

**A BASELINE OF ADOPTION OF CONSERVATION  
CROPPING - NORTH CENTRAL REGION**

**August 2001**

**AGRICULTURE VICTORIA - BENDIGO  
CENTRE FOR LAND PROTECTION RESEARCH**

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## SUMMARY

The aim of this report is to document baseline information about the state of adoption of conservation cropping practices in the North Central Region of Victoria.

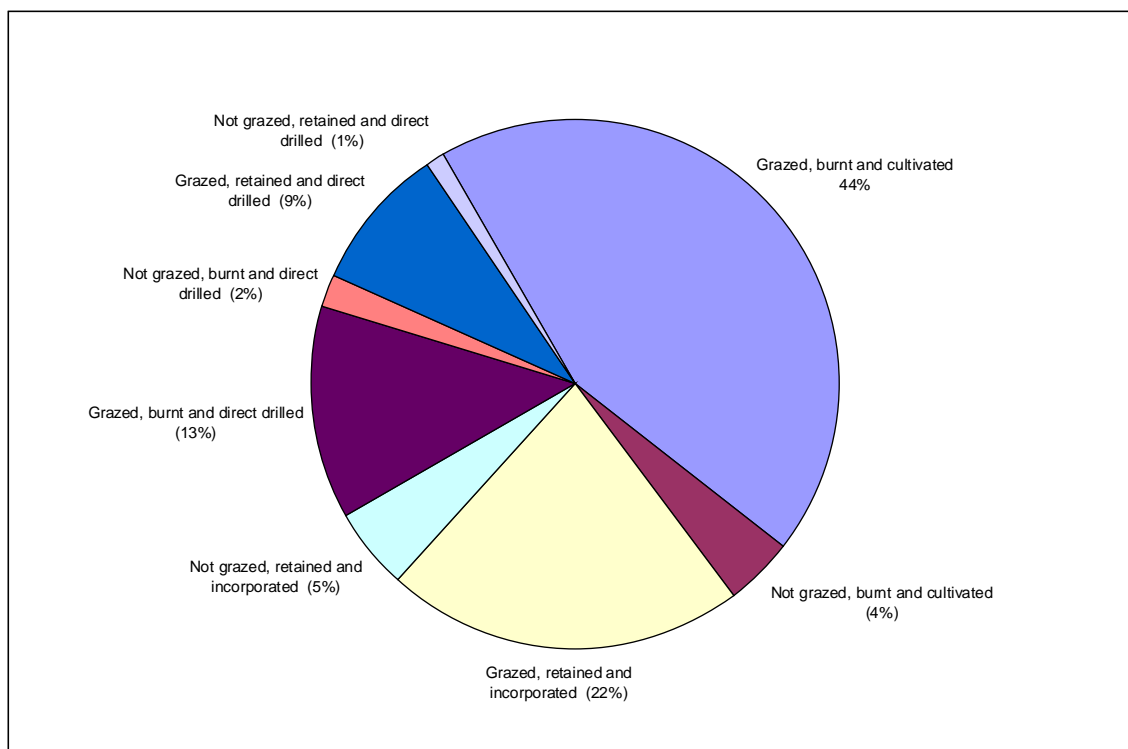
Based upon the available data, the progress towards adoption of conservation cropping practices on north central cropping farms can be summarised as follows:

- **Cultivation:** There was a significant decrease in the use of cultivation during the 1980s and early 1990s. In the 1980s the trend to reduced cultivation was strongest on land that had been cropped the previous year. There was little move away from cultivation on land traditionally fallowed. The continuing trend towards fewer cultivations in the early 1990s appears linked to a move away from cultivated fallow. The trend towards decreased cultivation has slowed down since the mid 1990s.
- **Fallow:** Measurement problems make it difficult to draw conclusions. There appears to have been a strong trend away from fallow in a small segment of the population, although the majority of croppers appear to have made only small changes in fallow practice.
- **Stubble retention:** There has been a dramatic fall in the use of burning as a means of managing stubble. The trend has been to incorporation rather than to full stubble retention. Full stubble retention is still an uncommon practice.
- **Herbicide Use:** There is also a clear trend away from cultivated fallow towards more use of chemical fallow.

In order to understand the extent of adoption of the full package of conservation cropping options, the Agriculture Victoria baseline study was used. In this study, stubble and soil management practices were classified into one of four management regimes, and the application of these regimes to each paddock studied in the survey was determined. The four regimes were:

- **Conventional:** Stubble is burnt and the soil is then cultivated.
- **Incorporation:** Stubble is not burnt, but is incorporated into the soil.
- **Direct drilling:** Stubble is burnt but the soil is not cultivated.
- **Trash farming:** Stubble is not burnt and soil is not cultivated. Stubble mulching, grazing and baling were included within this category.

In order to be more precise about stubble management methods, these areas were further divided according to whether or not the stubble was grazed prior to each of the management regimes. Only 3 percent of cropping farmers have adopted full trash farming defined as no grazing, burning or cultivation. This was practiced on 1 percent of all cropping land only. Figure 1 shows the proportion of stubble area treated under each of these management regimes.



Source: Agriculture Victoria baseline survey (1993)

**Figure 1** Proportion of area under different stubble management regimes

Farmers were classified into four groups according to their cultivation and stubble management practices. These groups are shown in Table 1.

- **Conventional farmers:** These farmers only burnt and cultivated stubbles. Thirty percent of the cropping farmers in the sample were members of this group. Half of the stubble managed by these farmers was grazed prior to burning.
- **Incorporators:** All of these farmers practised some form of stubble incorporation. Thirty-seven percent of the sampled cropping farmers belonged in this group, making it the largest group. Stubble grazing and incorporation dominated the stubble management of this group. Eighty percent of stubbles managed by this group were incorporated, mostly after grazing. The remaining twenty percent of stubbles were burnt prior to cultivation. No land was direct drilled or trash farmed.
- **Direct drillers:** All of these farmers practised direct drilling on part of their farm. Sixteen percent of the sampled cropping farmers belonged to this group. Burning and direct drilling dominated the stubble management practices of this group, accounting for seventy-eight percent of the stubble managed by the group. Most of the remaining stubble area was burnt and cultivated. No stubbles were either trash farmed or incorporated. Members of the group were driven either by a concern for the effects of cultivation over concern for burning and its impacts on soil structure or by an inability to handle stubble with their existing machinery. These farmers were concerned at the increased use of chemicals they perceived as implied by the use of trash farming, presumably because of poor spray coverage within a standing stubble, rather than because of environmental or health concerns (Luke, Karunaratne & Barr 1995).

- Trash farmers:** The fifteen percent of farmers in this group all practised some form of trash farming. Sixty percent of the stubbles managed by this group were trash farmed. The remaining stubbles were either incorporated or burnt and cultivated. No stubbles managed by this group were burnt and direct drilled. This surprising finding suggests that if members of this group are unable to farm a trash stubble, they will incorporate it rather than burning and direct drilling. If they must burn, they will also cultivate. These farmers are driven by the benefits of retaining organic matter and are far less concerned about the environmental costs of cultivation.

**Table 1** Segmentation of conservation cropping systems adopted in North Central Victoria

Conservation cropping classification	Proportion of sample (%)	Land to which stubble management technique applied as a percentage of all land managed by members of conservation cropping segment (%)			
		Conventional	Incorporation	Direct drilling	Trash farming
Conventional	30	100	0	0	0
Incorporators	37	21	79	0	0
Direct drillers	16	19	3	78	0
Trash farmers	15	22	16	0	60

Source: Agriculture Victoria baseline survey (1993)





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# **A BASELINE OF ADOPTION OF CONSERVATION CROPPING - NORTH CENTRAL REGION**

