# 4.0 Historical Overview of Horticulture in Canterbury

## 4.1 Background

Horticulture, primarily orcharding and market gardening, has a long standing and important history in Canterbury since the 1800s. In particular, Christchurch originally developed as a service centre, mainly in response to the demands of agriculture, orcharding and market gardening, on the fertile soils of the Canterbury Plains.

During the late 19th and early 20th Centuries, Canterbury was recognised by many to be one of the most important centres of horticulture in New Zealand, and in the early days had more nurseries than other regions in the country. The two main reasons for the prevalence of horticulture in Canterbury were cited by Robert Nairn is his Banks Lecture to the New Zealand Institute of Agriculture (1932) as the wide treeless plains, which needed shelter, and the fact that the early settlers were mostly men who came to the area with considerable knowledge of horticulture and arboriculture (Ward, 1995). However, the fertile plains' soils, and a climate which mitigated much of the pressure from diseases and pests that were commonly experienced elsewhere in New Zealand, also encouraged the establishment of horticulture in the area.

It was found during the course of the scoping study that much of the information available on horticulture in Canterbury is general and anecdotal in nature and therefore it has proved difficult to find accurate information or statistics, particularly in relation to fertiliser use and spray regimes.

Information has been collated from a number of sources including Environment Canterbury, Christchurch City Council (CCC), interviews with local horticultural growers and a range of agricultural statistics surveys from Statistics New Zealand (http://www.stats.govt.nz/default.htm) and its predecessor, the former New Zealand Department of Statistics. More information was located for the Christchurch area than for other areas of the region, and thus the information gathered may not fully represent the region as a whole.

### 4.1.1 Climate

The Canterbury climate can be described generally as warm and dry in summer and cold in winter with frequent frosts. Due to the fact that the local climate is generally colder and less humid than other areas of intensive horticultural in New Zealand, such as Tasman or Gisborne, there is generally less insect and disease pressure, and accordingly significantly fewer horticultural chemicals, such as organophosphates, have been used. Perhaps the region with the most similar climate to Canterbury would be the Hawke's Bay.

The combination of local microclimates and soils of the valleys in and around Christchurch, such as the Governers Bay, Horotane and Heathcote valleys, have favoured the growth of particular crops such as stone fruits and glasshouse crops due to the lack of frosts experienced by these valleys (Ward, 1995).

### 4.1.2 Topography and Soils

Soils in Canterbury are generally dependent on the local topography. Most of the region's soils are formed from parent material derived from greywacke rock, loess, alluvium and colluvium. The soils over much of the Canterbury Plains are mainly formed from alluvium and loess overlying generally free-draining outwash gravels and sands from the braided rivers that traverse the plains. Some of Canterbury's most fertile and versatile soils are the deeper soils, derived from loess, located on the high terraces mainly found on the western side of the plains, in narrow strips on the south side of the major rivers. Soils nearer the coast tend to be finer textured gley soils where groundwater levels approach or intrude on the soil profile. Soils in and around the Port Hills are derived from basalt and loess, and soil formation processes are affected by local microclimates. Many of the soils in this area are susceptible to erosion, soil creep and gully erosion (CCC, 2000).

Within Christchurch, CCC uses the Horticultural Versatility System to assess the extent of high productivity soils in Christchurch City. Versatility is assessed in terms of the physical characteristics of the soils and assumes that any nutrient and soil moisture limitations are overcome by fertiliser application and irrigation. According to calculations done by CCC approximately 30% of the non-urban land in the City is highly versatile with minimal limitations to horticultural crop production (CCC, 2000). Unsurprisingly, these areas traditionally supported market gardening, berry fruit production and town supply dairying.

## 4.2 Horticultural Crops in Canterbury

A wide variety of fruit and vegetable crops have been grown historically in the Canterbury Region. The following sections give a general indication as to the main crops that have been grown around Canterbury since the 19$^{th}$ Century.

### 4.2.1 Fruit Growing and Viticulture

Fruit growing, and apple orcharding in particular, has been one of the mainstays of horticulture in Canterbury, especially in and around the Christchurch City area. Indeed much of the historical information available on horticulture in Canterbury focuses on fruitgrowing. Table 7 provides an example of the main types of fruit crops that have been planted in particular areas of Canterbury, since the early development of horticulture in the late 19$^{th}$ Century. The table has been compiled mainly from information contained in Ward (1995) and an interview with Alistair Malcolm, a local fruit grower, and should not be considered an exhaustive list of areas under pip and stone fruit cultivation in Canterbury.

