g ai/ha)			Do not apply post-blossom. 14 day WHP. On another label: Repeat while pests are active for 50 ml/100L rate.
Lawn	EC 10 g/l	2 L/50 m^2 (20 g ai/50 m^2)			Beetle control in lawns in home gardens.
Lawns	EC 200 g/l	100 ml/100 m^2 (20 g ai/100 m^2)			Beetle control in lawns.
Leafy crucifers including Chou Moullier, Kale, Mustard, and Rape	EC 500 g/l	300 ml/ha (150 g ai/ha)			For control of certain mites. “Nil” WHP specified. See also “Vegetables”.

Lettuce	EC 500 g/l	800 ml/ha (400 g ai/ha)		Nil WHP. See also “Vegetables”.
Lettuce	EC 500 g/l	300 ml/ha (150 g ai/ha)		For control of certain mites. 7 day WHP. See also “Vegetables”.
Loquat	EC 500 g/l	400 ml/100L (200 g ai/100L) + yeast autolysate	Every 7 days	Apply to strip or patch on tree. Avoid contact with fruit.
Lucerne	EC 500 g/l	900 ml/ha (450 g ai/ha)		Retreatments as needed. 2 day grazing WHP.
Lucerne (young plants)	EC 500 g/l	700 ml/ha (350 g ai/ha)		2 day grazing WHP.
Lucerne and medics in pasture and forage crops	EC 500 g/l	350 ml/ha (175 g ai/ha)		2 day grazing WHP.
Macrocarpa hedges	WP 500 g/kg	50g/100L (25 g ai/100L) or 500 g/ha (250 g ai/ha)		Apply in late winter to early spring to act as a barrier to entry into orchards.
Macrocarpa hedges	WP 250 g/kg	100 g/100L (25 g ai/100L) or 1 kg/ha (250 g ai/ha)		Hedges sprayed to make a barrier into orchards.
Maize	ULV 300 g/l	25 ml/100m row (7.5 g ai/100 m row or 2.5L/ha (750 g ai/ha)		In furrow treatment at planting

Maize	EC 500 g/l	20 ml/100 m row (10 g ai/100 m row) or 2L/ha (1 kg ai/ha)/1 metre row spacing		At sowing. WHP not applicable.
Maize	EC 500 g/l	2 L/ha (1000 g ai/ha) or 20 ml/100 m row (10 g ai/100 m row)		Apply at sowing. Nil WHP established.
Maize, soybeans, sunflower	EC 500 g/l	100 ml/2.5 kg bait (50 g ai/2.5 kg of bait)		At sowing. WHP not applicable.
Maize, sunflower	EC 500 g/l	15 ml/100 m row (7.5 g ai/100m row) or 1.5 L/ha (750 g ai/ha) for rows of 1 m spacing		In furrow use. WHP not applicable.
Mango	EC 500 g/l	100 ml/100L (50 g ai/100L) 200 ml/100L (100 g ai/100L)		Ensure fruit given thorough coverage. Higher rate for green tree ant control and allows for application to canopy. 21 day WHP
Mung beans, Navy beans, Chickpea, Cowpea, Pigeon pea, Soybean	EC 500 g/.	90 or 250 ml/ha as a bait with cracked wheat or sorghum (45 or 125 g ai/ha)		As baits. "Nil" WHP.

Oil seeds	EC 500 g/l	900 ml/ha (450 g ai/ha)	See “Other”		Repeat when necessary.
Oil seeds, cereals	WP 250 g/kg	160g/100 kg seed (40 g ai/100 kg seed)			Seed dressing.
Oil seeds, cereals	Dust	160g/100 kg seed (40 g ai/100 kg seed)			Seed dressing.
Passion fruit	WP 500 g/kg	120 g/30L (60 g ai/30L)		7 -10 days	Strip or patch low on tree. Avoid contact with fruit. Used with yeast hydrolysate. 14 day WHP.
Passion fruit	WP 250 g/kg	240 g/30L (60 g ai/30L)		7 to 10 days	Mixed with yeast hydrolysate as a bait on tree trunks. Not allowed to contact fruit. 14 day WHP
Pasture	EC 500 g/l	900 ml/ha (450 g ai/ha)			2 day grazing WHP. Retreatment allowed for some pests.
Pasture, forage crops	EC 500 g/l	900 ml/ha (450 g ai/ha)	See “Other”		Repeat when necessary. 2 day grazing WHP.
Pears	WP 500 g/kg	50 g/100L (25 g ai/100L)		2 weeks	Multiple applications from petal fall. 14 day WHP.

Pears	EC 500 g/l	100 ml/100L (50 g ai/100L) or 500 ml/ha (250 g ai/ha) or 50 ml/100L (25 g ai/100L).	10-14 for some uses.	Depending on purpose, apply in mid-late November and later as necessary. If necessary can be applied to 2-3 weeks before harvest. Per hectare and lower /hl rate for control of wingless grasshoppers. 14 day WHP.
Pears	WP 250 g/kg	100 g/100L (25 g ai/100L)	2 weeks	From petal fall as required. 14 day WHP
Peas	EC 500 g/l			See "Vegetables"
Pineapples	EC 500 g/l	100 ml/100L (50 g ai/100L) or 5l/ha (2500 g ai/ha)	90 days	Withholding period stated to be not applicable on one label, 14 days set on another.
Pineapples	EC 500 g/l	5L/ha (2.5 kg ai/ha)		Pre-planting spray. Withholding period stated to be not applicable.
Polluted water impoundmen ts	EC 450 g/l 500 g/l	2 ml/10000L (1 g ai/10000L) or 20 ml/m^3 (10 g ai/ cubic metre)		Mosquito control.

Pome fruit	EC 500 g/l	50 ml/100L (25 g ai/100L) or 500 ml/ha (250 g ai/ha) or 400 ml/100L + yeast autolysate.		7 days for product with autolysate.	Grasshopper control. 14 day WHP. Fruit fly control with the 400 ml/100L rate. Applied to strip/patch on trees with direction to avoid contact with fruit.
Potatoes	EC 500 g/l	6 L/ha (3 kg ai/ha)		Repeat as necessary for some pests.	From pre-planting to final hilling up (800-1000 ml/ha). With-holding period stated to be not applicable.
Potatoes	EC 500 g/l	500 ml/ha (250 g ai/ha) or 50 ml/100L (25 g ai/100L)			Grasshopper control, applied to infested area or as a barrier. Nil withholding period set.
Rapeseed	EC 500 g/l	1.5 L/ha (750 g ai/ha)			Withholding period stated to be not applicable.
Rice	EC 500 g/l	1.5 L/ha (750 g ai/ha) for Brown plant-hopper or 60 or 150 ml/ha (30 or 75 g ai/ha) for Bloodworm.	See “Other”		Repeat when necessary. 10 day harvest WHP, 2 day grazing WHP. Also covered by “cereals” use.

Safflower	EC 500 g/l	1.5 L/ha (750 g ai/ha) or 15 ml/100 m row (7.5 g ai/100 m row)		Applied in furrow at planting. A 2 day grazing WHP is set.
Silver beet	EC 500 g/l	300 ml/ha (150 g ai/ha)		Withholding period stated to be not applicable. One label states a 7 day WHP for control of certain mites.
Soil treatment for new and existing pole protection - e.g. fence posts etc.	EC 450 g/l 500 g/l	440 ml/10L (198 g ai/10L) or 400 ml/10L (200 g ai/10L)	See "Other"	Retreatment needed within 3 to 5 years depending on the location.
Sorghum	ULV 300 g/l	25 ml/100m row (7.5 g ai/100 m row or 2.5L/ha (750 g ai/ha)		In furrow treatment at planting
Sorghum	EC 500 g/l	1.5 L/ha (750 g ai/ha)		Repeated sprays allowed for some pests. 2 day WHP. Highest rate is for locust control. Rates are between 350 ml and 1.5 litres/ha.

Sorghum	EC 500 g/l	15 ml/100 m row (7.5 g ai/100m row) or 1.5 L/ha (750 g ai/ha) per row of 1 metre spacing			In furrow application. WHP period stated as not applicable but on another product, a 2 day grazing WHP is listed.
Sorghum	EC 500 g/l	100 ml/2.5 kg bait (50 g ai/2.5 kg bait)			Apply at crop planting. 2 days WHP and 2 day grazing WHP.
Stone fruit	WP 500 g/kg	50 g/100L (25 g ai/100L)		2 weeks	Multiple applications from petal fall. 14 day WHP.
Stone fruit	WP 500 g/kg	120 g/30L (60 g ai/30L)		7 days	Strip or patch low on tree. Avoid contact with fruit. Used with yeast. hydrolysate.
Stone fruit	EC 500 g/l	100 ml/100L (50 g ai/100L) or 2L/ha (1000 g ai/ha) or 200 ml/5 kg cereal based bait (100 g ai/5 kg)			Apply in spring for earwig control. Bait applied by spreader. Scale control spray in dormant period and also mid-late November or later for crawler control. 14 day WHP.
Stone fruit	WP 250 g/kg	100 g/100L (25 g ai/100L)		2 weeks	From petal fall as required. 14 day WHP
Stone fruit	WP 250 g/kg	240 g/30L (60 g ai/30L)		7 days	Mixed with yeast hydrolysate as a bait on tree trunks. Not allowed to contact fruit. 14 day WHP

Strawberries	EC 500 g/l	100 ml/10 kg bait (50 g ai/kg)		Used in recently ratooned or newly planted runner situations. Withholding period stated to be not applicable.
Strawberry	EC 500 g/l	100 ml/ha (50 g ai/ha)		As bait. 14 day WHP.
Sugarcane	EC 500 g/l	2L/ha (1 kg ai/ha)	See “Other”	Frequently at planting or setting (750-1000 g chlorpyrifos/ha). Later stage application possible (locust control 175-750 g chlorpyri-fos/ha, armyworm control 350-450 g chlor-pyrifos/ha). 7 day WHP and 2 day grazing WHP set for all applications.
Sugarcane	Granule 140 g/kg	28 kg/ha (3.9 kg ai/ha) or 420 g/100 m row (59 g ai/100 m row)		Incorporated into the soil at planting, first working, or cutaway or drill fill-in. A WHP period is not specified for this use.
Sunflower	EC 500 g/l	1.5 L/ha (750 g ai/ha) or 15 ml/100 m row (7.5 g ai/100 m row)		Applied in furrow at planting. A 2 day grazing WHP is set.
Sunflower	ULV	25 ml/100m		In furrow

	300 g/l	row (7.5 g ai/100 m row or 2.5L/ha (750 g ai/ha)			treatment at planting
Swede	EC 500 g/l	300 ml/ha (150 g ai/ha) or 100 ml/100L (50 g ai/100L)		Apply when necessary	"Nil" WHP.