**August 2001**

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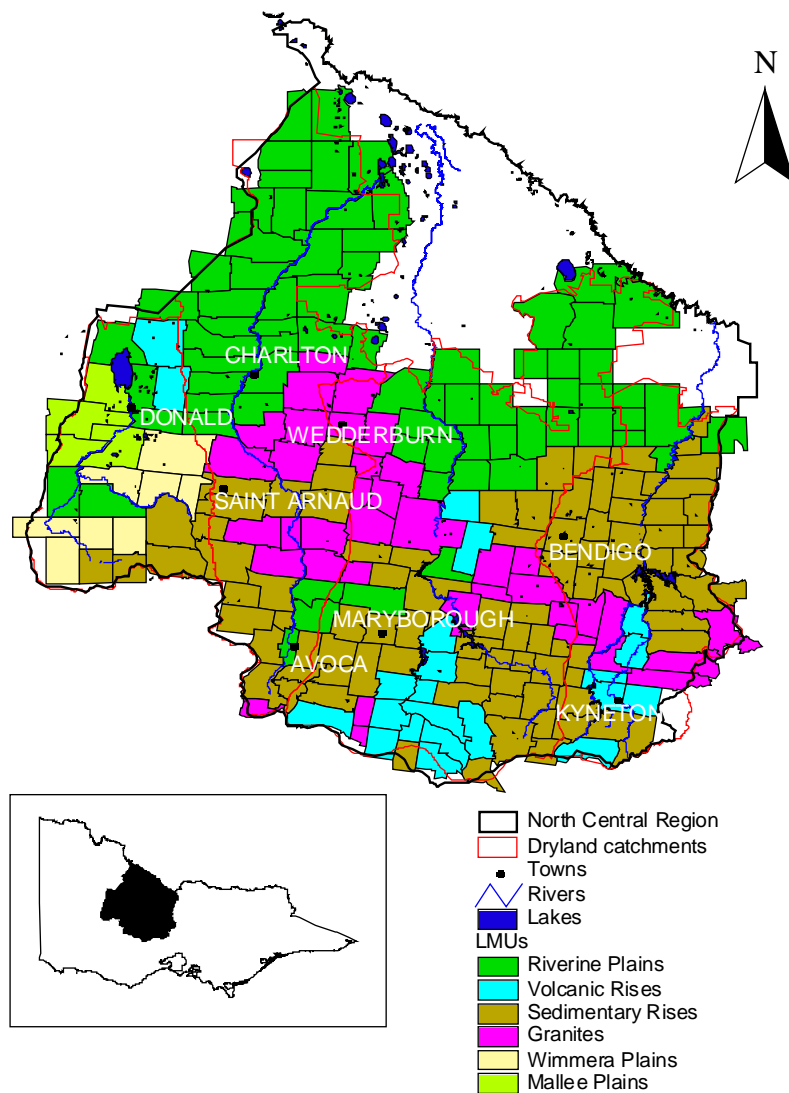
## **1 THE NORTH CENTRAL REGION**

### **1.1 Sustainable cropping in the North Central Region**

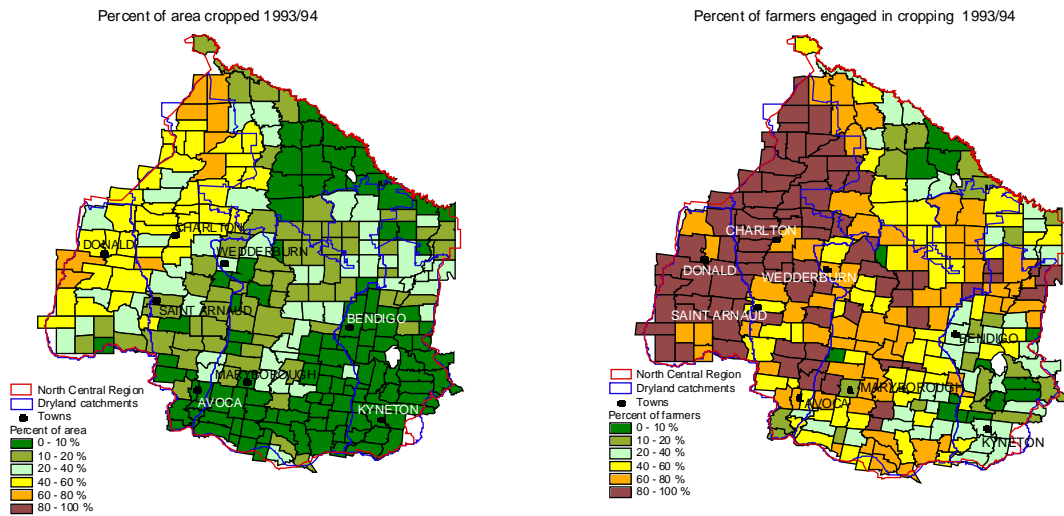
The North Central Region comprises the non-irrigated regions of the catchments of the Loddon, Avoca, Campaspe and the Avon Richardson rivers and covers approximately 2.3 million hectares. The rainfall in the region varies from 1200 mm/yr in the highlands to 300 mm/yr in the north. The predominant land management units (Lmus) in the region are: the Riverine Plains; the Mallee Plains; the Volcanic Rises; the Wimmera Plains; the Granites; and the Sedimentary Rises (Figure 2). Cropping occurs on the first four of these land units. Except for isolated areas of cropped volcanic soil and a limited area of cracking clays, most cropping occurs on duplex soils. These are in the north and west of the region. Cropping intensity in the North Central Region in 1993/94 and 1994/95 is shown in Figures 3 and 4 respectively.

The duplex cropping soils of the North Central Region are relatively fragile in comparison to the cracking clays of the Wimmera. The major sustainability issues facing cropping enterprises on these soils are: soil structure decline, dryland salinity and water erosion (Commissioner for the Environment 1991). Of these, soil structural decline has the greatest impact upon productivity (Victoria's Decade of Landcare Plan 1992; North Central Regional Catchment Strategy 1997).

Conservation cropping practices are generally seen as being a solution to the problems of soil structure decline, salinity and erosion. Conservation cropping in the region is generally taken to include minimum tillage, direct drilling, stubble retention, fallow reduction and improved pasture ley management (Avoca-Loddon-Campaspe Regional Landcare Plan 1993; North Central Regional Catchment Strategy 1997).

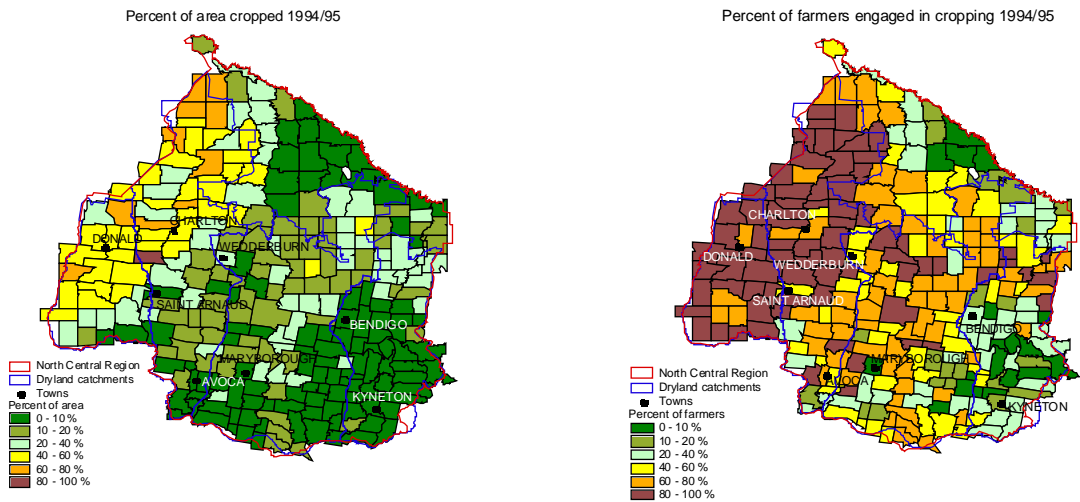


**Figure 2** Land management units in the North Central Region



Source: Australian Bureau of Statistics (1993/94)

**Figure 3** Cropping intensity in North Central Victoria (1993/94)



Source: Australian Bureau of Statistics (1994/95)

**Figure 4** Cropping intensity in North Central Victoria (1994/95)

## 1.2 Indicator practices

The following practices have been selected as indicators of the extent of adoption of sustainable cropping practices in the North Central Region of Victoria:

1. Cultivations used to sow a crop
2. Use and length of fallow
3. Adoption of stubble retention practices
4. Use of pastures in the crop rotation cycle
5. Use of herbicides
6. Perception of seriousness of erosion and salinity

The first four practices are generally accepted as being most likely to minimise the adverse impacts of cropping activities on the soil resource (Avoca-Loddon-Campaspe Landcare Plan 1993; Avoca Catchment Salinity Management Plan 1992; Campaspe Catchment Salinity Management Plan 1992; Loddon Catchment Salinity Management Plan 1992; North Central Regional Catchment Strategy 1997). The authors do not wish to suggest that these indicators are a substitute for the physical indicators of the resource condition. However, physical resource indicators are much more difficult and expensive to measure and there are few cheap and accepted standard tests in common use on farms (Rendell McGuckian 1996).

The use of the fifth indicator, herbicide use, may be contentious. The reason for including this indicator is that direct drilling is dependent upon herbicide usage. The hope is that as more sophisticated techniques are used in conservation cropping, herbicide use will gradually decline.

The final indicator is perception of soil degradation. This is an indicator of awareness rather than resource condition. Awareness of degradation is not generally a sufficient condition to initiate changed agricultural practice. The link between awareness and environmental action is seldom so simple (Barr & Cary 1992). Rather, awareness is a pre-condition for the inclusion of resource conservation considerations within farm management decision making. This indicator is reported in the accompanying report on Community attitudes to environmental issues: statewide and regional overview (Karunaratne, Barr & Brown 2001).