**Table 7: Areas of Pip, Stone and Berry Fruit Horticulture in Canterbury**

| Area | Pip Fruit | | Stone Fruit | | | | Berries |
|---|---|---|---|---|---|---|---|
| | *Apples* | *Pears* | *Apricots* | *Peaches* | *Cherries* | *Plums* | |
| Belfast | √ | √ | | | √ | | √ |
| Chaneys/Ouruhia | √ | √ | | √ | | √ | √ |
| Governers Bay | | | √ | | | √ | √ |
| Harewood | √ | √ | | | | | √ |
| Heathcote | | | √ | | | | √ |
| Horotane | | | √ | | | | √ |
| Marshlands | √ | √ | | √ | | | √ |
| Papanui | √ | √ | | | | | √ |
| Styx | | | | | | | |
| Loburn | √ | √ | | √ | | | |
| Rangiora | √ | √ | | | | | |
| Amberley | √ | | √ | | | | |
| Waimate | √ | | | √ | | | √ |
| Geraldine | √ | √ | | √ | | √ | |
| Temuka | √ | √ | | | | | |
| Fairview/Timaru | √ | √ | | | | | |
| StoneyCroft, Winchester | √ | | | | | | |

### 4.2.2 Christchurch City

The Papanui district was the original hub of fruitgrowing in Canterbury for many years. However, there were many other areas in and around Christchurch City where fruitgrowing has a long history. Several of the areas that have been historically cultivated, such as Harewood, Papanui, Belfast and Opawa have already undergone redevelopment and the land use has changed from horticulture to residential, business or industry, as is demonstrated by the Applefields situation, discussed in later sections of this report.

The Marshlands area is one of the major areas still under horticultural cultivation in Christchurch, with smaller corners of glasshouse and orchard cultivation in the Port Hills valleys of Heathcote and Horotane.

### 4.2.3 North Canterbury

Rangiora, Loburn, and to some extent Amberley, were areas of former fruitgrowing in northern Canterbury. Rapid expansion of fruit growing took place in Rangiora between 1910 and 1920, however, the orchards in this area have long since been developed into residential lots. It is understood that orcharding has also occurred around Eyrewell.

Loburn has one of the longest histories of apple growing in Canterbury and to this day is still one of the main areas under orchard cultivation. Comparison of the aerial photographs and topographic information available on the ECan GIS database shows that the net area of horticultural land in Loburn has notably decreased in recent years.

### 4.2.4 South Canterbury

In south Canterbury, Waimate, Geraldine and Timaru are the foremost horticultural growing areas. There was a rapid expansion in tree-fruit and berry-fruit growing in Waimate in the early 1900s. Ward (1995) indicates that most fruit-growing in the Waimate district took place to the north of Waimate town, from Waituna in the west to Hook in the east. It was estimated that some 160 hectares were sub-divided and planted around the Waituna area, 7km north-west of Waimate in the years between 1916 and 1918. Strawberries have also been grown around the Waimate area. Much of the original fruit growing in South Canterbury appeared to be short-lived and unprofitable, possibly due to a combination of a harsher colder climate and poorer soil conditions, although some berry fruit growing still exists on the northern outskirts of Waimate today.

At present there are approximately 40 hectares under blackcurrant production by Ribena around Pareora, south of Timaru (Andrew Brough, PDP, pers. comm.).

### 4.2.5 Viticulture

There was very little viticulture in Canterbury prior to 1970 according to the Agricultural Production Statistics. Information provided by Mr. Malcolm states that the first grape plantings in Christchurch City occurred in the Belfast and Coutts Island areas. It is also known that there was some viticulture in the Opawa area in the early 20$^{th}$ Century. Since the 1980s, viticulture has increased considerably especially around Amberley and Waipara in North Canterbury. Viticulture has been and is also established around West Melton, Burnham, Pleasant Point, Brassels Bridge and some smaller areas around Washdyke, north of Timaru.

## 4.3 Vegetables and Market Gardening

The main vegetable crops that have been grown traditionally in Canterbury include peas, potatoes, onions, cabbage, cauliflower, pumpkin and carrots. The following table has been compiled based on the information provided during an interview with a local vegetable grower, Tex Mundy, whose family has a long history of vegetable growing in the area. Table 8 provides an indication of what areas have been under certain crop types in the past. Note that this table should not be considered an exhaustive list of vegetable cultivation areas in Canterbury.

**Table 8: Areas where Outdoor Vegetable Horticulture has taken place in Canterbury**

| Area | *Potatoes* | *Asparagus* | *Beans* | *Beetroot* | *Cabbage* | *Carrots* | *Cauliflower* | *Celery* | *Peas* | *Onions* | *Sweetcorn* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belfast | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Chaneys/Ouruhia | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Harewood | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Heathcote | Glasshouse/market gardening | | | | | | | | | | |
| Horotane | Glasshouse/market gardening | | | | | | | | | | |
| Marshlands | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Papanui | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Styx | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Rangiora | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Ashburton | √ | | | | | √ | | | √ | | √ |
| Waimate | √ | | | | | | | | √ | | |
| Geraldine | √ | | | | | | | | √ | | |
| Temuka | √ | | | | | | | | | | |
| Timaru | √ | | | | | | | | | | |

According to Mr. Mundy, the net area of vegetable horticulture in Christchurch City has significantly decreased since the 1970s, as land on the semi-rural city periphery has been redeveloped with new subdivisions and lifestyle blocks. However, he stated that there has been an overall increase in vegetable growing in the wider Canterbury region in recent years. Mr. Mundy indicated that much of this increase has been due to increased production of processed and export vegetables, such as peas and sweetcorn, in South Canterbury around the Rakaia, Chertsey and Ashburton areas. Heinz Wattie has been established in southern Canterbury since the 1970s and there is a large pea processing plant at Washdyke. McCains carry out potato production around Ashburton and Fairton. Historically there has also been potato cultivation around Makikihi, north-east of Waimate.