Termite nest treatment	EC 450 g/l 500 g/l	110 ml/10L (49.5 g ai/10L) or 100 ml/10L (50 g ai/10L)			
Termite protection in buildings (post-construction)	EC 500 g/l	400 ml/10L (200 g ai/10L)		See “Other”	Retreatment as needed - determined by inspection. Expected effectiveness as an external barrier is 3 to 5 years depending on situation.
Termite protection in existing build- ings, including animal houses, sheds, fences etc. and reticulation systems	EC 450 g/l 500 g/l	440 ml/10L (198 g ai/10L) or 400 ml/10L (200 g ai/10L)		See “Other”	Retreatment as needed - determined by inspection. Expected effectiveness 3 to 10 years depending on situation.
Termite protection in houses, ..., farm buildings under construction.	EC 450 g/l	440 ml/10L (198 g ai/10L)		See “Other”	Retreatment as needed - determined by inspection. Expected effectiveness 3 to 10 years depending on situation.
Tobacco	EC	3L/ha (1.5 kg ai/ha)			Pre-planting application. Nil WHP.
Tomatoes	EC 500 g/l	200 ml/100L (100 g ai/100L) or 2L/ha (1000 g ai/ha)		7-10 days	Spray from commencement of flowering or when pest seen. 3 day WHP. See also “Vegetables”.

Tomatoes	EC 500 g/l	300 ml/100L (150 g ai/100L) as a drench or 5L/ha (2.5 kg ai/ha) at planting (soil application)		Repeat as necessary dependent on the pest.	At planting or to base of plant. Follow-up treatment may be necessary. A withholding period considered not applicable. Repeat as necessary.
Turf	EC 500 g/l	6 L/ha (3 kg ai/ha) or 100 ml/100L (50 g ai/100L)			2 day grazing WHP. Feeding restraints.
Turf and lawn	EC 500 g/l	10 ml/10L (5 g ai/10L) and 80 ml/m^2 (40 g ai/m^2). Turf bait: 30 or 90 ml/ha (15 or 45 g ai/ha)			Repeat sprays allowed for certain pests. Use as a turf bait has a 2 day grazing WHP. Turf use is for turf farms only.
Turnip	EC 500 g/l	300 ml/ha (150 g ai/ha) or 100 ml/100L (50 g ai/100L)		Apply when necessary	"Nil" WHP.

Vegetables	EC 500 g/l	70 ml/100L (35 g ai/100L) or 100 ml/10 kg bran bait (50 g ai/10 kg bait) or 800 ml/ha (400 g ai/ha)		Seedling stage (800 ml/ha) and as required. Specific withholding periods: Tomatoes 3 days, cole crops 5 days, asparagus 14 days. One label on specified an asparagus WHP of 14 days with others "Nil".
Vegetation	EC 450 g/l 500 g/l	120 ml/ha (54 g ai/ha) or 105 ml/100L (52.5 g ai/100L)		Mosquito control

Table entries are based on examination of labels examined in the chlorpyrifos residue ECRP evaluation. Labels were those presented for the evaluation.

ATTACHMENT B - Analytical methodology

Analysis of chlorpyrifos was described for a large number of commodities. The methodology used standard extraction and clean-up procedures and determination by GLC. Recoveries were generally good and could be reliably done at levels of down to at least 0.01 mg/kg.

Commodities analysed (plus method reference where appropriate) were alfalfa (ref. 45) (ACR 78.10), apples (ref. 46, 47, 48) (ACR 76.3.S1), apples and apple juice and pomace (ref. 49 and 50) (ACR 73.5, Modification S1), bananas (ref. 51) (ACR 72.14), cattle meat (ref. 52 and 53), cottonseed and cottonseed fractions (ref. 54) (ACR 74.4), grapes and wine (ref. 55) (ERC 87.8), (ref. 56) (ACR 72.15), (ref. 57, 58, 59, and 60)'. (ERC 76.1 and modifications) (ref. 61), lettuce (ref. 62) (ACR 84.4), mango (ref. 63) (ACR 76.9 and 72.13), milk and cream (ref. 64), oranges (ACR 73.5.S1) and orange juice (ACR 73.5.S2), peel (ref. 65), and pulp (ref. 66), pasture (ref. 67). (ECR 90.13), peaches (ref. 68) (ACR 71.14), peas (ref. 69) (ERC 76.1), potatoes (ref. 70 and 71) (ACR 73.5 with modifications), poultry and eggs (ref. 72 and 73) (ACR 72.3), sorghum grain, green forage, and fodder (ref. 74) (ACR 84.4.S3), stone fruit (ref. 75) (ACR 84.4), Sugar (sugar, bagasse, syrup etc.) (ref. 76), Swine (pig) tissues (ref. 77) (ACR 72.1), vegetables (ERC 76.1).

ATTACHMENT C - Summary of Australian chlorpyrifos residue data

Crop, State,	Application details				Residues, mg/kg or ppm			Comment & reference
Year	**Form-ulation**	**No. of applic-ations**	**Interval between appli-cations**	**Conc. g ai/hl or ha or other**	**PHI days**	**Chlor-pyrifos**	**3,5,6 or as stated**	
Apples, Tasmania, 1972	25W	8	14	0.025 % = 25 g ai/100 L ai, 1138 l/ha.	1 7 14 28	0.24 0.12 0.41 (0.14) 0.10 (0.04)		High volume. Granny smith var. Oxygen analogue not detected. Ref. study number 201 (ref. 78) . Day 14 & 28 samples considered too high, next highest values 0.14 & 0.04 ppm.
Apples, Tasmania, 1972	25W	8	14	0.025 % = 25 g ai/100 L ai, 1138 l/ha.	1 7 14 28	0.28 0.14 0.07 0.04		High volume. Margaret Sturmer var. Oxygen analogue not detected. Ref. study number 201.
Apples, Victoria , Hastings, 1972	25W	7	14	0.025 % ai = 25 g ai/100	3 7 14 28	0.41 0.3 0.16 0.11		High volume, Jonathon var..

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
				L, 1138 l/ha.				Oxygen analogue not detected. Ref. study number 201
Apples, Victoria, Hastings, 1972	25W	7	14 days	0.025 % = 25 g ai/100 L ai, 1138 l/ha.	2 7 14 28	0.41 0.42 0.15 0.15		High volume, Jonathon var. Oxygen analogue not detected. Ref. study number 201.
Avocados, Queensland, 1985	Lors-ban 50 EC	1	na	1000 g ai/ha (1x) 2000 g ai/ha (2x maximum label rate)	7 14 7 14	0.37 0.32 1.9 1.3		High volume spray. Variety not reported. Analytical method ACR 73.6. Av. recovery 85.7% (0.01-2 mg/kg). Corrected mean values reported. Ref. Eshak (ref. 79).
Avocados,	Lors-	11	14 days	500 g	0	0.82		7-10 l/tree.

Crop, State,	Application details				Residues, mg/kg or ppm			Comment & reference
Year	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
Queensland, 1986	ban 50 EC		(mean)	ai/ha (50 g ai/100 L) 1000 g ai/ha (100 g ai/100 L)	7 14 21 28 0 7 14 21 28	0.22 0.12 0.037 0.046 1.1 0.81 0.27 0.078 0.027		Seed re-moved before analysis. Not specified whether results calculated on whole fruit basis. Re-sults corrected for con-trol and recovery (aver-age recovery 80.4% (0.01-1 ppm). Methods ACR 76.9 & 72.13. Ref. Payne (ref. 80). The 1000 g ai/ha rate stated to be double the normal use rate (on a /hl basis assumed).
Bananas, Queensland, 1981	50EC	1	na	800 g ai/ha	 1 14	Peel nd nd	Pulp nd nd	Aerial spraying. William

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
								hybrid var. Maximum uncorrected peel residues: 0.08 and 0.03 ppm respectively. (ref. 81). Study number PAU-3183 042
Bananas, Queensland, 1996	500 WP & 1% dust	2	14-21 days	0.1% soln. 5 g ai/5 L and then 5 (1X) or 10 (2X) g of the 1% dust	120 1x 2x 120 1x 2x 117 1x 2x 114 1x 2x 80* 1x 2x 80 1x 2x 76* 1x 2x 70* 1x 2x	UW 0.07 nr 0.10 0.10 0.08 0.07 0.03 0.10 0.10 0.14 0.03 0.07 0.03 0.12 0.03 0.08	W 0.07 0.18 0.08 nr 0.05 nr 0.04 nr 0.16 nr 0.05 nr 0.02 nr 0.12 nr	UW = unwashed fruit residues. W = washed fruit residues. Residues reported are the maximum values recorded. Whole fruit values calculated from skin and pulp results. PHIs marked with an asterisk also had results