## 2 DATA SOURCES AVAILABLE

### 2.1 Australian Bureau of Statistics

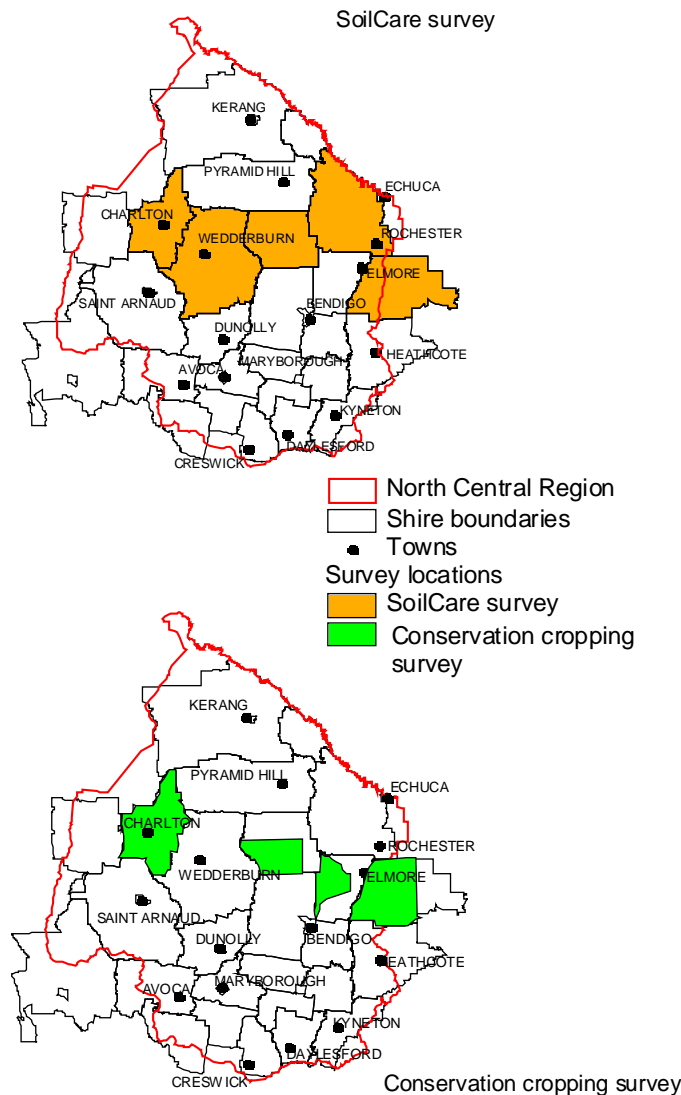
The Australian Bureau of Statistics (ABS) farm census is distributed annually to all Australian farming businesses that meet a minimum gross income criterion. There is a legislative requirement for all farm business operators to complete and return the farm census. In the last decade the ABS farm census has intermittently included questions covering use of fallow, grain legumes, soil ameliorants, fertiliser use and pastures. In recent years, questions have covered perception of land degradation hazard, cultivation practice and use of stubble retention. Data from the ABS farm census is normally available only in aggregated form at state or local government area levels. As part of this project, data is purchased disaggregated at parish level. As parishes are significantly smaller than local government areas, ABS data was reaggregated according to catchment and soil type boundaries.

### 2.2 Ballarat College conservation cropping surveys (Harvey *et al.* 1990 1985)

The experience of the 1982/83 drought prompted the Soil Conservation Authority to begin a conservation cropping campaign across the wheat belt. As part of this program the project funded a longitudinal study of the adoption of conservation cropping practices. A mail survey of 489 Victorian grain growers was conducted by the University of Ballarat in 1984 in order to investigate the use of cultivation and cropping practices, as well as farmers' perceptions of, and



attitudes to, these practices. This survey was repeated in 1989 with 255 respondents from the same sample, to measure any changes in farmers' attitudes and the degree of adoption of these practices (Harvey *et al.* 1985, 1990). The sample was grouped into three regions; north-west, central and north-east.



**Figure 5** Location of cropping adoption studies in the North Central Region

The sample for the North Central Region included respondents from the then shires of Charlton, East Loddon, Huntly and Waranga. This study is compromised by the poor response rates achieved. In 1984 only 47 percent of farmers responded to the 359 survey forms mailed. The 1989 survey was mailed only to the addresses of those who responded to the 1984 study. The response rate for this survey was 52 percent. For this reason, any findings of these studies related to the absolute extent of adoption should be treated with caution and where possible compared with data available from other sources. The findings of these studies related to the reasons for adoption or non adoption, are likely to be more reliable. Data for this study was not available for reanalysis.

### 2.3 SoilCare study of farmer attitudes to conservation tillage practices (Williamson 1993)

The SoilCare extension project established five farmer discussion groups in North Central Victoria in the shires of Waranga (Colbinabbin), Charlton (Charlton), Korong (Korong), East Loddon (Serpentine) and Rochester (Rochester) to highlight the benefits of conservation tillage practices

and perennial pasture in overcoming the land degradation problem (Figure 5). As part of this project a survey was carried out in 1992 to determine farmer attitudes to conservation cropping techniques, the use of perennial pastures, and effectiveness of the Department of Conservation and Natural Resources Machinery Loan Scheme. All the members of the five SoilCare groups were surveyed and the survey received a 64 percent response rate. Results of this study should only be taken as indicative. The work by Luke, Karunaratne and Barr (1995) has shown that, in North Central Victoria, members of Landcare and SoilCare type groups are significantly more likely to be adopters of conservation cropping. Data for this study was not available for reanalysis.

#### **2.4 Agriculture Victoria baseline salinity control survey (Luke, Karunaratne & Barr 1995)**

The four salinity management plans developed for the Campaspe, Loddon, Avoca and Avon-Richardson dryland catchment areas in North Central Victoria have recommended specific land management practices to reduce the threat of dryland salinity in the area. The use of minimum tillage, stubble retention and the elimination of long fallow is among these recommended practices. Each of these practices has set targets to be achieved. Measuring the progress in adoption of these management practices was one of the tasks of the Community Working Group in each catchment. Agriculture Victoria has undertaken a farm survey to document the baseline information about the state of adoption of these practices and farmers' beliefs about the advantages and disadvantages of the salinity control practices. A random sample of 129 farmers representing all four catchments was interviewed for this survey. The information on conservation cropping practices was collected on a paddock by paddock basis (Luke, Karunaratne & Barr 1995) based upon a methodology developed by the University of Melbourne (Wilkinson & Cary 1993). This survey will be repeated in future to measure the changes in farmers' attitudes and the degree of adoption of these practices. The sample for the study was drawn from ABS records. The survey obtained a response rate of 86 percent. Some confidence can therefore be placed in the results of the study. Data for this study was available for reanalysis.

### **3 MEASURING CONSERVATION CROPPING PRACTICES**

#### **3.1 Cultivation**

##### **3.1.1 1984 Ballarat College survey (Harvey *et al.* 1985)**

The Harvey *et al.* study of 1984 reported the time of first cultivation for land cropped in the previous year and land not cropped in the previous year. The time of first cultivation is a good proxy for extent of cultivation. The 1984 study found the modal cultivation frequency for land first cultivated before October to be five cultivations, and the mode for land first cultivated after the autumn break to be two cultivations.

##### **3.1.2 1989 Ballarat College survey (Harvey *et al.* 1990)**

The second Ballarat College study did not report on the number of cultivations per paddock, but did report again on the time of first cultivation (Harvey *et al.* 1985, 1990). The results of 1989 survey and the changes from the 1984 survey were reported separately for land cropped in the previous year and land not cropped in the previous year. The results in Table 2 and Table 3 show a clear trend towards minimum tillage amongst those who responded to the survey. Respondents reporting cultivation as soon as possible after harvest decreased by 17 percent. Most of these farmers changed the time of their first cultivation to after the autumn break. There was only a small increase in direct drilling frequency. In land under pasture the previous season, the move to fewer cultivations was less marked. Land which in 1984 was cultivated between Christmas and the autumn break was more likely to be cultivated after the autumn break. However there was little shift away from cultivation prior to Christmas. Minimum tillage was adopted where it did not conflict with the traditional long fallow of land entering a cropping phase.

### 3.1.3 1993 SoilCare study of farmer attitudes (Williamson 1993)

Although not based upon a random sample, the 1992 survey of SoilCare groups indicates a continuance in trends towards adoption of minimum tillage. Farmers in SoilCare groups identified themselves as practising conservation tillage more often in 1992 compared with three years earlier in 1989. Eighty-two percent of these farmers described the adoption of conservation tillage practice as one of the most important management changes in their cropping practices during this period. (Williamson 1993).