## 4.4 Glasshouse Cultivation

It was difficult to obtain any comprehensive information on glasshouse cultivation in Canterbury during the course of this study. Most of the information presented in this

report comes from discussion with Mr. Brian Gargiulo, Director of Horticulture New Zealand[2].

The major glasshouse crops cultivated in Canterbury have been capsicums, tomatoes, cucumber, beans, lettuces and radishes. The main areas in Christchurch that have historically had glasshouse cultivation are in the Port Hills valleys of Heathcote, Horotane and Avoca. There have also been glasshouses around Bowenvale and Birdwood avenues in the Huntsbury area of Christchurch, particularly prior to 1970, but significantly decreased in recent years. To Mr. Gargiulo's knowledge there are possibly only two remaining glasshouses in Christchurch that were in existence prior to 1970. These are thought to be located in Richardson Terrace in the Opawa/Woolston area and the Heathcote valley.

In the wider Canterbury area there were some glasshouses in Rangiora, which have since disappeared, and some tomato cultivation was undertaken in Timaru.

Since the 1980s, glasshouse crops have been cultivated in grow bags, but in the past, crops were planted directly into the soil, and the same section of land underwent intensive cultivation year after year, rather than being left to lie fallow or undergoing crop rotation as was the case in outdoor vegetable growing areas.

Some local horticultural growers that were interviewed during the study have indicated that soils in areas that have a history of glasshouse cultivation may have more residual soil contamination than that associated with other crops, however this remains unsubstantiated without carrying out further detailed investigations.

## 4.5 Land Areas under Horticultural Production in Canterbury

Statistical data detailing the land area under different types of horticulture from the early 1950s to the present day were collated and analysed. The data were gathered from information collected and published by the New Zealand government in the form of the Annual Agricultural Census, Annual Agricultural Production Survey, Agricultural and Pastoral Statistics and New Zealand Farm Production Statistics (New Zealand Department of Statistics/Statistics New Zealand). These data sets appear to be essentially the same in their basic nature and have all been compiled by the government statistics department, however the title and content of these surveys appears to have changed over time.

Data are presented in two series in Appendix A, pre-1980s (Figures 1 and 2) and 1980s to the present (Figures 3, 4, 5 and 6). Information from these original data sets has been summarised in Figures 7 and 8, Appendix A.

The data series prior to 1980 does not contain a breakdown of the land areas under specific crops (e.g. pip fruit, stone fruit, berry fruit) and this therefore makes any analysis of change of scale over time difficult. For the period 1950 to 1970 data exist on general orchard and market garden areal production. These data are organised by territorial

[2] Formed from the NZ Vegetable and Potato growers Federation (Vegfed) and the New Zealand Fruitgrowers Federation (FruitFed).

authority (there were 25 territorial authorities in Canterbury prior to reorganisation) and is summarised in Figure 7 in Appendix A. Figure 8 shows the area under tree fruit and vine cultivation in Canterbury for the period 1979-2005.

The data series from the 1980s to the present is reasonably complete and provides a good indication of the areas under certain crop types over that period. There are some gaps in the data during this period as information has been suppressed for commercial confidentiality reasons or due to an incomplete or unreliable data set.

Figure 1 illustrates the total area under orchard and market garden production in Canterbury from 1950 to 1970. The chart shows that the overall areas under orchard and market garden production more than halved over this period from approximately 1,650 hectares in 1950-1951 to 719 hectares in 1969-1970. Figure 2 compares the net areas of orchards and market gardens from 1950-1970. The graphs show that the areas under market garden vegetable production were greater than the areas under orchard horticulture, especially during the 1950s. The area of orchard experienced an overall decrease between 1950 and 1970 although there was a slight increase during the late 1960s in particular. However, there was a significant decrease in market garden production from over 1,000 hectares in 1950 to approximately 300 hectares in 1969-1970.

Figures 3 and 4 illustrate the number of hectares under fruit growing cultivation in Canterbury for the period 1980 to 2005 based on data from the aforementioned surveys. Although this data series extends to 2005, the most recent comprehensive horticultural data are in fact contained within the 2002 Agricultural Production Survey (Statistics New Zealand). Figure 8 provides more detail on the total area under specific crop production in Canterbury during this period.

Figures 3 and 4 show that since 1980, pip fruit, in particular apples, have been the main type of fruit growing in Canterbury. As shown on the Figure 3, the area under pip fruit production increased from approximately 446 hectares in the year 1985-1986 to 1,969 hectares in the year 1994-95. The area of apple production increased from 336 hectares in 1979-1980 to a peak of 1,856 hectares in 1994-1995 (see Figure 4). No tree fruit production data could be found in the Agricultural Production Survey (Statistics New Zealand) for the period 1997 to 1999, however Appendix 5 of the Ministry of Agriculture and Forestry (MAF) Review (1999) indicates that 1,000 hectares were under apple production in Canterbury in the season 1998-1999. This demonstrates a rapid decline in the area under pip fruit production at the beginning of the 21$^{st}$ Century considering there were only 533 hectares remaining in pip fruit production in the year 2000.