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
								from the injection (0.1% soln.) treatment only. In those three trials, chlorpyrifos residues at harvest were all "not detected". Ref. FR427 (ref. 82).
Banana, Queensland, 1996	Suscon Blue Soil In-secti-cide, 140 g/kg ai, on a poly-mer strip	1	na	not stated trial permit	Not clear 70 days set by per-mit	1x rate 0.01 - 0.04 0.03 - 0.10 nd 2x rate 0.05 - 0.06 0.13 - 0.15 nd	1x rate Whole banana Skin Flesh 2x rate Whole banana Skin Flesh	Brief summary data only. Full details lacking. Treatment is a trial process using chlorpyrifos impreg-nated strips placed in covers on bananas. Pinese (ref. 83).
Celery, Victoria, 1996	Lors-ban 500EC	3	6 and 86 days	350 g ai/ha	15 26	0.11 0.08		Summary details of trial only. Residues in washed and unwashed

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
								plants considered equivalent. DowElanco (ref. 84).
Celery, Victoria, 1996	Lors-ban 500EC	3	20 and 46 days	241 g ai/ha	19 29	1.48 1.0		Summary details of trial only. Residues in washed and unwashed plants considered equivalent. Ref. DowElanco.
Cotton, New South Wales, air application, 1986	Predat-or 300	1	na	750 g ai/ha	0 1 3 5 7 10 14 21	<0.025 <0.025 <0.025 nd nd nd <0.025 nd		DP 90 var. Formulation has 300 g chlorpyrifos /L. Residues are those reported in the cottonseed. PAU-3107 (ref. 85).
Cotton, New South Wales, air application, 1986	Predat-or 300	4	7 days	750 g ai/ha	14	<0.025		DP 90 var. Ref. PAU-3107
Cotton, New South Wales, air	Predat-or 300	4	7 days	1500 g ai/ha	14	nd		DP 90 var.. Ref. PAU-3107

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
application, 1986								
Cotton, New South Wales, 1996	Predat-or 300	1		1500 g ai/ha	Seed 28	<0.01		CS85 var. Broadcast application. Residues are those reported in the cottonseed. Trash values on dry wt basis. Trial 962002DD. Trash was green or partially green cotton leaves and bracts and is really a type of forage/fodder. It is not gin trash. These results and following cotton results all corrected for control and recovery values. Ref. NRA (ref. 86).
					Trash 0	642		
					7	25		
					14	7.5		
					28	1.4		
				3000 g ai/ha	Seed 28	<0.01		
					Trash 0	1679		
					7	43		
					14	12		
					28	3.7		

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
Cotton, New South Wales, 1996	Predat-or 300	1		1500 g ai/ha	Seed 28	<0.01		CS85 var. Broadcast application. Residues are those reported in the cottonseed. Trash values on dry wt. basis. Trial 962001DD, trash is not gin trash. Ref. NRA
					Trash 0	375		
					7	19		
					14	4.2		
					28	0.8		
				3000 g ai/ha	Seed 28	0.01		
					Trash 0	1169		
					7	30		
					14	12		
					28	2.3		
Cotton, Queens-land, 1996	Predat-or 300	1		1500 g ai/ha	Seed	nr		SK14 var. Broadcast application. Trial 964006GW, nr not reported Trash is not gin trash. Ref. NRA.
					Trash 0	655		
					7	39		
					14	20		
				3000 g ai/ha	Seed	nr		
					Trash 0	2007		
					7	110		
					14	35		

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
Cotton, New South Wales, 1996	Predat-or 300	2	7 days	1500 g ai/ha	Seed 28 Trash 0 7 14 28	 <0.01 479 116 25 14		CS85 var. Broadcast application. Residues are those reported in the cottonseed. Trash values on dry wt basis. Trial 962002DD. Trash was green or partially green cotton leaves and bracts and is really a type of forage/fodder. It is not gin trash. Ref. NRA.
				3000 g ai/ha	Seed 28 Trash 0 7 14 28	 <0.01 1270 109 19 7.2		
Cotton, New South Wales, 1996	Predat-or 300	2	7 days	1500 g ai/ha	Seed 28 Trash 0 7 14 28	 <0.01 590 32 7.6 2.2		CS85 var. Broadcast application. Residues are those reported in the cottonseed. Trash values on

Crop, State, Year	Application details Form-ulation	 No. of applic-ations	 Interval between appli-cations	 Conc. g ai/hl or ha or other	Residues, mg/kg or ppm PHI days	 Chlor-pyrifos	 3,5,6 or as stated	Comment & reference
				3000 g ai/ha	Seed 28 Trash 0 7 14 28	0.01 1175 46 17 6.2		dry wt basis. Trial 962001DD. Trash was green or partially green cotton leaves and bracts and is really a type of forage/fodder. It is not gin trash. Ref. NRA.
Cotton, Queens-land, 1996	Predat-or 300	2		1500 g ai/ha	Seed Trash 0 7 14 21 28	0.04 722 51 17 9.7 2		SK14 var. Broadcast application. Trial 964006GW, nr not reported Trash is not gin trash.
				3000 g ai/ha	Seed Trash 0 7 14 21 28	0.01 1443 92 23 14 7.1		Ref. NRA.
Grapes, South Australia,	25W	1	na	250 ppm = 25 g	0	0.08		Cab. sauvignon var. PAU-

Crop, State, Year	Application details Form-ulation	 No. of applic-ations	 Interval between appli-cations	 Conc. g ai/hl or ha or other	Residues, mg/kg or ppm PHI days	 Chlor-pyrifos	 3,5,6 or as stated	Comment & reference
1976				ai/100 L				3121-005 (ref. 87)
Grapes, South Australia, 1976	25W	1	na	500 ppm = 50 g ai/100 L	0	0.09		Cab. sauvignon var. Ref. PAU-3121-005
Grapes, South Australia, 1976	25W	1	na	250 ppm = 25 g ai/100 L	0 7 14	0.07 0.02 <0.01		Grenache var. Ref. PAU-3121-005
Grapes, South Australia, 1976	25W	1	na	500 ppm = 50 g ai/100 L	0 7 14	0.12 0.03 <0.01		Grenache var. Ref. PAU-3121-005
Grapes, Victoria, 1984	Lors-ban 50 EC	1	na	~1.2 kg ai/ha, ~20 g ai/100 L (170 ppm) and ~2.4 kg ai/ha, ~40 g ai/ 100L	 1 7 35 50 1 7 35 50	Grape 2.7 1.1 0.2 0.2 Grape 9.4 5.4 1.0 0.8	DF 1.6 1.3 0.4 0.3 DF 9 4.4 1.1 0.9	Sultana vines, clone M12 var. ~6000 l/ha Lorsban label rate 250 g chlorpyrifos /ha or 25 g chlorpyrifos /100L. Results were the means of 8 replicates. DF = dried fruit 21

Crop, State, Year	Application details Form-ulation	 No. of applic-ations	 Interval between appli-cations	 Conc. g ai/hl or ha or other	Residues, mg/kg or ppm PHI days	 Chlor-pyrifos	 3,5,6 or as stated	Comment & reference
				(430 ppm)				days post harvest. Murray (ref. 88)
Grapes, South Australia, 1993	Lors-ban 500 EC	3	10 days	25 g ai/hl (0.675 kg ai/ha.) 50 g ai/hl (1.35 kg ai/ha	7 14 28 7 14 28	2.7, 1.6 1.4, 0.99 0.66, 0.43 3.3, 4.2 3.2, 3.8 1.4, 1.0		Riesling var. Spray volume 2700 l/ha, sprayed to run-off, plot size 15x3.5 m. results corrected for mean control and recovery (92%). Duplicate results reported. Wilson (ref. 89).
Grapes, Victoria, 1993	Lors-ban 500EC	1	na	50 g ai/hl (2.94 kg ai/ha)	 0 2 7 14 21 28 35 42 49	Grapes 4.8-7.3 2.8-5.3 1.9-2.9 1.5-2.4 1.3-1.8 0.87-1.2 0.84-1.2 0.43-1.3 0.57-0.7	 DF 0.43-1.4 (day 7) & 0.68-1.8 (day 21) W 0.006 L 0.21 (both day	Ungrafted M12 Sultana var. DF = dried fruit. W = wine, L = lees. All treatments sprayed to run-off. 50 g ai/hl study was a simulated mis-use situation at >10x max.

Crop, State, Year	Application details Form- ulation	 No. of applic - ations	 Interval between appli- cations	 Conc. g ai/hl or ha or other	Residues, mg/kg or ppm PHI days	 Chlor- pyrifos	 3,5,6 or as stated	Comment & reference
							14)	/ha Lorsban label rate of 250 g/ha but 2x the maximum /hl rate. Label withholding period 14 days. Grapes dried according to commercial practice. Results not corrected for recovery (80-100% for grapes & 100% for dried fruit). Ref. MacGregor (ref. 90).
Grapes, Victoria, 1993	Lors- ban 500EC	1	na	25 g ai/hl (0.39 kg ai/ha)	 0 1 3 7 15 21 28 35	Grapes 7.6-15 6.3-8.2 1.8-4.0 0.40- 0.7 0.06- 0.1 ≤0.025 na na		Ungrafted M12 Sultana var. 1500 l spray/ha 1.5x max. /ha Lorsban label rate. Results not corrected for recovery Ref. MacGregor.

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
Grapes, Victoria, 1993	Lors-ban 500EC	1	na	25 g ai/hl (0.39 kg ai/ha)	 0 1 3 7 14 21 28 35	Grapes 1.2-1.9 0.31-1.0 0.6-0.8 0.26-0.3 0.16-0.3 0.07-0.1 0.07-0.2 0.09-0.1	DF 0.06-0.13 (day 14) W <0.005 (day 14)	Ungrafted M12 Sultana var. DF = dried fruit. W = wine. All treatments sprayed to run-off. 1500 l spray /ha. 1.5x max. /ha Lorsban label rate. Results not corrected for recovery Ref. MacGregor.
Maize, New South Wales, 1980	Lors-ban 25W	1 at sowing as a seed band	na	500 g ai/ha	ca 6 mo-nths	<0.01		Efficacy study with no analytical details. De-Kalb XL81 var. Average residues in crushed grain or cobs. NSW (ref. 91)
Mango, Queenslan	Lors-ban 500	1	na	100 g ai	0 7	2.2 1.4		For scale control.