**Table 2** Timing of first cultivation for land not cropped in the previous season (North Central Region)

Timing	Percent of farmers <sup>1</sup>		Percent of area <sup>2</sup>	
	1989	Change	1989	Change
Before Oct 1 <sup>st</sup>	54	-11	37	+1
Between Oct - Christmas	40	+4	32	-2
Between Christmas – autumn break	32	-14	26	-7
After autumn break	68	+17	67	+7
Not cultivated	10	0	22	+7

Source: Harvey *et al.* (1990)

<sup>1</sup> Percent of respondents who reported first cultivating some of their land at the indicated time. Does not total to 100 as some respondents had more than one commencement time.

<sup>2</sup> For each respondent the area cultivated at each specified time was expressed as a percentage of land not cropped in the previous year by that respondent. The reported figure is the median value of these percentages.

**Table 3** Time of first cultivation of land cropped in the previous year (North Central Region)

	1989 % farmers)	Change
As soon as possible after harvest	17	-17
After autumn break	74	+15
Did not cultivate at all	10	+3

Source: Harvey *et al.* (1990)

### 3.1.4 1995 Agriculture Victoria baseline survey (Luke, Karunaratne & Barr 1995)

The trend to minimum cultivation continued in the period between 1989 and 1993. The Agriculture Victoria baseline survey on salinity management practices reported a mean cultivation frequency of 2.5 and a mode of 2 cultivations in the region during 1993/94 season (Table 4). This is a dramatic decrease in cultivation intensity over a relatively short time. Minimum tillage, defined as one or two cultivations prior to sowing, was being practised on 45 percent of the cropping land while another 21 percent of the cropping area was direct drilled (Luke, Karunaratne & Barr 1995) (Table 5).

**Table 4** Adoption rates for cultivation frequency (North Central Region: 1993)

Number of cultivations before sowing (Mean = 2.5)	Proportion of farmers (%) <sup>1</sup> (N=92)
0	28
1	31
2	52
3	39
4	15
5	9
6	6
7	7
more than 7	3

Source: reanalysis of data presented in Luke, Karunaratne & Barr (1995)

<sup>1</sup> Percentages add to more than 100 due to multiple response to this question

**Table 5** Cultivation techniques used by North Central cropping farmers (1993/94)

	Number of cultivations				
	0	1	2	3	4+
% cropped area	21	25	22	20	12

Source: reanalysis of data presented in Luke, Karunaratne & Barr (1995)

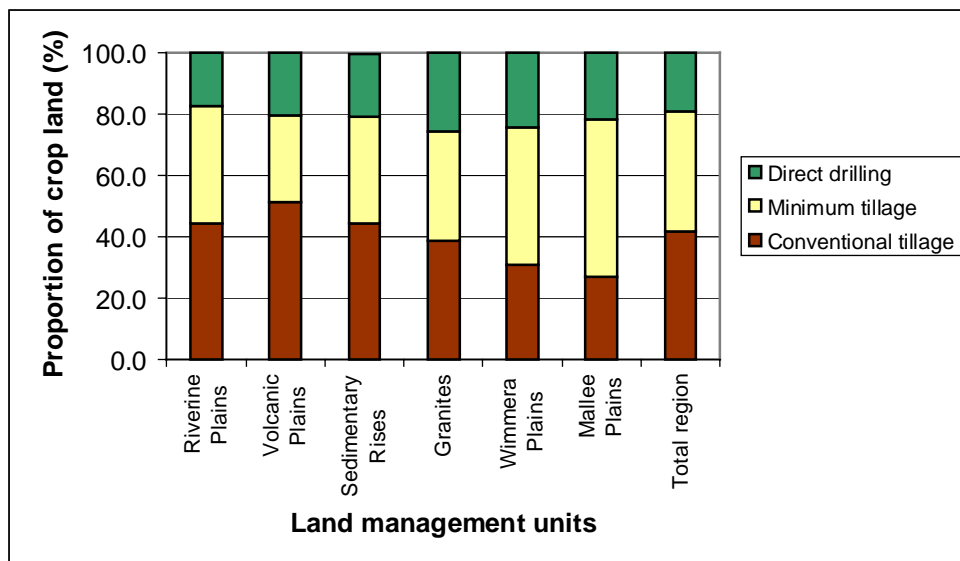
### 3.1.5 1993/94 Australian Bureau of Statistics

In the same year a question on cultivation was included on the 1993/94 farm census data provided by the Australian Bureau of Statistics. The question on the census asked farmers the area of cropping land sowed with conventional tillage, minimum tillage and direct drilling. The format of this question is given in Appendix 1.

This data does not provide information on the number of cropping farmers answering this question. A response rate to ABS tillage question is estimated in the next section, based on farmers' responses to the 1993 Agriculture Victoria baseline survey.

The parish data from the North Central dryland region showed the total tillage area exceeded the total crop area in most of the parishes with low cropping intensities, giving high adoption rates of direct drilling. This may be due to the inclusion of sown pasture areas by the farmers in these parishes when responding to the question on tillage methods. Hence, parishes with less than 5 percent of land under cropping were eliminated from this analysis to minimise the problem of overestimating the amount of direct drilling on cropping land.

The ABS data shows less than half of cropping land (42 percent) being sown with conventional tillage, 39 percent being sown with minimal tillage and 19 percent sown with direct drilling (Figure 6). Cropped areas on granites and the Wimmera Plains Lmus had the highest proportion of land direct drilled, while minimum tillage was more common on the Mallee Plains and the Wimmera Plains Lmus to the west of the region. The differences between these findings and the findings of the baseline study are explored in the next section.



Source: Australian Bureau of Statistics (1993/94)

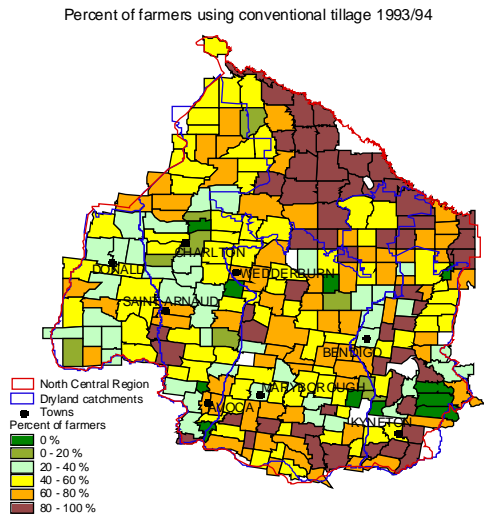
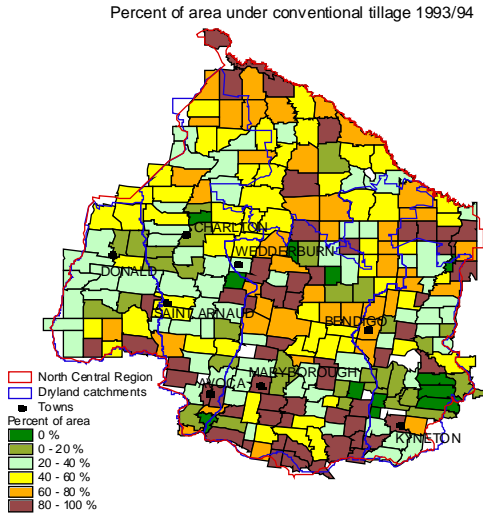
**Figure 6** Proportion of tillage methods used on land management units in the North Central Region

The mapping of parish data reveals few obvious patterns in the adoption of direct drilling. The concentration of cropping is in the western part of the region. Mapped data for the east and south-east should be treated with some caution as this will also include significant areas of direct drilled pastures. Minimum tillage is common in the west of the region, mainly in the Charlton, Wedderburn and St Arnaud districts. Conventional tillage is mostly used in a belt from north to the south going through the centre of the region (Figures 7, 8 and 9).