The trend visible in these figures can be explained due to the fact that from the early-1980s, the corporate grower, Applefields, planted large areas of orchards around the urban-rural periphery of Christchurch in areas such as north of Johns Road near Belfast, Northwood, Halswell, Rolleston and Harewood. These orchards contributed significantly to the area under pip fruit cultivation as is clearly illustrated on Figure 4. However,

changing market forces led to Applefields halting pip fruit production in the mid-1990s, and latterly they decommissioned and redeveloped their orchards.

Between 1984-1985 and 1990, stone fruit and berry fruit had similar areas under production (totals of less than 250 hectares) however since earlier 1992 the area under berry fruit production has greatly increased, to more than 500 hectares. Since 2000, there has also been a considerable increase in grape and olive production in Canterbury. According to the statistics, since 2000 berry fruit (namely blackcurrants), grapes and, since 2002, olives have been the main fruit growing crops in Canterbury (see Figure 3). Data for citrus fruit and sub-tropical fruit has been excluded from Figures 3 and 4, as these areas are unsurprisingly (given the Canterbury climate) negligible compared to the areas under pip and berry fruit production.

The areas under vegetable production are far greater than those under fruit production, however. Figures 5 and 6 show the net areas under vegetable cultivation in Canterbury since 1978-1979. For ease of illustration in this report, the produce types have been divided into 'Level 1' (Figure 5) and 'Level 2' crops (Figure 6). Level 1 vegetable crops include potatoes, peas, onions and sweetcorn. Level 2 crops include beans, carrots, cauliflower and pumpkin or squash. The area under Level 1 vegetable horticulture has increased considerably since the 1970s as demonstrated in Figure 5. Peas have been the major vegetable crop in Canterbury with production peaking in the 1994-95 growing season. The area under potato cultivation has increased steadily since the mid 1980s and in 2002 there were over 9,000 hectares of combined peas and potato cultivation in Canterbury. Level 2 crops cover significantly less area than Level 1 as shown in Figure 6. The extent of pumpkin and squash production increased considerably during the early 1990s and peaked at just over 900 hectares in 1992. However, since then the area has decreased markedly to just over 200 hectares in 2002. Bean cultivation, however, has steadily increased and between 2000 and 2002 shows the greatest area of Level 2 crops in cultivation.

The latest agricultural survey results, produced in June 2005, state that there were at least 6,120 hectares in Canterbury in horticultural production at this time however this figure only includes the combined net area of apples, pears, peaches, onions and potatoes. Statistics from the Agricultural Production Statistics 2000 are more inclusive and indicate there were approximately 21,000 hectares of horticultural land in Canterbury. Considering that the statistics of the 2005 dataset are limited to specific produce, it is reasonable to assume that a significantly larger total area is actually under current horticulture production in the Canterbury region than is reflected in these statistics.

## 4.6 Comparison of Areas in Horticulture with Other Regions

Canterbury has always had a smaller scale fruit and market garden horticultural industry than most other regions. It is this part of horticulture that is most likely to have persistent soil residues. A brief search of readily available literature confirms this, in Table 9.

**Table 9: Regional Comparison of Historical Areas in Orchard (hectares)**

| Region | 1950 – 1951 [1] | 1964 – 1965 | 1968 – 1971 | 1979 – 1981 |
|---|---|---|---|---|
| Auckland | | 5,782 | | 8488 |
| Hawke's Bay | | | 19,830 | |
| Tasman | 3,577 [2] | | 5,709 | 4,296 |
| Canterbury | 1,734 | 921 | 911 | |

Notes:
1. Data for particular region is for one year in the range of dates given.
2. Waimea County only.

Table 9 summarise data from this study and Auckland (ARC, 2002), Hawke's Bay (Macaskill, 2004) and Tasman (Gaw, 2002) for various years. Exact comparison cannot be made because there is not an exact correspondence of the years that the data have been compiled for, however it can generally be seen that, at least for the 1950s through to the 1970s, a period when some of the persistent chemicals were being used, Canterbury had a smaller fruit-growing industry than the other regions listed. Hawke's Bay is the largest pip and stone fruit growing area in New Zealand.

# 5.0 Use of Horticultural Chemicals in Canterbury

## 5.1 General

New Zealand does not have a system in place for gathering detailed statistics on pesticide use. Some information is collected by the MAF, the former Pesticides Board, NZ Association for Animal Health and Crop Production and agricultural producer boards, however the data often remains confidential and is random in its form.

The term 'pesticide' is generally used to encompass both the use of fungicides and insecticides. As discussed earlier, some obvious factors influencing pesticide use include climate, agricultural systems, alternative plant protection strategies, export orientation, regulatory systems and so forth.