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
d, 1987	EC			/100L	14 21	0.32 0.04		Sprayed to run-off. Seed removed for analysis. Results corrected for average recovery of 87.2%. PAU-3107-266 (ref. 92).
Mango, Queensland, 1987	Lors-ban 500 EC	1	na	200 g ai /100L	0 7 14 21	3.5 2.3 0.26 0.07		For scale control. Sprayed to run-off. Seed removed for analysis. Results corrected for average recovery of 87.2%. Ref. PAU-3107-266
Passionfruit, Queensland, 1988	Lors-ban 500 EC	1, 7, and 11	Weekly	200 g ai/100 L	1, 6, 10 appn 0 2 7	1, 6, or 10 applns. nd nd nd		Concentrated band spray applied to lower portion of vine with a protein bait. Results corrected

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
								for average recovery of 93% with limit of quantitation 0.05 ppm. PAU-3107-293 (ref. 93).
Passionfruit, Queensland, 1988	Lors-ban 500 EC	1, 7, and 11	Weekly	400 g ai/100 L	 0 2 7 0 2 7	1 appln. nd nd nd 6 or 10 applns. <0.05 nd <0.05 (10) and nd (6)	.	Concentrated band spray applied to lower portion of vine with a protein bait. Results corrected for average recovery of 93% with limit of quantitation 0.05 ppm. Ref. PAU-3107-293
Potatoes, NSW, Dorrigo, 1983	50EC	2	29	3 kg/ha then 450 g ai/ha	136	0.001		Applications at pre-plant and pre-emergent stages. PAU-3183-068 (ref. 94)
Potatoes,	50EC	2	29	1.5	136	0.001		Application

Crop, State, Year	Application details				Residues, mg/kg or ppm			Comment & reference
	Form-ulation	No. of applic-ations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6 or as stated	
NSW, Dorrigo, 1983				kg/ha then 450 g ai/ha				s at pre-plant and pre-emergent stages. Ref. PAU-3183-068
Potatoes, Queens-land, 1983	Control release			5 kg/ha		0.001		PHI not stated. PAU-3183-069 (ref. 95)
Potatoes, Western Australia, 1986	500EC	2	43 days	3000 g ai/ha then 500 g ai/ha	81	Whole potato 0.01 Flesh <0.01 Skin 0.08		Applications at planting and hilling up (7 weeks after planting). WA Dept of Ag (ref. 96).
Sorghum, New South Wales, 1974	Lors-ban 50 EC	1	ns	70 g ai/ha 140 g ai/ha 280 l/ha	1 7 1 7	0.94 0.12 1.18 0.18		E 65 (4) var. Treatment rates given as 0.14 and 0.28 kg/ha. This is assumed to be of the Lorsban formulation. GHF-P-019 (ref. 97).
Sorghum, Queensland, 1974	Lors-ban 50 EC	2	8	60 g ai/ha 125 g	100 100	0.022 0.018		Gold finger var. Aerial application

Crop, State, Year	Application details: Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Residues, mg/kg or ppm: Chlorpyrifos	3,5,6 or as stated	Comment & reference
				ai/ha 30 l/ha				at flowering stage. Trial described as "preliminary" and report noted no firm conclusions could be drawn. Treatment rates given only as kg/ha and assumed to refer to the 50EC formulation. GHF-P-018 (ref. 98).
Sugarcane, Queensland, 1983	Granular 140 g ai/kg	1	na	2, 4, 4.8, 6, and 7.2 kg ai/ha	~ 250 to 600 days	nd		Sugar cane juice extracted from treated cane analysed. Slow release formulation. Limit of detection 0.001 ppm. Average recovery 87-94% at 1-10 ppm. PAU-3017-107 (ref. 99).

Crop, State,	Application details				Residues, mg/kg or ppm			Comment & reference
Year	Form- ulation	No. of applic - ations	Interval between appli- cations	Conc. g ai/hl or ha or other	PHI days	Chlor- pyrifos	3,5,6 or as stated	
Sugarcane , New South Wales, 1985	Gran- ular 140 g ai/kg	1	na	4 kg ai/ha	~ 9 mon ths.	nd		Sugar cane juice extracted from treated cane analysed. Slow release formulation. Limit of detection 0.0001 ppm. Consol Fert (REF. 100).
Wheat, New South Wales, 1983	Lors- ban 25W	1 either as a seed- dress- ing or as a dry sowin g mixtu re	na	200 g chlor- pyrifo s/ 100 kg seed as a seed dressi ng or 500 g ai/ha as a dry sow- ing mix.	ca 140 days	Seed dressin g Grain <0.01 (averag e values) Sowing mix Grain <0.01 (averag e values)	Seed dressi ng Hulls <0.02 (avera ge values) Sowin g mix Hulls <0.02 (avera ge values)	Condor var. Average method recovery 83.7-99.2% for grain and husk (0.1-5.0 ppm µg/g fortification levels). Most effective chlorpyrifos wheat treatments were 2 g chlorpyrifos / kg seed and 500 g chlorpyrifos /ha and

Crop, State,	**Application details**				**Residues, mg/kg or ppm**			**Comment & reference**
Year	**Form-ulation**	**No. of applic-ations**	**Interval between appli-cations**	**Conc. g ai/hl or ha or other**	**PHI days**	**Chlor-pyrifos**	**3,5,6 or as stated**	
								samples of wheat from these treatments were analysed. Analytical reports stated to be for a "200 ppm" treatment while correspondence indicates 2000 or 200 ppm value. NSW (ref. 101)

. 3,5,6 = 3,5,6-trichloro-2-pyridinol . na = not applicable or not analysed depending on context.
. nd = not detectable . nr = not reported or recorded
. Results reported are generally corrected for recovery and background. Recoveries were considered acceptable in all cases. The 1986 cotton trials results were identified as mean values. Results reported are generally to two significant figures when the data permitted this. When space constraints dictated it, results were reported to one significant figure.

ATTACHMENT D - Summary of overseas chlorpyrifos residue data

A large number of overseas residue studies were examined in the ECRP residue evaluation. The commodities and relevant references were as shown in the following table. To minimise the report size, summaries of the residue results are not presented. In the case of cottonseed and its byproducts, corn and maize, cereals, seed dressings, and animal feeds, residue details are given because of their use in reaching decisions on the Australian situation.

Commodities (and references) of Overseas Data Examined in the ECRP Residue Review for Chlorpyrifos
Apples (USA) GH-C 1107 (ref. 102), GH-C 1485 (ref. 103), and GH-C 1789 (ref. 104)
Apricots (USA) GH-C 1679 (ref. 105)
Beans (South Africa) GHE-P 721 (ref. 106)
Carrots (South Africa) GHE-P 542 (ref. 107), carrots (United kingdom) GHE-P 439 (ref. 108) and GHE-P 567 (ref. 109)
Cherries (USA) GH-C 1679 (see Apricots (USA) GH-C 1679 for reference)
Gooseberries (United Kingdom) GHE-P 575 (ref. 110)
Grapes (France) GHE-P-444 (ref. 111), grapes (South Africa) GHE-P-792 (ref. 112), GHE-P-746 (ref. 113), and GHE-P-788 (ref. 114)
Kiwi fruit (New Zealand) GHF-P-229 (ref. 115) and material given reference number (ref. 116 a & b)
Lettuce (United Kingdom) GHE-P 578 (see "onions (United Kingdom)" reference)
Lettuce, head (USA) GH-C 1696 (ref. 117)
Nectarines (USA) GH-C 1679 (see Apricots (USA) GH-C 1679 for reference)
Onions (Canada) GHS-C 43 (ref. 118) and GHS-C 16 (ref. 119), onions (United Kingdom) GHE-P 578 (ref. 120)
Oranges (South Africa) Hollick and Pine (ref. 121), oranges (USA) GH-C 1041 (ref. 122)
Peaches (USA) GH-C 1679 (see Apricots (USA) GH-C 1679 for reference) and peaches (USA) GH-C 479 (ref. 123)
Peas (South Africa) GHE-P 543 (ref. 124)
Plums (USA) GH-C 1679 (see Apricots (USA) GH-C 1679 for reference)
Potatoes (Canada) GHS-C-12 (ref. 125), potatoes (Colombia) GHB-P 013 (ref. 126), potatoes (South Africa) GHE-P 560 (ref. 127), potatoes (United Kingdom) GHE-P 572 (ref. 128)
Prunes (USA) GH-C 1679 (see Apricots (USA) GH-C 1679 for reference)
Raspberries (United Kingdom) GHE-P 575 (see Gooseberries reference)
Soybeans (USA) GH-C 1224 (ref. 129)
Strawberries (United Kingdom) GHE-P 575 (see Gooseberries reference)
Sugarbeet (United Kingdom) GHE-P 439 (see "carrots (United kingdom)" reference)
Sunflower (France) GHE-P 1184 (ref. 130), sunflower (USA) GH-C 1371 (ref. 131)
Wine (France) GHE-P-444 (See the Grapes (France) grapes references) and wine (Israel) GHE-P-603 (ref. 132)

ATTACHMENT E - Summary of overseas chlorpyrifos residue data – COTTON and COTTON GIN TRASH