#### Using the North Central baseline study to calibrate 1993/94 ABS tillage data

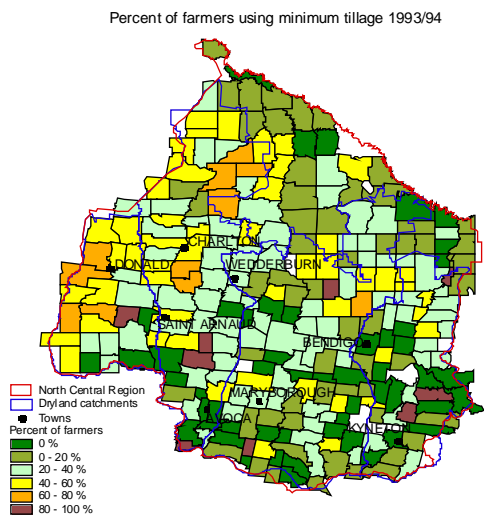
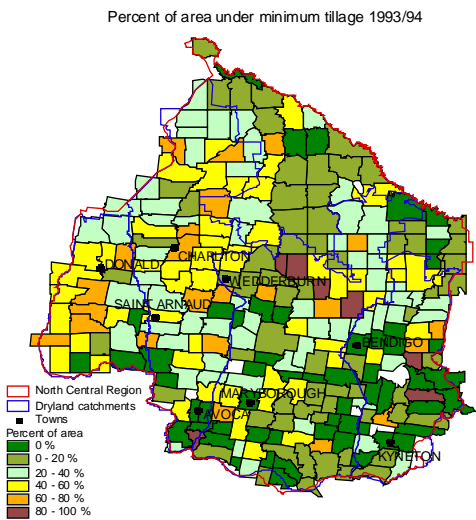
The ABS measure of the area of direct drilling and the Agriculture Victoria (AV) measure of the area of direct drilling correspond closely (19 percent and 21 percent respectively). However, there are no direct comparisons possible between the ABS measure of the area of land under 'limited cultivation with some use of herbicides' and the AV measure of number of cultivations. The ABS measured 39 percent of cropping land as being cultivated with 'limited cultivation'. The AV survey measured 25 percent of cropping land sowed with a single cultivation and 22 percent with two cultivations. It seems clear that some farmers were interpreting limited cultivation as being a single cultivation, and others are interpreting this as including two cultivations. The answers to this ABS question may also be influenced by varying interpretations of the meaning of the term '*some use of herbicides*'. This question implies a trade-off between the degree of herbicide use and the extent of cultivation. However, data from an accurate sample survey of cropping practices in the Wimmera (Karunaratne, Barr & Wilkinson 2001) has shown there can be no correlation between the extent of use of these two practices.

It is clear that the ABS question used in the 1993-94 agricultural census needed to be tightened considerably to be of any value as a measure of change in practice. Any measure of change in the extent of minimum tillage derived from this survey question may be a result of either a change in practice or a change in perceptions as to what constitutes 'limited cultivation'.



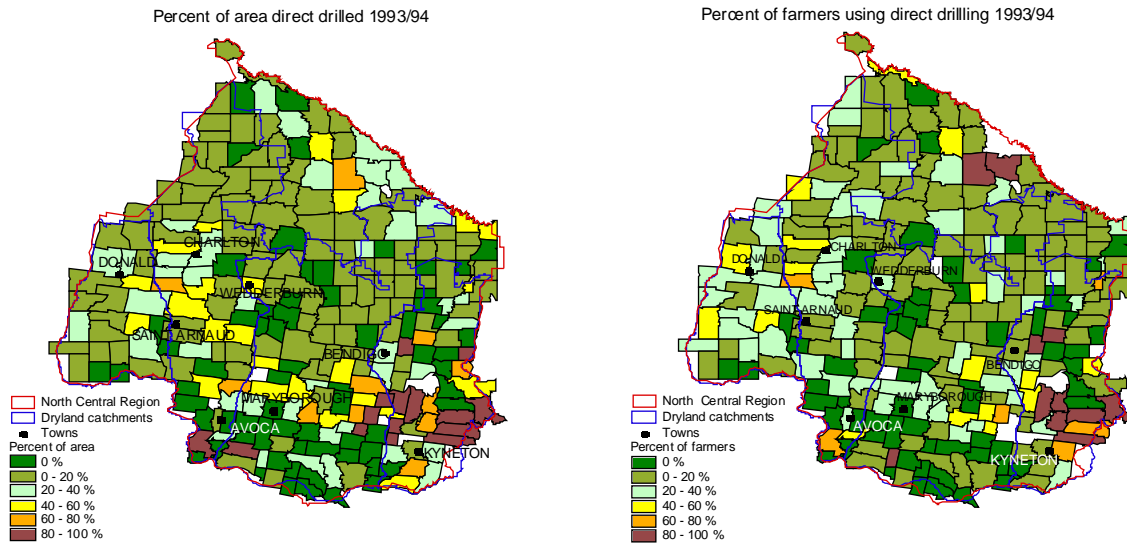
Source: Australian Bureau of Statistics (1993/94)

**Figure 7** Adoption of conventional tillage in the North Central Region (1993/94)



Source: Australian Bureau of Statistics (1993/94)

**Figure 8** Adoption of minimum tillage in the North Central Region (1993/94)



Source: Australian Bureau of Statistics (1993/94)

**Figure 9** Adoption of direct drilling in the North Central Region (1993/94)

### 3.1.6 1994/95 Australian Bureau of Statistics

An amended format of the tillage question was included in the 1994/95 farm census (see Appendix 1).

This question did not provide data on the number of cropping farmers answering this question. A response rate to this question is estimated based on farmers' response to 1993 Agriculture Victoria baseline survey. The total frequency of responses to this question exceeds the total number of cropping farmers due to multiple responses by farmers to different tillage classes. In this regard 129 responses were reported to the tillage question in the Agriculture Victoria baseline survey, by 92 croppers who responded to the question. This can be interpreted as a response rate of 140 percent. The total response to all classes in the ABS tillage question was 93 percent. If it is assumed that there is no particular bias in non-response to each of the three tillage classes, using the 140 percent from the baseline survey as the total, the response rate to the ABS question can be estimated at 66 percent. This is a very rough estimate, but indicates a lower than full response rate. Hence, the estimated adoption rates for the tillage methods using the ABS question are significantly lower than the true rate of adoption.

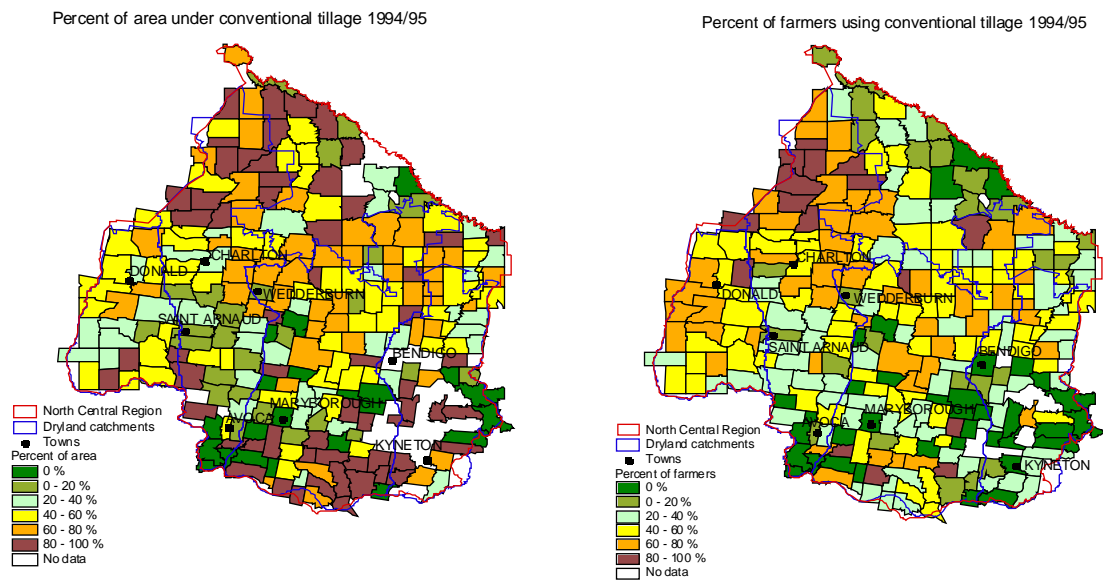
A change in the wording of the question makes comparison with the previous year's ABS question problematic. However, the amended question allows direct comparison with the 1993 baseline study. There was an extremely close correlation between the results of the two studies (Table 6). It can be concluded, therefore, that the amended form of the survey question was producing valid data.

The spatial distribution of adoption levels in each parish for the 1994/95 season is shown in Figures 10, 11 and 12. High adoption of direct drilling was shown on the plains to the north of Avoca and also the Sedimentary Rises LMU between Charlton, Donald, St Arnaud and Wedderburn. Of the significant cropping areas, adoption of direct drilling seems lowest in the northern Avoca catchment north of Charlton.