Chapter 8 (Soil Conservation) of ECan's Proposed Natural Resources Regional Plan identifies the two main contaminants in Canterbury's soils that are likely to cause adverse effects are DDT (and its breakdown residues DDD and DDE), due to the widespread treatment of grass grub infestations, and cadmium accumulation in soils from past and present widespread use of phosphate fertilisers. However, assuming Canterbury is similar to other regions in New Zealand, the data presented earlier in the report suggests that arsenic and lead from the use of lead arsenate, copper in fungicides, and DDT will be present at elevated concentrations in many former horticultural soils.

## 5.2 Probable Sprays used on Particular Crops

In the absence of any robust data on the quantities of chemical usage on horticultural crops in Canterbury the information presented in this report has been mainly gathered from anecdotal details contained in Ward (1995) and interviews with local growers.

Historically there have been a variety of chemicals used on horticultural crops in Canterbury, similar to those used elsewhere in New Zealand. As discussed in previous sections of the report, the key transition date in terms of horticultural chemical use in New Zealand was around 1970. Prior to this time the main substances used in Canterbury included lime sulphur, caustic soda, potash, lead arsenate, copper, mercury, DDT, dieldrin and aldrin. Following 1970, many of the chemicals which would be most persistent in soils, such as DDT, were deregistered or were withdrawn from use. However, judging by local accounts, it is likely that in many areas in Canterbury existing private supplies of withdrawn or deregistered chemicals continued to be used after this time.

MAF (1999) provides information on spray used in the 1980s and 1990s. These are not expected to significantly contribute to soil residues on broad-acre land, although hotspots could occur at storage and mix locations.

Historically, orchards have not used significant amounts of weed killers.

### 5.2.1 Spray Use on Fruit Crops

Information from other regions suggests the areas where there is the potential for the greatest concentration of contaminants to exist are the areas that were under orchard production prior to 1970. It was beyond the scope of this study to determine exactly what areas had orchards in existence prior to 1970, however Mr. Malcolm gave the examples of Loburn, Marshlands, Geraldine and Timaru as areas where there were large orchards producing prior to 1970. Smaller areas existed in the Port Hills valleys.

Ward (1995) briefly comments on the insect and disease pressures commonly experienced by the early fruitgrowers in Canterbury and gives an indication of the type of chemicals to treat these diseases. Common diseases afflicting pip fruit in the late 19$^{th}$ and early 20$^{th}$ Century were black spot, woolly aphis (American Blight), scale, red spider, leach, clack fungus, powdery mildew and codlin moth.

A general account from an orchardist in Winchester during the early 20$^{th}$ century highlights that black spot was the most difficult disease to control (Ward, 1995). The most frequent sprayings involved lime sulphur and Bordeaux Mixture (copper sulphate and hydrated lime) to combat this. Blight was also treated with the application of lime sulphur and lead arsenate. Lead arsenate was also commonly used in orchards to combat codlin moth. Black lead forty, a nicotine-based spray, was used for blight and red spider. Residues of copper, arsenic and lead would have resulted from this spraying regime.

Mr. Malcolm was of the opinion that that lead arsenate was not used after 1960 in Canterbury, although this claim is inconsistent with use elsewhere in New Zealand until the 1970s and seems unlikely.

Copper is still commonly used to fight bacterial diseases in stone fruit. Therefore it might be expected that Governers Bay, Heathcote and Horotane valleys will have elevated copper residues in the soils, although this may not pose a direct risk to human health.

The MAF Review of Trends in Agricultural Pesticide Use in New Zealand from 1984-1994 gives an indication of more recent chemical use on horticultural crops. Blackcurrants, the major berry crop in Canterbury, and blueberries have few serious pest and disease problems and pesticide use is relatively low. However, boysenberries require an intensive fungicide programme, mainly for downey mildew and botrytis (MAF, 1999). This suggests that copper-based sprays may have been used in former times, with the possibility of persistent copper residues in current and former berry fruit growing areas around Waimate.

MAF (1999) has little information specific to Canterbury on current pesticide use, but information for apples suggests that organophosphate compounds are the most commonly used synthetic insecticide, followed by carbamates. Mineral oils are also extensively used. For the fungicides, dithiocarbamates are significantly used (e.g. maneb), while inorganic pesticides (principally sulphur and copper-based compounds) are also used. Copper compounds will leave persistent residues.

Information from the MAF (1999) report states that insect problems are generally minor on grapes, therefore those areas under viticulture will have had generally low insecticide use. However mildew during the growing season at harvest time is significant and relatively intense fungicide programmes tend to be followed in the wine grape industry. There is a high use of copper and sulphur as well as a range of synthetic fungicides. Only copper will be persistent.

Given that viticulture has only really become established in Canterbury since the 1980s it is thought that it is unlikely that there will be significant copper residues present. However, results from soil sampling conducted by PDP in an area that was under small-scale viticulture in the early 20$^{th}$ Century revealed significantly elevated lead concentrations.

### 5.2.2 Spray Use on Vegetable Crops

Potatoes are one of the major vegetable crops in Canterbury in terms of area and according to comments made by Mr. Mundy require very little spraying. Blight has been one of the main diseases afflicting potato crops, and this has usually been treated with a copper-based chemical. Cabbage and cauliflower tend to succumb to some insect pressure and DDT was historically used to treat these crops. Carrot rust fly is the main disease for carrot crops, and dieldrin was commonly used in the past in carrot growing areas.