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of appli-cations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
Cotton seed, ground application United States, Texas, 1975	Lors-ban 4E	4 at 0.28 kg/ha, 13 at 1.12 kg/ha	7-14 days for 1st four then 3-12 days for rest	280 g/ha x 4 then 1120 g ai/ha x 13	6	Seed 0.06 Trash 2.9	Seed 0.06 Trash nd	Stoneville 213 var. Applied as a broadcast foliar spray. Lorsban 4E had 4 lb chlor-pyrifos/gal ≈ 480 g/L GHC-840 (ref. 133)
Cotton seed, ground application United States, Mississippi, 1975	Lors-ban 4E	2 at 0.28 kg/ha, 12 at 1.12 kg/ha	19 days for 1st 2 then 4-14 days for rest	280 g/ha x 2 then 1120 g ai/ha x 12 93 l/ha	15	Seed 0.06 Trash 2.0 not corrected	Seed 0.05 Trash 2.5 not corrected	Stoneville 213 var. Applied as a broadcast foliar spray. Trash controls heavily contaminated. Ref. GHC-840
Cotton seed, ground application United States, Mississippi, 1975	Lors-ban 4E	11 at 1.12 kg/ha	5-14 days	1120 g ai/ha	31	Seed nd Trash 60	Seed <0.05 Trash 11	DPL 16 var. Applied as a broadcast foliar spray. Ref. GHC-840
Cotton seed, ground application United States,	Lors-ban 4E	4 at 0.28 kg/ha and 13 at 1.12	2-8 days	280 g/ha x4 then 1120 g ai/ha x	34	Seed 0.14 Trash 23	Seed 0.13 Trash 63	Coker 310 var. App-lied as a broadcast foliar spray. Ref. GHC-840

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of appli-cations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
South Carolina, 1975		kg/ha		13 47 l/ha				
Cotton seed, aerial application United States, South Carolina, 1975	Lors-ban 4E	13 at 1.12 kg/ha	4-12 days	1120 g ai/ha x 13 9 l/ha	38	Seed 0.05	Seed <0.05	Coker 310 var. App-lied as an aerial spray. 14 treatment dates given. Ref. GHC-840
Cotton seed, aerial application United States, Mississippi, 1975	Lors-ban 4E	2 at 0.28 kg/ha & 12 at 1.12 kg/ha	19 days and then 4-9 days	1120 g ai/ha x 12 9 l/ha	8	Seed nd Trash 14 (not correc t-ed)	Seed nd Trash 120 (not co-rrected)	DPL 16 var. Applied as an aerial spray. Trash controls contaminated. Ref. GHC-840
Cotton seed, aerial application United States, 1975	Lors-ban 4E	4 at 0.28 kg/ha & 12 at 1.12 kg/ha	32, 12, & 9 days then 2-14 days	4 at 560 g ai/ha then 1120 g ai/ha x 12 19 l/ha	18	Seed 0.11 Trash 0.24	Seed 0.11 Trash 3.8	Stoneville 213 var. Applied as an aerial spray. Ref. GHC-840
Cotton seed, aerial application, United States, Mississippi,	Lors-ban 4E + pyridin	2		560 g ai/ha 2.3 l/ha	24 31	nd nd	nd nd	Stoneville 825 var. Treatment “late season”. ULV application. GH-C 1658

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of appli-cations	Intervalbetween appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
1982								(ref. 134)
Cotton seed, aerial application, United States, California, 1982	Lors-ban 4E + pyridin	4	7 days	560 g ai/ha 2.3 l/ha	14 21	0.27 0.08	0.16 0.11	DPL 56 var. ULV application. Ref. GH-C 1658
Cotton seed, aerial application, United States, Mississippi, 1982	XR M-4656	8	4-8 days	560 g ai/ha 2.3 l/ha	14 21	0.03 0.03	nd nd	DPL 56 var. ULV application. Ref. GH-C 1658
Cotton seed, aerial application, United States, Mississippi, 1982	XR M-4656	8	4-8 days	560 g ai/ha 9.3 l/ha	14 21	0.07 0.17	0.07 0.13	DPL 56 var. ULV application. Ref. GH-C 1658
Cotton seed, aerial application, United States, Arizona, 1982	XR M-4656	10	6-7 days	560 g ai/ha 2.3 l/ha	21 28	0.24 0.30	0.08 0.27	DPL 56 var. ULV application. Ref. GH-C 1658
Cotton seed, aerial application, United States, Arizona,	XR M-4656	10	6-7 days	560 g ai/ha 47 l/ha	21 28	0.65 0.34	0.55 0.46	DPL 56 var. low volume application. Ref. GH-C 1658

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	**No. of applications**	**Interval between applications**	**Conc. g ai/hl or ha or other**	**PHI days**	**Chlorpyrifos**	**3,5,6**	
1982								
Cotton seed, ground application, United States, 1974	M-3518	9	4-29 days, 4 days between last 2 applns.	1120 g ai/ha 93 l/ha	Seed 0 3 7 14 Trash 3	Seed 1.4 0.50 nd 0.16 Trash 24	Seed 0.79 0.59 nd <0.05 Trash 22	DPL 16 var. M-3518 had 4 lb chlor-pyrifos/gal EC (≈ 490 g/litre. Applied as a broadcast foliar spray. GH-C 739 (ref. 135)
Cotton seed, ground application, United States, 1974	M-3518	9	4-29 days, 4 days between last 2 applns.	2240 g ai/ha 93 l/ha	Seed 0 3 7 14 Trash 3	Seed 4.0 1.2 0.05 0.14 Trash 54	Seed 1.7 0.86 0.11 0.16 Trash 43	DPL 16 var. Applied as a broadcast foliar spray. Ref. GH-C 739

. Maximum values generally reported.
. nd = not detected nr = not reported
. na = not applicable.
. Residues corrected for control and recovery. Recoveries acceptable in all cases.

ATTACHMENT F - Summary of overseas chlorpyrifos residue data - CORN or MAIZE

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
Corn, Field, United States, 1977	Lorsban 4E or 15G	15G - 1 at planting or 1 foliar appn. with 4E	na	1120 g ai/ha 280 l/ha	102 127	Green forage nd Grain and fodder <0.01	Green forage nd Grain and fodder nd	Pioneer 3780 var. Aerial appln. at 2-4 leaf stage. Ground appnl. at same stage. GH-C 1068 (ref. 136).
Corn, Field, United States, 1977	Lorsban 4E or 15G	15G - 1 at planting & 1 later foliar appn. 4E one	26 days between row & foliar treatment	1.5 kg at planting & 1120 g ai/ha 280 l/ha	89 114	Green forage nd Grain and fodder <0.01	Green forage <0.05 Grain and fodder nd	Pioneer 3965 var. Ground appnl. at 5 leaf stage. Ref. GH-C 1068.
Corn, Field, United States, 1977	Lorsban 4E or 15G	1 foliar appn. with 4E	na	1120 g ai/ha 140 l/ha	47 & 66 104 & 109	Green forage nd Grain nd	Green forage nd Grain nd	G-4776, Funks G4776 var.. Ground appnl. at 2 or 5-6 leaf stage. Ref. GH-C 1068
Corn, Field, United States, 1977	Lorsban 4E or 15G	15G - 1 at planting & 1	32 days between row	1.1 kg at planting & 1120 g	63 126	Green forage nd Grain and	Green forage <0.0	No var. given. Ground appnl. at sowing, aerial at 4 leaf stage. Ref.

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
		later foliar appn. 4E one	& foliar treat-ment	ai/ha 18.7 l/ha		fodder nd	5 Grain and fodder nd	GH-C 1068.
Corn, Field, United States, 1978	Lors-ban 4E or Lors-ban 15G	1 pre-sowing	na	3.4 kg ai/ha. 280 l/ha for EC	105 Both for mns 151	Green forage nd Fodder nd Grain nd	Green forage <0.05 Fodder nd Grain nd	GH-C 1284 (ref. 137) (also referred to as GH-C 1264)
Corn, Field, United States, 1978	Lors-ban 4E or Lors-ban 15G	1 pre-sowing (& two foliar sprays for 4E only)	23 and 10 days for 4E formn. only	3.4 kg ai/ha for the 15G and 3.4 + 2x1.7 kg ai/ha (EC 280 l/ha)	77 (15 G)& 44 (4E) 176 & 143 174 & 141	Green forage nd Fodder <0.05 Grain nd	Green forage <0.05 Fodder <0.05 Grain nd	DeKalb 45A and Pioneer 3958 varieties. Ref. GH-C 1284 (also referred to as GH-C 1264)
Corn, South Africa, 1978	Durs-ban 10G	One pre-emer	12 days	0.5 kg ai/ha for	187 or 199	Grain <0.01	Forage 0.24	Maize SA4 var. Foliar applications

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of appli-cations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
	& 4	-gence, 1 foliar		10G and 480 or 960 g ai/ha for 4				applied to 4-6 cm high plants. GH-P 723 (ref. 138).
Corn, United States, 1972	Granul-ar & EC formns.	At plant-ing	na	1.1 and 3.4 kg ai/ha for granular, EC as ULV at 1.1 kg ai/ha. 4.7 l/ha	27 57 87 112 149 149	Green forage nd any time Grain nd Stover nd	Green forage nd any time Grain nd Stover nd	Surface band or seed furrow applns. Varieties: Pioneer 3510 for granular applns. and Funks 17014 for EC. GH-C530 (ref. 139).