**Table 6** Cultivation techniques used by North Central farmers (1993/94-1994/95)

Year	Conventional tillage		Minimum tillage		Direct drilling	
	% farmers	% area	% farmers	% area	% farmers	% area
1993 baseline survey	72	54	27	25	24	21
1994/95 ABS data	51	53	30	24	19	23

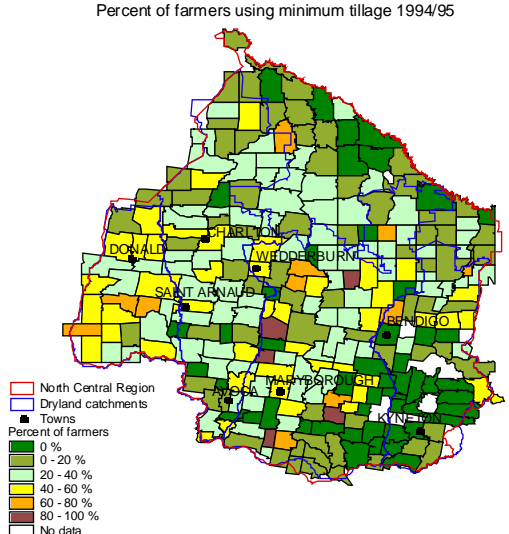
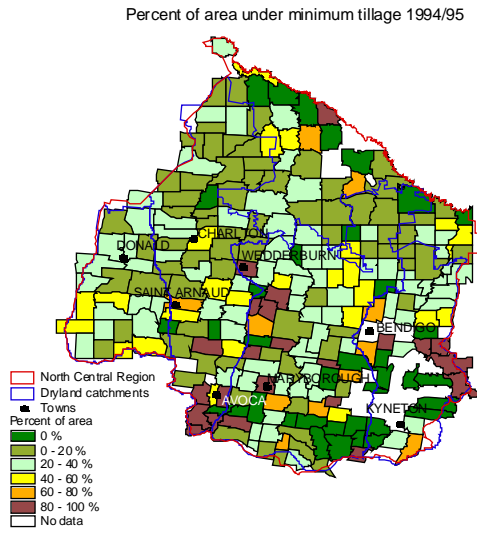
Source: reanalysis of data presented in Luke, Karunaratne & Barr (1995) and Australian Bureau of statistics (1994/95)



Source: Australian Bureau of Statistics (1994/95)

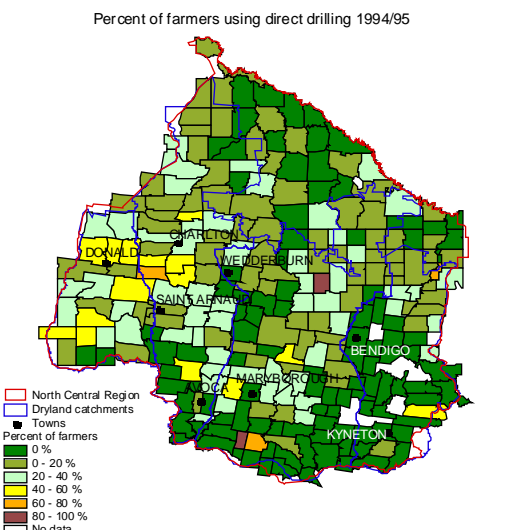
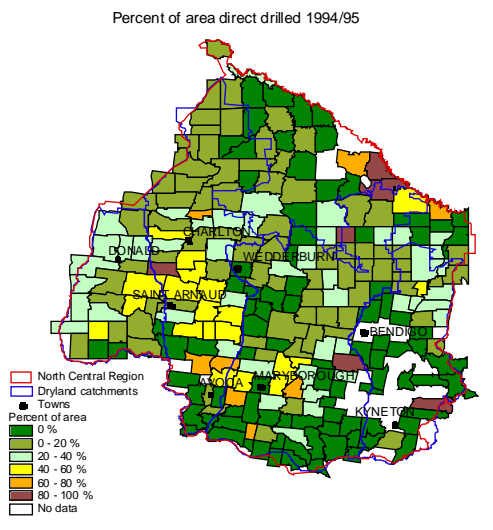
**Figure 10** Adoption of conventional tillage in the North Central Region (1994/95)





Source: Australian Bureau of Statistics (1994/95)

**Figure 11** Adoption of minimum tillage in the North Central Region (1994/95)



Source: Australian Bureau of Statistics (1994/95)

**Figure 12** Adoption of direct drilling in the North Central Region (1994/95)

### 3.1.7 1995/96 Australian Bureau of Statistics

The 1994/95 form of the tillage question was used again in 1995/96 with a small change to the definition of limited cultivation (see Appendix 1). The percentage of crop land sown with direct drilling dropped by 3.5 percent during this year, while the percentage of farmers direct drilling crops remained unchanged (Table 7). However, the actual number of farmers direct drilling crops increased within this period indicating more farmers direct drilling smaller areas. The change in the ABS question referring to the number of cultivations that define 'minimum tillage' from *one* in 1994/95 question, to *one or two* cultivations in 1995/96, restricts the possibility of direct comparisons for conservation cropping and minimum tillage between the two years.

### 3.1.8 1996/97 Australian Bureau of Statistics

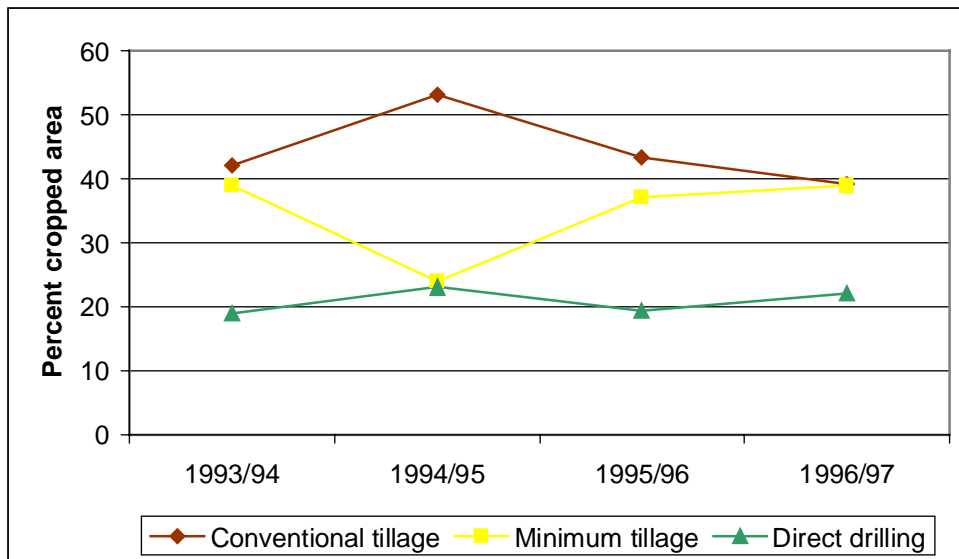
In 1996/97, the ABS repeated the 1995/96 form of the tillage question to overcome the problems of definition between the previous questions. This allows a direct comparison between these two sets of data. In contrast to the previous year, the area direct drilled had increased considerably, while the number of farmers using direct drilling remained unchanged. This could be interpreted as an increase in the area of direct drilling by farmers reporting drilling in the previous survey. There is a trend towards an increase in the adoption of minimum tillage, while the use of conventional tillage has declined (Table 7).

Figures 13 and 14 show the trends in adoption of different tillage methods on crop land in the North Central catchment management region from 1993/94 to 1996/97. The impact of wording changes in definitions of 'limited cultivation' should also be taken into consideration when interpreting these trends.

**Table 7** Cultivation techniques used by North Central farmers (1994/95-1996/97)

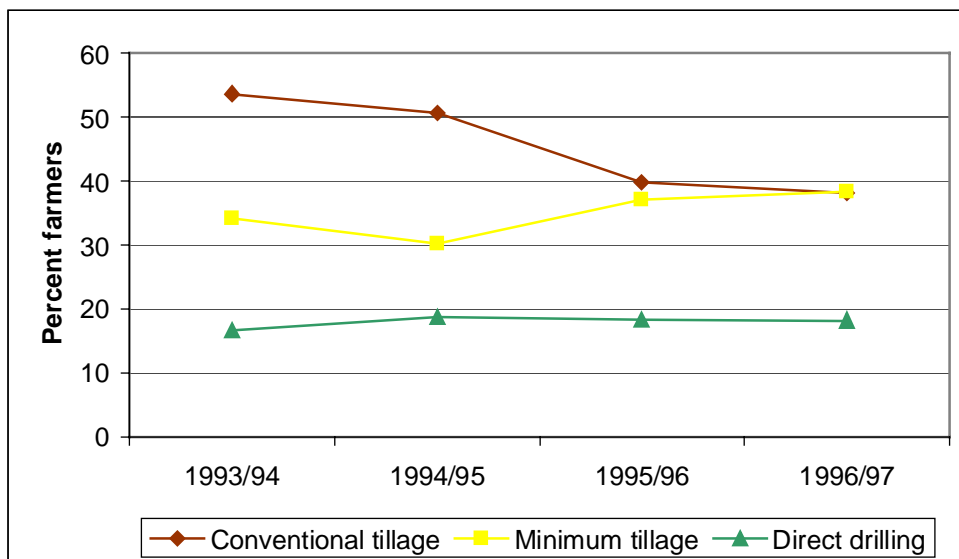
Year	Conventional tillage		Minimum tillage		Direct drilling	
	% farmers	% area	% farmers	% area	% farmers	% area
1994/95	51	53	30	24	19	23
1995/96 ABS data	39.9	43.4	37.2	37.2	18.5	19.4
1996/97 ABS data	38.1	39.2	38.3	38.8	18.2	22.0