It is understood from Mr. Garguilo that historically there was very little arsenic, lead, dieldrin or DDT used on glasshouse crops, however copper was commonly used to combat blight during summertime.

According to local growers there is a significant difference between the spray regimes for vegetables in the North Island, compared to the South Island. The Canterbury climate favours a variety of vegetable growing and onion crops perhaps undergo the most intensive of pesticide spraying regimes out of all the crops. In the past, copper has been applied generously to onion crops.

The MAF Review states that pesticide use in vegetables such as asparagus, green peas and sweetcorn is relatively low, while fresh vegetables such as lettuce, brassicas and potatoes tend to have intensive spray programmes throughout the growing season.

It is worth noting that in former glasshouse areas there may be elevated polycyclic aromatic hydrocarbon (PAH) residues from clinker put in glasshouses to aid drainage and regulate temperatures within the glasshouses. In addition, PAH residues and heavy metals may be associated with burnt coal used to heat the glasshouses. More recently, sites may have onsite underground/aboveground storage of diesel or fuel oil for glasshouse heating. Human health and environmental issues can be associated with these fuels should they be present at the site. An assessment of these petroleum hydrocarbon products is considered to be outside the scope of this report.

## 5.3 Soil Residue Measurements in Canterbury

To date, no large-scale studies investigating contamination of soils in areas currently or formerly used for horticultural purposes in Canterbury have been completed. However, investigations of individual properties are routinely being conducted at the time of subdivision and redevelopment where territorial authorities suspect soil residues may be present.

A number of such contaminated site assessment reports, for sites that were formerly under horticultural or market gardening cultivation in Christchurch, were obtained from ECan for this study. The site investigations typically involved sampling of the near surface soils on the sites and the results were analysed for a variety of heavy metals and organochlorine/DDT compounds. The concentration ranges for arsenic, copper, lead, zinc and DDT are summarised in Table 10 below. It is important to emphasise that the data summarised are only representative of sample locations in certain individual sites in Christchurch and may not give an accurate representation of potential horticultural soil contamination for the general Christchurch area, nor over the wider Canterbury area.

**Table 10: Selected Near-Surface Soil Sampling Results from Around Christchurch (mg/kg)**

| Former Land Use | Arsenic | Copper | Lead | Zinc | Dieldrin | Total DDT [2] |
|---|---|---|---|---|---|---|
| Orchard (N=1; n=9)[3] | 6 – 40 | 14 – 334 | 17 – 135 | - | 0.06 – 0.15 | <0.03 – 24.1 |
| Market Gardening (N=3; n=19) | 3 – 14 | 9 – 961 | 18 – 293 | - | 0.001 | 0.03 – 0.74 |
| Glasshouse (N=5; n=63) | 6 – 64 | 11 – 129 | 42 – 797 | 82 – 562 | <0.01 – 2.82 | 0.005 – 8.38 |
| Vineyard [4] (n=4) | 6 – 11 | 19 – 47 | 32 – 771 | - | - | 0.225 – 10.09 |

Notes:
1. The sum of DDT, DDD and DDE.
2. N = number of properties; n = total number of samples
3. A single historic vineyard not expected to be typical of modern vineyards.

These results suggest that some samples from orchards will fail human health guidelines for arsenic, and possibly DDT, while glasshouse samples may fail human health guidelines for arsenic, lead (perhaps from lead paint) and dieldrin. Some market garden samples approached human health guidelines for lead, while some copper concentrations are in excess of toxic concentrations for some plants.

The samples from the single vineyard show what could be found on a very old property, but is not representative of vineyards in general. Contrary to the general expectation for old vineyards, copper concentrations were low.

To put these results into a regional context, they have been compared with regional sampling results copied from Table 5 in Table 11 below.