. **Maximum values generally reported. . nd = not detected nr = not reported**
. **na = not applicable. . Residues corrected for control and recovery.**

ATTACHMENT G - Summary of overseas chlorpyrifos residue data - CEREAL GRAINS

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
Barley, Canada, 1991	Lorsban 4E	1	na	420 g ai/ha 105-150 l/ha	Grain 63-67 Straw 63-67	Grain nd Straw 0.01	Grain 0.03 Straw <0.05	Bonanza, Bedford, Heartland var. Results from 3 barley trials. GH-C 2574 (ref. 140). NB in the Alberta and Saskatchewan trials, the [chlorpyrifos] was given as 480 g/l, in the Manitoba trial, the conc. is given as 280 g ai/L.
Barley, Canada, 1991	Lorsban 4E	1	na	480 g ai/ha 105-150 l/ha	Grain 42-47 75-77 Straw 42-47 75-77	Grain 0.02 nd Straw 0.09 0.01	Grain 0.09 nd Straw 0.08 nd	Bonanza, Bedford, Heartland var. Results from 3 barley trials. Ref. GH-C 2574.
Barley, Canada,	Lorsban	1	na	576 g ai/ha	Grain	Grain 0.19	Grain	Bonanza, Bedford,

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
1991	4E			105-150 l/ha	30-32 80 88-91 Straw 30-32 80 88-91	nd nd Straw 0.43 nd nd	0.09 nd 0.02 Straw 0.12 nd nd	Heartland var. Results from 3 barley trials. Ref. GH-C 2574.
Barley, Canada, 1991	Lorsban 4E	4 or 5	11-35 days	576, 480, 420 and 480 or 576 g ai/ha 105-150 l/ha	Grain 27-29 32 42-44 47 Straw 27-29 32 42-44 47	Grain 0.17 0.06 0.04 0.01 Straw 0.51 0.58 0.23 0.03	Grain 0.18 0.16 0.09 0.04 Straw 0.17 0.10 <0.05 0.06	Last application at 480 (4 applns.) or 576 (5 applns) g ai/ha. Bonanza Bedford, Heartland var. Results from 3 barley trials. Ref. GH-C 2574.
Oats, Canada, 1991	Lorsban 4E	1	na	420 g ai/ha 111 &150 l/ha	Gf 5 54 Grain 63-66 Straw	Gf 2.4 nd Grain 0.03 Straw nd nd	Gf 0.28 <0.05 Grain <0.05 Stra	Gf = green forage. Victory, Dumont var. Results from 2 oat trials. Ref. GH-C 2574 (ref 140). NB the conc. of

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
					54 63		w 0.05 0.06	chlor-pyrifos is given as 280 g ai/l.
Oats, Canada, 1991	Lors-ban 4E	1	na	480 g ai/ha 111 & 150 l/ha	Gf 17 34 67 Grain 42-46 75-79 Straw 34 42 67-75	Gf 0.08 0.03 nd Grain 0.01 nd Straw 0.02 0.02 nd	Gf 0.13 0.12 nd Grain 0.27 nd Straw 0.10 0.15 nd	Gf = green forage. Victory, Dumont var. Results from 2 oat trials. Ref. GH-C 2574. NB the conc. of chlorpyrifos is given as 280 g ai/l.
Oats, Canada, 1991	Lors-ban 4E	1	na	576 g ai/ha 111 & 150 l/ha	Gf 5 19 78 Grain 30-31 90 Straw 30 46 78-88	Gf 2.6 0.11 nd Grain 0.02 nd Straw 0.06 0.19 nd	Gf 0.31 0.13 nd Grain 0.28 0.05 Straw 0.18 nd nd	Gf = green forage. Victory, Dumont var. Results from 2 oat trials. Ref. GH-C 2574. NB the conc. of chlorpyrifos is given as 280 g ai/l.
Oats, Canada,	Lors-ban	4 or 5	11-35 days	576, 480,	Gf 19	Gf 0.25	Gf 0.23	Gf = green forage.

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
1991	4E			420 and 480 or 576 g ai/ha 111 & 150 l/ha	34 Grain 27-31 44-66 Straw 19 27 34 42	0.15 Grain 0.03 0.03 Straw 0.24 0.15 0.24 0.01	0.20 Grain 0.62 0.37 Straw 0.16 0.53 0.27 0.25	Victory, Dumont var. Results from 2 oat trials. Ref. GH-C 2574. NB the conc. of chlor-pyrifos is given as 280 g ai/l. Last application at 480 (4 applns.) or 576 (5 applns) g ai/ha.
Sorghum, Brazil, 1993	Lors-ban 480 BR	3	59 and 52 days	360 g ai/ha 720 g ai/ha 300l/ha	21	360 g ai/ha 0.07 720 g ai/ha 0.17		BR 301 var. 480BR has 480 g ai/L. Chlorpyrifos only analysed. Residues not corrected for recovery (68-100%, 0.05 to 0.2 mg/kg) or control (<0.05 mg/kg). Ref. GHB-P 188 (ref. 141).
Sorghum, United States, 1991 (Kansas)	Lors-ban 4E	3	7 & 8 day in-tervals	3 x 560 g ai/ha	29	0.22-0.29 0.28-0.39	Grain Fodder	Foliar applications. Results corrected for average recoveries of 92% for grain

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
Sorghum, United States, 1991 (Kansas)	Lorsban 4E	2	7 day interval	1 x 560 then 1 x 1120 g ai/ha	60	0.09-0.22 0.04-0.15	Grain Fodder	and 100% for fodder. Chlorpyrifos only was determined. GH-C 2555 (ref. 142).
Sorghum, United States, 1991 (Texas)	Lorsban 4E	3	7 & 7 day intervals	3 x 560 g ai/ha	30	0.03-0.05 0.01	Grain Fodder	Foliar applications. Results corrected for average recoveries stated above.
Sorghum, United States, 1991 (Texas)	Lorsban 4E	2	7 day interval	1 x 560 then 1 x 1120 g ai/ha	60	0.01-0.03 0.01-0.02	Grain Fodder	Ref. GH-C 2555
Sorghum, United States, Kansas 1994	Lorsban 4E	2 (60 day PHI) or 3 (30 days PHI)	~7 days	560 x 3 (30 day PHI). 560 and then 1120 g ai/ha (60 day PHI) ~177 l/ha	30 60	0.23 0.17 1.5 <0.01 0.05 0.40	Grain Gf Fodder Grain Gf Fodder	NK2030 var. Gf = green forage. Chlorpyrifos only determined.. Ref. RES93016.

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
Sorghum, United States, Texas, 1994	Lorsban 4E	2 (60 day PHI) or 3 (30 days PHI)	~7 days	560 x 3 (30 day PHI). 560 and then 1120 g ai/ha (60 day PHI) ~190 l/ha	30 60	0.03 0.04 0.20 <0.002 0.01 0.09	Grain Gf Fodder Grain Gf Fodder	F200 var. Gf = green forage. Chlorpyrifos only determined. Results corrected for percent recovery & average of multiple analysis. In control, chlorpyrifos = not detected (<0.002 mg/kg). RES93016 (ref. 143).
Wheat, Canada, 1991	Lorsban 4E	1	na	420 g ai/ha 105-150 l/ha	Grain 63-68 Straw 63-68	Grain nd Straw 0.02	Grain nd Straw 0.05	Columbus, Katepwa, Benito var. GH-C 2574 (ref. 144).
Wheat, Canada, 1991	Lorsban 4E	1	na	480 g ai/ha 105-150 l/ha	Grain 42 44-48 75-81 Straw	Grain 0.01 nd nd Straw 0.06 0.05 0.01	Grain <0.05 nd nd Straw 0.18	Columbus, Katepwa, Benito var. Ref. GH-C 2574

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
					42 44-48 75-81		<0.05 nd	
Wheat, Canada, 1991	Lors-ban 4E	1	na	576 g ai/ha 105-150 l/ha	Grain 29-33 88-92 Straw 29-33 88-92	Grain 0.03 nd Straw 0.54 nd	Grain 0.06 nd Straw 0.20 nd	Columbus, Katepwa, Benito var. Ref. GH-C 2574
Wheat, Canada, 1991	Lors-ban 4E	4 or 5	11-35 days	576, 480, 420 and 480 or 576 g 105-150 l/ha	Grain 27-29 33 42-44 48 Straw 27-29 33 42-44 48	Grain 0.05 0.02 0.01 nd Straw 0.60 0.08 0.07 0.05	Grain 0.11 <0.05 <0.05 nd Straw 0.36 0.24 0.26 0.06	Columbus, Katepwa, Benito var. Last application at 480 (4 applns.) or 576 (5 applns) g ai/ha. Ref. GH-C 2574
Wheat, Germany, 1992	Durs-ban 480 g	1	na	240 g ai/ha 400 l/ha	Wp 1 Ears 13-	Wp 1.43 Ears 0.18	Wp 0.95 Ears 0.23	Kanzler, Ares, Haivar. Results from four field

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
	ai/L EF 747				14 17 26-32 42-52 57-58 Rp 13-14 17 26-32 42 52-58 Grain 59-69 Straw 59-67	0.03 0.01 <0.01 <0.01 Rp 0.30 0.05 0.06 0.01 0.02 Grain <0.01 Straw 0.02	0.08 <0.05 <0.05 nd Rp 0.37 0.14 0.15 0.06 0.10 Grain nd Straw 0.13	trials. Wp = whole plant. Rp = rest of plant. Grain and straw at harvest. GHE-P-2634 (ref. 145).
Wheat, United Kingdom, 1994	Durs-ban 480 g ai/L EF 747	3	approx. 46 and 157 days	336 g ai/ha	18 (re-ported but see refer-ence col-umn	Grain <0.01 Straw 0.07		Apollo var. First two applns at 720 g ai/ha. NB date of 3rd appln given as 25 Jun 93 and harvest 13 Aug 93 ~49 days. Assumed 25 Jun 93 should be 25 Jul 93.

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Form-ulation	No. of appli-cations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
								GHE-P-3720 (ref. 146).

. 3,5,6 = 3,5,6-trichloro-2-pyridinol . na = not applicable. . Results generally corrected for recovery and control.