Source: Australian Bureau of Statistics (1995/96-1996/97)



Source: Australian Bureau of Statistics (1993/94-1996/97)

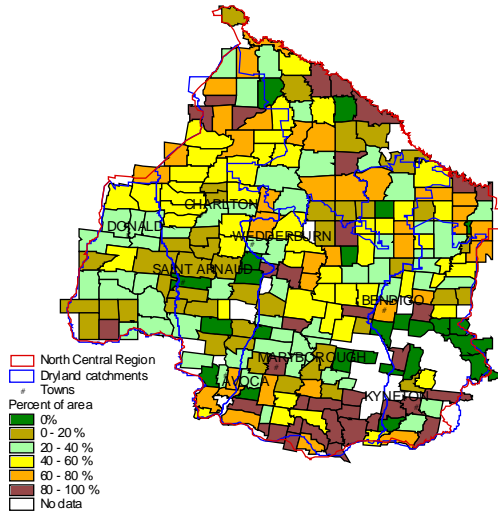
**Figure 13** Cultivation techniques used by farmers (percent area) in the North Central Region (1993/94-1996/97)



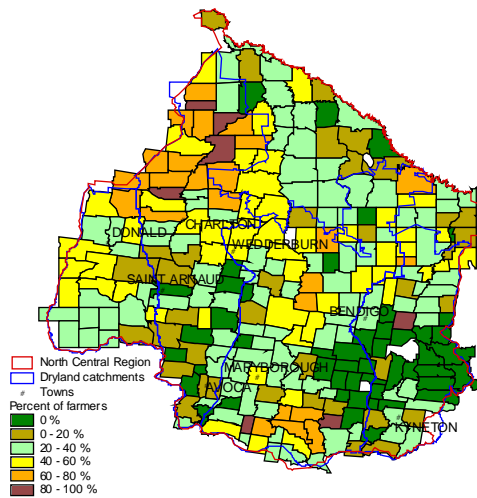
Source: Australian Bureau of Statistics (1993/94-1996/97)

**Figure 14** Cultivation techniques used by farmers (percent farmers) in the North Central Region (1993/94-1996/97)

Percent of area under conventional tillage 1995/96



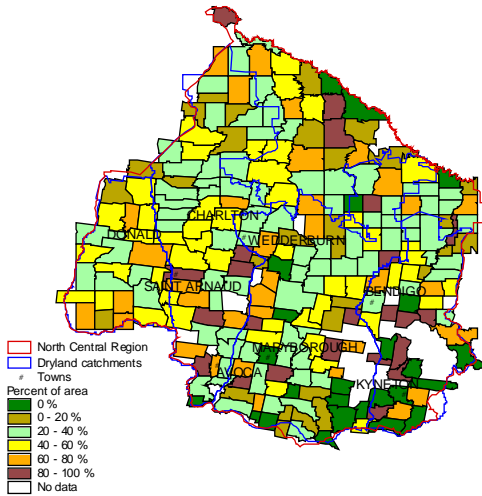
Percent farmers using conventional tillage 1995/96



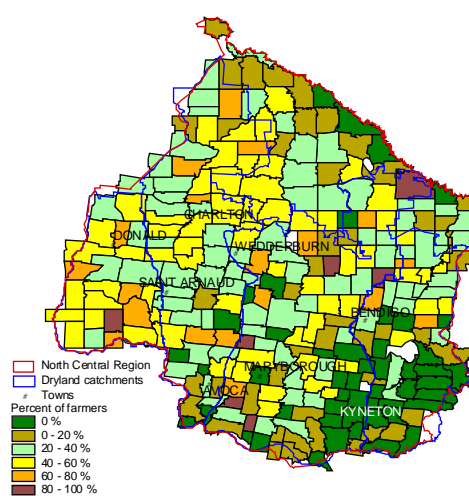
Source: Australian Bureau of Statistics (1995/96)

**Figure 15** Adoption of conventional tillage in the North Central Region (1995/96)

Percent of area under minimum tillage 1995/96

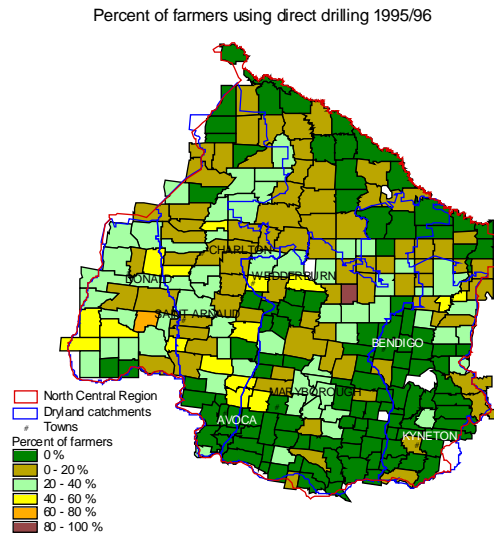
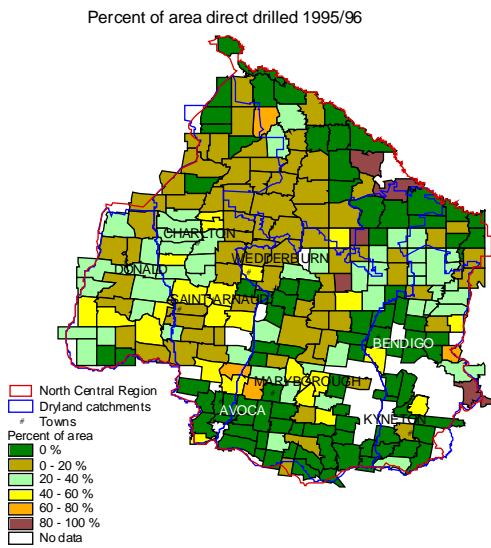


Percent of farmers using minimum tillage 1995/96



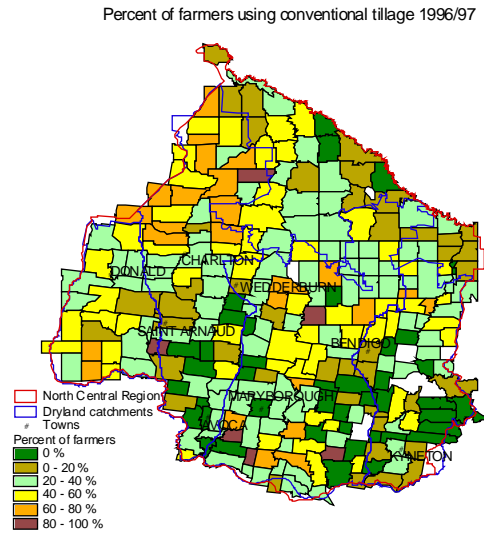
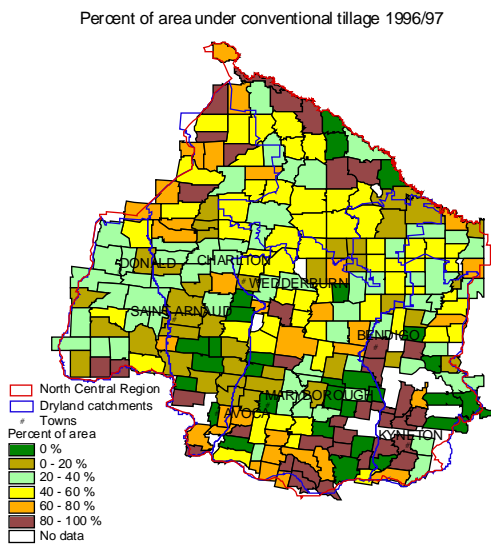
Source: Australian Bureau of Statistics (1995/96)