**Table 11: Selected Canterbury Studies Compared with Regional Near-Surface Soil Sampling Results (mg/kg)**

| Land use | Result Range | Arsenic | Copper | Lead | Total DDT [1] |
|---|---|---|---|---|---|
| Pip/Stone Orchard | Auckland (n=12)[2] | 2 – 34 | 21 – 490 | 11.4 – 178 | <0.03 – 24.4 |
| | Waikato (n=7) | 4 – 58 | 242 – 523 | 14 – 251 | 0.73 – 34.5 |
| | Bay of Plenty (n=17) | 3 – 48 | 6 – 304 | 4.6 – 184 | <0.03 – 6.09 |
| | Hawke's Bay (n=18/10)[2] | 4 – 73 | 28 – 542 | 16 – 341 | 0.02 – 15.3 |
| | Tasman (n=5) | 3 – 48 | 10 – 123 | 15 – 243 | 1.49 – 7.14 |
| | **Canterbury** | **6 – 40** | **14 – 334** | **17 – 135** | **<0.03 – 24.1** |
| Glasshouses | Auckland (n=12) | <2 – 20 | 7 – 253 | 6.0 – 1250 | <0.03 – 289 |
| | **Canterbury** | **6 – 64** | **13 – 129** | **36 – 562** | **0.005 – 8.38** |
| Market Gardens/Vegetable Cropping | Auckland (n=8) | 4 – 11 | 21 – 137 | 14.4 – 45.7 | 0.08 – 0.91 |
| | Waikato (n=7) | 6 – 11 | 26 – 112 | 21 – 48 | 0.04 – 1.68 |
| | Bay of Plenty [3] (n=24) | <2 – 28 | 11 – 215 | 6.2 – 63.2 | <0.03 – 4.37 |
| | Hawke's Bay (n=6) | 3 – 10 | 8 – 58 | 10 – 32 | <0.01 – 0.12 |
| | Tasman (n=5) | 2 – 21 | 6 – 67 | 8 – 21 | 0.06 – 1.16 |
| | **Canterbury** | **3 – 31** | **9 – 961** | **22 – 797** | **0.003 – 0.74** |
| Vineyard | Auckland (n=11) | <2 – 14 | 16 – 152 | 2.7 – 87.6 | <0.03 – 2.84 |
| | Waikato (n=7) | 6 – 15 | 22 – 115 | 22 – 51 | <0.03 – 1.26 |
| | Hawke's Bay (n=5) | 2 – 7 | 43 – 119 | 12 – 56 | 0.02 – 0.35 |
| | **Canterbury [4]** | **6 – 11** | **19 – 47** | **32 – 771** | **0.225 – 10.09** |

Notes:
1. The sum of DDT, DDD and DDE
2. n = number of samples. Also see Note 3, Table 5.
3. Glasshouses and market gardens lumped together in SEM (2005). No information as to how "horticulture" category. differs from other apparent horticulture uses, and has therefore been combined with glasshouse/market garden to be more consistent with other regions.
4. A single historic vineyard (early 1900s) which will not be representative of a modern vineyard.

It is apparent that, for orchards, arsenic and DDT concentrations are similar to other regions, copper concentrations tend to be lower than Northern Island regions, but are higher than Tasman, and lead concentrations are generally lower (possibly suggesting different retention of lead relative to arsenic in Canterbury soils compared with other regions).

Recent spray-use data from MAF (1999) for apple orchards, and local anecdotal accounts for horticulture in general, suggest that insecticide use in Canterbury is less than that for horticultural areas in the North Island. However, the Christchurch site investigations

suggest, at least for arsenic, that pre-1970 insecticide use on orchards may not have been very different to other regions.

Few conclusions can be arrived at for glasshouses, as the only comparison is with Auckland. Given the extreme values of lead and DDT found in some Auckland glasshouses, and PDP experience suggesting that the Auckland data from ARC (2002) underestimates the true range of arsenic concentrations likely to be found in glasshouses, it is difficult to make meaningful comparisons with the Christchurch data. However, the arsenic concentrations are in line with PDP experience in Auckland glasshouses and an extreme lead result in the Christchurch data suggests lead paint may be an issue.

The market gardening and cropping areas appear to be at the high end of the regional range for arsenic, and high values for copper and lead are well in excess of other regions (although the high copper and lead values suggest a hotspot, rather than typical results). DDT concentrations fall within the range found in other regions, being similar to Auckland and Tasman, but lower than the Bay of Plenty.

The vineyard results for other regions suggest only copper is likely to be elevated, with the other metals typical of, or only slightly elevated over background concentrations. DDT is similar to pasture land. It is expected that a similar situation would exist for Canterbury vineyards established from pasture.

## 6.0 Implications for Horticultural Land in Canterbury

The key indicator of residue concentration is crop type and period of cropping. Without research into exactly where major cropping areas were formerly located and then further field investigations, it is difficult to ascertain exactly where and to what extent there has been historical contamination of Canterbury's soils. However, some tentative conclusions can be made.

The study has shown that chemicals which are known to be persistent in soils such as arsenic, lead, copper, dieldrin and DDT have been used historically in Canterbury. However, from this investigation it is thought that spraying of crops have been, and are, less frequent and intense than those used in other areas of New Zealand, and therefore contaminant residues, if any, may be lower in Canterbury compared to other regions in the North Island. However, at least for arsenic on orchard land, the available soil investigation reports from the Christchurch area suggest that contamination could be similar to elsewhere in New Zealand. There is also clearly elevated copper, lead and DDT in some properties, the latter two approaching human health guidelines.

In the last ten years, a number of new subdivisions and lifestyle blocks have been developed not only in Christchurch, but in the larger Canterbury region. Some of the properties have been developed on former orchard or market garden land, especially on the periphery of Christchurch. Where the former use extended back before the 1970s there is a potential for excessive pesticide residues, particularly arsenic and to a lesser extent lead and DDT. This could include areas such as Marshlands and the valleys of the Port Hills. There is also former horticultural land along the West Coast Road (SH 73) and

around Yaldhurst, on the western fringe of Christchurch, and further west at Masham, which may be in demand for residential subdivision or lifestyle blocks in the coming years. The Loburn area, north of Rangiora, may also be in demand for liftestyle redevelopment.