ATTACHMENT H - Summary of overseas chlorpyrifos residue data - SEED DRESSINGS

Crop,	Application details				Residues, mg/kg or ppm			Comment &
Country, Year	Formulation	No. of application	Inter-val between applications	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	study reference
Beans, Canada, 1977	Lorsban 25% WP	Seed coated	na	55 g ai/100 kg seed	Wax & green 53-58 Lima 96	Beans and foliage nd Lima beans nd, foliage 0.06		Varieties: Wax beans: Resistant Kinghorn Green beans: Blue lake Lima beans: Milres CS 481 (ref. 147).
Beans, United States, 1978	25 or 50% WP	Seed coated	na	167 g ai/100 kg seed Fb, 55,	Kbs 75-93 117 Kbp 75-93 Kbv 75-93 96 117 161 Kbwp 28 41 Fb	Kbs nd 0.07 Kbp <0.05 Kbv nd <0.05 nd 0.14 Kbwp 0.10 0.19 Fb nd nd <0.05 Fbv	Kbs <0.05 nd Kbp nd Kbv 0.11 0.35 0.14 0.39 Kbwp 0.12 <0.05 Fb nd nd <0.05	Var.: Red kidney, Kbs = shelled kidney beans. Kbp = kidney bean pods. Kbv = kidney bean vines. Kbwp = kidney bean whole plants

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	**No. of appli-cation**	**Inter-val be-tween appli-cations**	**Conc. g ai/hl or ha or other**	**PHI days**	**Chlor-pyrifos**	**3,5,6**	
				110 & 220 g ai/100 kg seed	114 114 114 FBv 114 114 114	0.06 <0.05 0.96	Fbv 0.13 0.38 0.40	treated at 110 g ai/100 kg seed. 161 PHI Kbv samples from treatment at 110 g ai/100 kg seed. Fb = Field beans. Fbv = field bean vines. Var. white. Field bean results are for the treatments at 55, 110, and 220 g ai/100 kg seed. GH-C 1157 (ref. 148).
Corn, Canada, 1977	Lors-ban 25% WP	Seed coated	na	55 g ai/100 kg seed	73 95	Ears & stalks nd		DMC 216 & Midway var. CS 481 (ref. 149).
Corn, United	25% WP	Seed treat	Na	110 or	Gp 28	Gp nd	Gp nd	Pioneer 3390,

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Form-ulation	No. of appli-cation	Inter-val be-tween appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
States, 1973		ed		165 g ai/100 kg seed	43 75 St 110 194 Grain 110 Cobs 110	nd nd St nd nd Grain nd Cobs nd	nd nd St nd nd Grain nd Cobs nd	3773, X6231, DeKalk Xl-45 var. Gp = green plants. St = stalk. GH-C 666 (ref. 150).
Corn, United States, 1973	25 or 50% WP	Seed coated	na	165 g ai/100 kg seed	Gp 28 41-42 72-83 Kc 72-83 Husks 83 Ch 72	Gp <0.01 nd nd Kc nd Husks nd Ch nd	Gp nd nd nd Kc nd Husks nd Ch nd	Variety: not known, Royal gold, Jubilee, Golden goodsell. Gp = green plant. Kc = kernels and cob. Ch = cobs and husks. GH-C 664 (ref. 151)
Cucumber, United States, 1978	25% WP	Seed coated	na	167 & 1 at 220 g ai/100 kg	57-96	<0.01	<0.05	Tablegreen, National pickling, Straight 8 var. Ref. GH-C 1159.

Crop, Country, Year	Application details: Formulation	No. of application	Interval between applications	Conc. g ai/hl or ha or other seed	Residues, mg/kg or ppm: PHI days	Chlorpyrifos	3,5,6	Comment & study reference
Lima beans, United States, 1973	25% WP, one trial with 50% WP	Seed coated	na	55g ai/100 kg seed	Green plant			S-1 var. GH-C 659 (ref. 152).
					22	nd	nd	
					28	nd	nd	
					96	≤0.01	nd	
					Beans 96	nd		
					Green plant			
					43	0.08-0.18	≤0.22	
					59	0.02-0.25	<0.05	
					110	≤0.01	nd	
					Beans 110	nd	nd	
					Green plant			Fordhook var. Ref. GH-C 659
					27	nd	<0.05	
					43	nd	<0.05	
					Seed 86	nd	nd	
					Green plant			Henderson var. Ref. GH-C 659
					28	0.20-0.64	0.22-0.6	
					43	0.01-0.02	≤0.05	
					73	nd	nd	
					Beans 70	nd	nd	
Lima beans,	25% WP,	Seed coat	na		Green plant	0.02-	0.16-	Unknown var. Ref.

Crop, Country, Year	Application details Formulation	 No. of application	 Inter-val between applications	 Conc. g ai/hl or ha or other	Residues, mg/kg or ppm PHI days	 Chlor-pyrifos	 3,5,6	Comment & study reference
United States, 1973	one trial with 50% WP	ed			28 42 88 Beans 88	0.05 0.01 nd nd	0.2 0.09-0.1 <0.05 nd	GH-C 659.
Lima beans, United States, 1973	25% WP, one trial with 50% WP	Seed coated	na	167 g ai/100 kg seed	Green 22 28 96 Beans 96	plant nd 0.01 0.03 nd	 nd 0.08 0.05 nd	S-1 var. Ref. GH-C 659
					Green 43 59 110 Beans 110	plant 0.55-0.83 0.01-0.16 0.02-0.09 nd	 ≤0.21 ≤0.21 ≤0.05 nd	
					Green 27 43 Bean 86	plant 0.02 0.03 nd	 0.06 0.06 nd	Fordhook var. Ref. GH-C 659
					Green 28 43	plant 0.09-0.73 0.01	 0.1-0.4 <0.05	Henderson var. Ref. GH-C 659

Crop,	Application details				Residues, mg/kg or ppm			Comment &
Country, Year	Formulation	No. of application	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	study reference
					73 Beans 70	0.01-0.03 nd	<0.05 nd	
					Green 28 42 88 Beans 88	plant 0.06-0.12 0.02-0.04 nd-0.06 nd	 0.2-0.3 ≤0.13 ≤0.05 nd	Unknown var. Ref. GH-C 659.
Peas, United States, 1979	25% WP	Seed coated	na	55 g ai/100 kg seed	Peas & pods 58-77 Pea vines 58-73 Whole plants 28 42	Peas & pods nd Pea vines 0.19 Whole plants nd nd	Peas & pods <0.05 Pea vines <0.10 Whole plants <0.05 nd	213 Lot 1321, Perfection, 8221, Wando var. GH-C 1158 (first page GH-C-1178) (ref. 153).
Peas, United States, 1979	25% or 50% WP	Seed coated	na	167 g ai/100 kg seed	Shell-ed pea 46 52 Pea vines	Shell-ed pea 0.16 <0.05 Pea Vines	Shell-ed pea nd <0.05 Pea vines	213 Lot 1321, Early Market Pea, Progress No.9,

Crop, Country, Year	Application details: Formulation	No. of application	Interval between applications	Conc. g ai/hl or ha or other	Residues, mg/kg or ppm: PHI days	Chlorpyrifos	3,5,6	Comment & study reference
					46 59	1.3 <0.05	nd <0.10	Perfection var. 59 day PHI pea vine results from treatment at 110 g ai/100 kg seed. Ref. GH-C 1158.
Pumpkin, United States, 1978	25% WP or 50% WP	Seed coated	na	55 or 167 g ai/100 kg seed	75-95 118 & 167	<0.05 nd	<0.05 <0.05	Seed slurry treated. Spooky, Jack O'lantern, & Libby's Select var. A Chlorpyrifos value of 0.72 ppm at an 80 day PHI was considered to be contamination. GH-C 1159 (ref. 154).
Snapbeans,	25% WP	Seed coat	na	56 g ai/1	Green	Green plant	Green	Slimgreen & Snap

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of appli-cation	Inter-val be-tween appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
United States, 1973		ed		00 kg seed	plant 16 28 31 41 46 57-58 Beans 58	nd nd-0.01 0.03 ≤0.01 nd nd-0.01 Beans nd	plant nd ≤0.12 <0.05 <0.05 nd ≤0.05 Beans nd	var. GH-C 660 (ref. 155).
Snapbeans, United States, 1973	25% WP	Seed coated	na	56 g ai/100 kg seed	Green plant 28 43 59 Beans 57-58	Green plant 0.04-0.07 nd-0.01 0.01-0.04 Beans nd	Green plant ≤0.32 ≤0.1 <0.05 Beans nd	Contender var. Ref. GH-C 660
Snapbeans, United States, 1973	25% WP	Seed coated	na	56 g ai/100 kg seed	Green plant 48 61	Green plant 0.3-0.66 ≤0.01	Green plant ≤0.14 nd	Tempo var. Ref. GH-C 660
Snapbeans, United States, 1973	25% WP	Seed coated	na	167 g ai/100 kg seed	Green plant 16 28 31 41 46 57-	Green plant 0.01 0.01-0.04 nd-0.25 0.01-0.02	Green plant nd ≤0.17 n<0.05 ≤0.08 nd	Slimgreen, Snap var. Ref. GH-C 660

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	**No. of application**	**Inter-val be-tween appli-cations**	**Conc. g ai/hl or ha or other**	**PHI days**	**Chlor-pyrifos**	**3,5,6**	
					58 Beans 57-58	nd 0.01-0.02 Beans nd	≤0.07 Beans nd	
Snapbeans, United States, 1973	25% WP	Seed coated	na	167 g ai/100 kg seed	Green plant 28 43 59 Beans 58	Green plant 0.07-0.44 0.01-0.02 0.06-0.2 Beans nd	Green plant 0.3-0.4 ≤0.09 ≤0.13 Beans nd	Contender var. Ref. GH-C 660
Snapbeans, United States, 1973	25% WP	Seed coated	na	167 g ai/100 kg seed	Green plant 48 61	Green plant 1.2-1.6 ≤0.08	Green plant ≤0.46 ≤0.05	Tempo var. Ref. GH-C 660

- **Maximum values reported.**
- **nd = not detected   nr = not reported**
- **na = not applicable.**
- **Residues corrected for control and recovery.**

ATTACHMENT I - Summary of overseas chlorpyrifos residue data - ANIMAL FEEDS

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Form-ulation	No. of appli-cations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
Alfalfa, United States, 1979	Lors-ban 4E	1 to 4	18-35	560 g ai/ha 93,187, or 579 l/ha 1120 g ai/ha 19, 93, 187, 234 l/ha	Gf 6 7-8 13-14 Hay 12 15 20 Gf 0 7 14 Hay 16-22	Gf 2.6 4.4 3.2 Hay 18 <0.5 2.2 Gf 122 12 5.0 Hay 13	Gf 1.2 2.2 0.82 Hay 17 1.6 2.2 Gf 7.9 5.0 3.0 Hay 4.4	Gf = green forage. Delta, DuPuis and Brome, Common, WL-318, Lahonton, MFA 307, Niagra N-78, Kansas common var. Applications made just before cutting. Results are from all applications. Hay cured in field or dried in laboratory. GH-C 1209 (ref. 156).
Alfalfa, United States, 1983	Lors-ban 4E	1	na	280 g ai/ha 187 l/ha	Gf 7 Hay 9 10 14	Gf 0.68 Hay 1.8 <0.05 0.96	Gf 1.4 Hay 2.7 1.2 1.2	Gf = green forage Lahonton, WA-1, Vernal, Apollo var. Hay field dried or kept in a warm place. GH-C 1610 (ref. 157)
Alfalfa, United	Lors-ban	4	7-28 days	1.12, 1.12,	Gf 7	Gf 1.4	Gf 0.69	Gf = green forage. LA

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of appli-cations	Interval between appli-cations	Conc. g ai/hl or ha or other	PHI days	Chlor-pyrifos	3,5,6	
States, 1984	4E			0.56 and 0.28 kg ai/ha for 1st, 2nd, 3rd, 4th applns. 187 l/ha	Hay 7	Hay 2.9	Hay 3.5	Honton, WA-1, JX-99 var. Intervals between applns. refer to time before cutting. Hay samples field dried. Wetters (ref. 158)
Alfalfa, United States, 1986	Lors-ban 4E	3	Approx. month-ly	560 g ai/ha 1120 g ai/ha 187 l/ha	Gf 14 Hay 22 Gf 21 Hay 22 28	Gf 0.87 Hay 1.0 Gf 0.86 Hay 0.72 1.1	Gf 0.76 Hay 2.3 Gf 0.78 Hay 1.8 1.6	Gf = green forage La Honton, WA-1 var. Hay samples field dried. Hay PHI = 14 + 7-8 or 21+7 days. GH-C 1805 (ref. 159).
Alfalfa, United States, 1990	Lors-ban 4E	4, cutt-ing 12-14 days after each appl n.	12-14 days	840 g ai/ha 187 l/ha	Gf 14 (14) Hay 14+ 2 14+ 10 (12+ 2)	Gf 0.89 (11) Hay 2.3 0.61 (33)	Gf 1.6 (2.2) Hay 1.8 4.7 (4.8)	Gf = green forage. Results are combined from 3 trials. Alfalfa analysed was from the fourth cutting. Hay air dried for 2 to 10 days. Bracketed results were

Crop, Country, Year	Application details: Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	Residues, mg/kg or ppm: PHI days	Chlorpyrifos	3,5,6	Comment & study reference
								maxima but not considered representative by the report authors. Results corrected for recovery. GH-C 2294 (ref. 160).
Alfalfa, United States, 1993	Lors-ban 4E	4, cutt-ing after each appl n.	7 or 14 days befor e cuttin g.	560 g ai/ha 1120 g ai/ha 19 l/ha, aerial 187 l/ha or 128-151 l/ha groun d	Gf 7 7 Hay 7 7	Gf 1.2 (A) 6.4 Hay 2.9 (A) 21	Gf	Gf = green forage. 4th cutting taken for residue analysis. Hay dried for 3-12 days. Results of trials in 4 US states, one aerial application, 3 ground applied. (A) = result from aerial appln. Sutter, Impact, Oneida Dart, var. GH-C 2752 (ref. 161) and GH-C 2752R (ref. 162)
Alfalfa, United States, 1993	Lors-ban 4E	4, cutt-ing after	7 or 14 days befor	1120 g ai/ha 19 l/ha,	Gf 7 7 14	Gf 5.1 (A) 16	Gf	Gf = green forage. 4th cutting taken for residue

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
		each appln.	e cutting.	aerial 187 l/ha or 128-151 l/ha ground	14 Hay 7 14 7 14	0.37 (A) 9.8 Hay 5.8 (A) 2.5 (A) 58 41		analysis. Hay dried for 3-12 days. Results of trials in 4 US states, one aerial application, 3 ground applied. (A) = result from aerial appln. Sutter, Impact, Oneida Dart, var. Ref. GH-C 2752 and GH-C 2752R.
Grass, Germany, 1985	Dursban 4 (480 g chlorpyrifos /L, 1.5 L/ha)	1	na	720 g ai/ha	1 14 20 27 35	3.2 <0.02 <0.02 <0.02 <0.02	Trial 55/85	Results are from four trials. Results uncorrected for recovery and control Limits of quantitation <0.02 mg/kg grass,
Grass, Germany, 1985					0 14 21 28 35 35 hay	30 0.5 0.17 0.06 0.03 0.09	Trial 79/85	<0.08 mg/kg hay. Recoveries: Grass at 0.02 to 2.5 mg/kg 60-89%, Hay at 0.4 mg/kg

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	For m-ulati on	**No. of appli - catio ns**	**Inter valbe twee n appli - catio ns**	**Conc. g ai/hl or ha or other**	**PHI day s**	**Chlor - pyrifo s**	**3,5,6**	
								73%. Hay was prepared by air drying.
Grass, Germany, 1985					0 14 21 28 36 36 hay	13 3.7 1.7 0.62 0.25 0.94	Trial 80/85	GHE-P-1559 (ref. 163)
Grass, Germany, 1985					16 21 28 35	1.7 1.0 0.51 0.06	Trial 101/85	
Grass, Germany, 1986	Durs-ban 4 (480 g chlor-pyrifos/L, 400 L spray /ha	1	na	720 g ai/ha	0 14 21 28 35 28 hay 35 hay	18.1 0.53 0.36 0.11 0.05 0.54 0.31	Trial RT 43/86	Results are the maxima from three trials. Results un-corrected for recovery & controls (<0.02 & <0.08 mg/kg for grass & hay).
Grass, Germany, 1986					0 14 21 28 35 28 hay	14.2 0.41 0.14 0.04 0.01 0.14 0.06	Trial RT 75/86 Site 2743	Recoveries - grass 0.1-20 mg/kg 68-94%, hay 0.08-4 mg/kg 65-90%

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	No. of applications	Interval between applications	Conc. g ai/hl or ha or other	PHI days	Chlorpyrifos	3,5,6	
					35 hay			
Grass, Germany, 1986					0 14 21 28 35 28 hay 35 hay	20.9 0.90 0.05 0.02 0.03 0.13 0.07	Trial RT 75/86 Site 2887	Hay cut on days 28 & 35 and stored in an open room for about a week. GHE-P-1665 (ref. 164)
Grass, United States, 1990	Lorsban Bait 3% chlorpyrifos on wheat bran flakes.	1	na	2.24 kg ai/ha	Grass 0 7 14 Hay 0 7 14	Grass 0.27 0.07 0.05 Hay 0.72 0.28 0.36	Grass nd 0.11 0.05 Hay nd 0.22 0.11	Types/varieties: Common Bermuda grass, pasture grass mixture, Red clover, Smooth Brome, Blue grass, Native pasture, Rangeland grasses, Fesar, Orchard grass, Bait broadcast. Hay allowed to dry in field or greenhouse for 1-12 days. Results are from trials conducted in 13 US states. Report noted there were

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	**No. of applications**	**Interval between applications**	**Conc. g ai/hl or ha or other**	**PHI days**	**Chlorpyrifos**	**3,5,6**	
								difficulties in getting a homogen-eous sample for analysis. GH-C 2367 (ref. 165).
Pasture, Belgium, 1995	Dursban 480	2	22	730 g ai/ha, 204 and 215 l/ha	0 1 15 29 44 57	30 32 1.0 0.16 0.09 <0.01		Pasture, variety not reported. Whole plant analysed. 0 time = 1 hr after last treatment. GHE-P-4230 (ref. 166)
Pasture, Belgium, 1995	Dursban WG	2	22	703 and 736 g ai/ha, 204 & 226 l/ha	0 1 15 29 44 57	50 35 1.1 0.13 0.04 <0.01		Pasture, variety not reported. Whole plant analysed. 0 time = 1 hour after last treatment. Ref. GHE-P-4230
Pasture, Belgium, 1995	Dursban WG	2	22	approx. 350 g ai/ha, 207 & 213 l/ha	0 1 15 29 44 57	1.1 19 0.53 0.06 0.02 <0.01		Pasture, variety not reported. Whole plant analysed. 0 time = 1 hour after last treatment. Study report listed 19

Crop, Country, Year	Application details				Residues, mg/kg or ppm			Comment & study reference
	Formulation	**No. of applications**	**Interval between applications**	**Conc. g ai/hl or ha or other**	**PHI days**	**Chlorpyrifos**	**3,5,6**	
								mg/kg results as -1 hr before last treat-ment and 1.1 mg/kg as result 1 hour after last treatment. 0 PHI (= +1 hour) was probably 19 mg/kg and -1 hr PHI 1.1 mg/kg (from report). Ref. GHE-P-4230

. 3,5,6 = 3,5,6-trichloro-2-pyridinol . na = not applicable. . All results considered corrected for recovery and control unless specifically stated otherwise.

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