It would be a relatively simple task to identify the areas around Christchurch which have already undergone redevelopment, or might undergo redevelopment in the next 10 to 15 years, by examining historic and current aerial photographs and consulting appropriate territorial authorities as to the likely patterns of redevelopment. Given that most redevelopment has or will occur around Christchurch, and that most horticultural land in Canterbury was also in and around Christchurch, this would seem to be the priority for any further investigation. Field sampling could be part of this investigation, or could follow once representative target areas had been identified, although there is probably sufficient information already available to choose investigation targets in the Port Hills valleys, and the Marshlands and Loburn areas.

Some of the recent residential redevelopment around Christchurch has been on former Applefields orchards (e.g. Northwood, Halswell on the Park). Given that these orchards were only developed since the early 1980s, it is unlikely that there would be significant soil residues of contaminants other than perhaps copper, unless there was prior horticultural use by other owners, thus these areas are not a priority for further investigation.

Vineyards around Christchurch and in North Canterbury are also considered a low priority for investigation, unless simply for completeness. While there may be slightly elevated concentrations of copper, other persistent pesticide residues are not expected to be significant unless a vineyard happened to be a redevelopment of an earlier horticultural use. In general, vineyards have been developed from grazing land.

It is uncertain whether existing or former horticultural areas in Canterbury other than around Christchurch are likely to experience redevelopment. When areas immediately around Christchurch are eliminated (the former Ashley, Rangiora, Waimairi, Paparoa, Papanui and Heathcote counties, covering Loburn, the western fringes of Christchurch, Marshlands and the Port Hills valleys), the main growing areas were in the former Ashburton, Geraldine, Levels (northern fringe of Timaru) and Waimate counties (see Figure 7). Further research is required to determine whether the specific areas in these former counties have, or are likely to, undergo redevelopment. The research would initially involve examining historic aerial photographs, talking to local growers and talking to the current territorial authorities as to likely development patterns in their districts. This would be a second priority after the immediate Christchurch area.

The wider Canterbury area is likely to be a lesser priority for further investigation given the small areas used for orchards and market gardens and the smaller likelihood of lesser redevelopment pressure around the smaller communities of rural Canterbury.

# 7.0 Conclusions and Recommendations

This scoping study has briefly identified the areas in and around Christchurch City and the Canterbury Region which have been used for horticultural in the past and has considered the Canterbury Region within a wider national and international context.

The information presented in this report has been compiled from various reports, documents and statistics databases as a desk-based exercise. No site visits have been undertaken to verify any of the information presented in this report. It is to be expected that these conclusions and associated recommendations can be refined, as further investigation is carried out, and if more information from investigation reports from individual properties become available.

The report conclusions can be summarised as follows:

- Pesticide chemicals which are known to be persistent in soils such as arsenic, lead, copper, dieldrin and DDT have been used historically in Canterbury, and are thus the contaminants of concern for Canterbury.
- Persistent soil residues are most likely in fruit growing and intensive market garden areas in production prior to the 1970s.
- Canterbury has a long history of fruit production going back many decades, although the scale of the industry is, and was, smaller than most other regions in New Zealand.
- The areas under vegetable production are far greater than those under fruit production. However the evidence points to there being less of a concern for vegetable cropping land, although DDT was applied to brassicas, dieldrin to carrots and copper to onions.
- A large part of the fruit and market gardening industry within Canterbury has been based around Christchurch and nearby North Canterbury towns, with smaller areas around Timaru, Waimate and Geraldine. Many of the areas that have been historically cultivated in Christchurch City have already undergone redevelopment. Marshlands and the Port Hills valleys are the major areas in Christchurch City still under cultivation.
- It is thought that spray regimes for crops have been less frequent and intense than those used in other areas of New Zealand and therefore contaminant residues, if any, may be lower. However, the limited comparison of available studies for individual properties around Christchurch with regional studies from other regions suggests concentrations of arsenic, DDT, lead and copper within former orchard or market garden land are comparable with other regions.
- Results from the Christchurch studies, conducted prior to subdivision or development, suggest that some samples will fail human health guidelines for arsenic and possibly DDT, while glasshouse samples may fail human health guidelines for arsenic, lead and dieldrin.

- The vertical and spatial patterns of contamination observed elsewhere in New Zealand are expected to be generally applicable to Canterbury. Soil residue concentrations drop off rapidly within the top 250 – 300 mm of soil, with background concentrations typically found at 450 mm below the surface. Spatially, there can be substantial variations between different orchard blocks, but reasonably consistent residues within blocks.

Based on the findings of the scoping study our recommendations are as follows:

- As a first priority, conduct further investigation of areas in and around Christchurch City which have already underdone redevelopment and might undergo redevelopment in the next ten to twenty years. Investigation target areas would include Marshlands, the Port Hills valleys, and Loburn, but other areas could be identified as part of preliminary investigations involving examining aerial photographs and discussions with local authorities. Soil sampling in a comparable manner to other regional studies should follow identification of specific areas to target.
- Undertake further research to determine whether areas in the former Ashburton, Geraldine, Levels and Waimate counties to identify specific growing areas and then identify whether they are likely to undergo redevelopment.
- The research and investigation of these areas may include the examination of historic aerial photographs, talking to local growers and current territorial local authorities. Field sampling may follow.

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