**Figure 16** Adoption of minimum tillage in the North Central Region (1995/96)



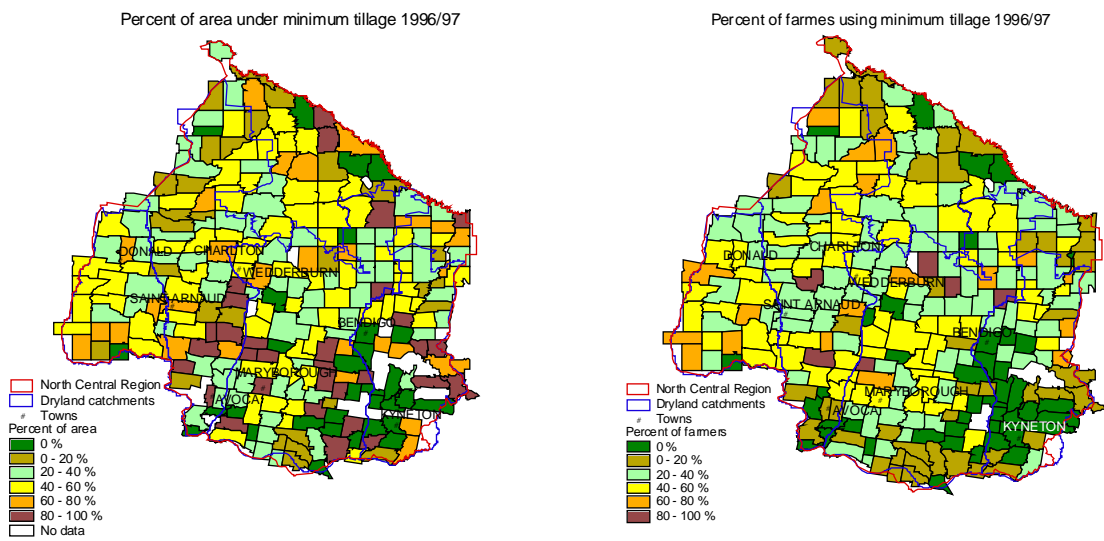
Source: Australian Bureau of Statistics (1995/96)

**Figure 17** Adoption of direct drilling in the North Central Region (1995/96)



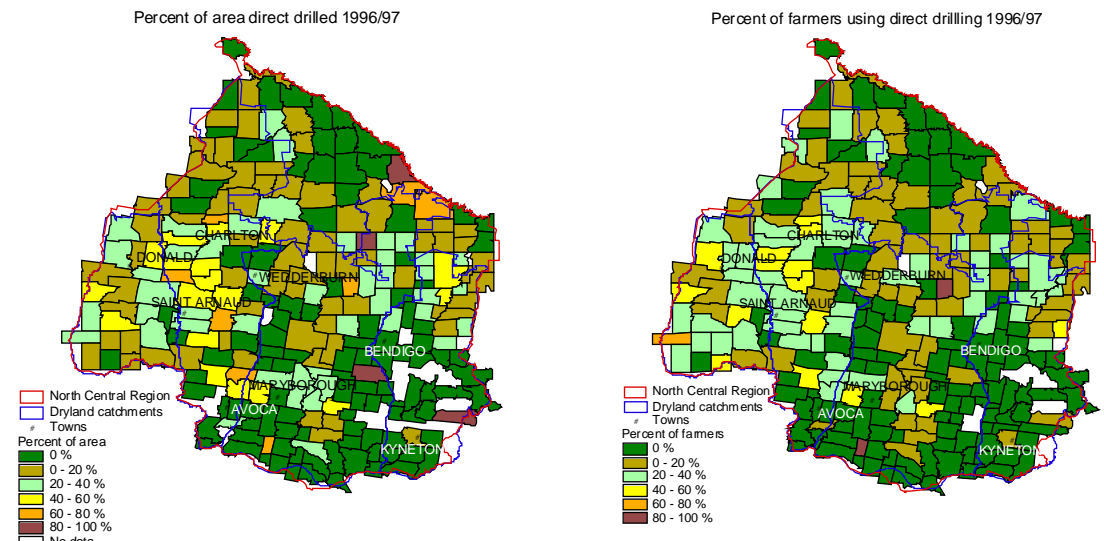
Source: Australian Bureau of Statistics (1996/97)

**Figure 18** Adoption of conventional tillage in the North Central Region (1996/97)



Source: Australian Bureau of Statistics (1996/97)

**Figure 19** Adoption of minimum tillage in the North Central Region (1996/97)



Source: Australian Bureau of Statistics (1996/97)

**Figure 20** Adoption of direct drilling in the North Central Region (1996/97)

### 3.1.8 Barriers to the adoption of direct drilling

The Agriculture Victoria baseline study survey provided information on what farmers see as the barriers to the adoption of direct drilling in the North Central Region. The advantages of direct drilling, in order of importance were:

- Saves money on fuel-50 percent ( $\pm 4.5$ )
- Saves time-50 percent ( $\pm 4.6$ )
- Improves soil-46 percent ( $\pm 4.5$ )
- Conserves moisture-34 percent ( $\pm 4.4$ )

The relationship between these beliefs and adoption has not been analysed. However similar analysis in other cropping regions of the state suggests savings in time and money are the beliefs most associated with adoption of direct drilling.

The major disadvantages of direct drilling were:

- Increased chemical use-42 percent ( $\pm 4.5$ )
- Need proper machinery-22 percent ( $\pm 4.5$ )
- Emergence problems-16 percent ( $\pm 3.6$ )
- Lower yields-7 percent (3.4)

## 3.2 Fallow

Measurements of fallow are notoriously unstable. This is because the amount of fallow in the landscape is an outcome of both the use of fallow as a management tool and changes in the relative balance between cropping and grazing in mixed farms. There are four measures of fallow that have been used in the available studies:

**Landscape fallow:** Fallow as a proportion of the total farm area in a given season. This measure fluctuates with both changes in management following practice and changes in the balance between crops and grazing on mixed farms. This measure best indicates the potential impact of farm practices on watertable rise for a given rainfall.

**Single year fallow/crop percentage:** Fallow as a proportion of the crop in a given season. This measure fluctuates in the same manner as the landscape fallow measure but is even more unstable. In a season when mixed farmers decide to move into cropping, the area of fallow land will increase, but the increase in cropped area will be in part delayed until the following season. The result is a large increase in this measure, followed by a large decrease the following year.

**Fallow management measure:** Fallow as a proportion of crop sown in the following year. This measure will not fluctuate with changes in the balance between cropping and grazing, but will measure changes in the propensity to use fallow in a cropping system. It will be more stable than the other measures. This is the best measure to use in a study of adoption of Best Management Practices.

**Adoption rate:** The proportion of farmers using fallow in any given year. This measures changes in management rather than changes in the balance between crops and pastures. It is, however, a relatively weak measure of the adoption of fallow. For example, a gradual reduction in a farmer's use of fallow will only become apparent in this measure when it is totally eliminated from the farming system.

These measures are complicated further by the differing lengths of fallow. Traditionally, long fallow is land that is cultivated prior to the harvest season. This land is out of crop production for a season. Land that is cultivated after harvest but before the autumn break is considered to be under short fallow. Land which is cultivated after the autumn break is often not considered to be under fallow, even though it may be fallowed for a number of months. If a farmer is asked what a paddock was used for in the previous season, the answer will most likely be a crop. Fallow will only be mentioned if the fallow was a long fallow. However, if a farmer is asked whether land for a crop was prepared using fallow, responses are more likely to include short fallows.

The studies examined below use a mix of the above measures. The particular measure used in any study needs to be considered when making comparisons.

### 3.2.1 1984 Ballarat College survey (Harvey *et al.* 1985)

Harvey *et al.* (1985) in their mail survey found 34 percent of farmers reporting cultivation as soon as possible after harvest. Thirty-six percent of the land not cropped in the previous season was prepared by long fallow. This question may be taken as a proxy measurement for conventional fallow practice. These figures need to be treated with some caution due to the low response rate to this mail survey.

### 3.2.2 1989 Ballarat College survey (Harvey *et al.* 1990)

In their repeat study Harvey *et al.* (1990) measured the number of farmers reporting tillage immediately after harvest at 17 percent, a fall of 17 percent (see Table 3). Again, despite the concerns about low response rates, this suggests a real fall in the incidence of fallow. Harvey *et al.* claimed this result was significant at the 0.01 level of confidence.

### 3.2.3 1989-92 SoilCare surveys (Williamson 1993)

The Williamson (1993) study reported a high rate of fallowing by the farmers in the region with an average of 68 percent practising fallow. On average about 28 percent of the cropped land was fallowed annually between 1989-1992 by farmers who were members of SoilCare groups. Once again, these results must be treated with caution as these farmers are self-selected, rather than being chosen through a random sample.

### 3.2.4 1991/92 Australian Bureau of Statistics

In the 1991/92 agricultural census, farmers were asked the proportion of land which was 'fallowed and/or spelled'. Fallow was adopted by 40 percent of North Central dryland cropping farmers. This result suggests that the low sample rate for the Harvey *et al.* studies resulted in a significant bias towards adopters of conservation cropping techniques. Combining data from the 1991/92 and the 1992/93 census, a fallow management measure for 1992/93 can be constructed. Twenty-two percent of the land cropped in 1992/93 was sown into land fallowed in 1991/92. Using only the single year data for 1991/92 a single year crop/fallow percentage measure of 20 percent can be constructed. Fallow was most common in the northern half of the region (Figure 21). Some obvious regional difference was demonstrated in the higher fallow management measure to the north of Charlton and lower measures to the west of Donald.

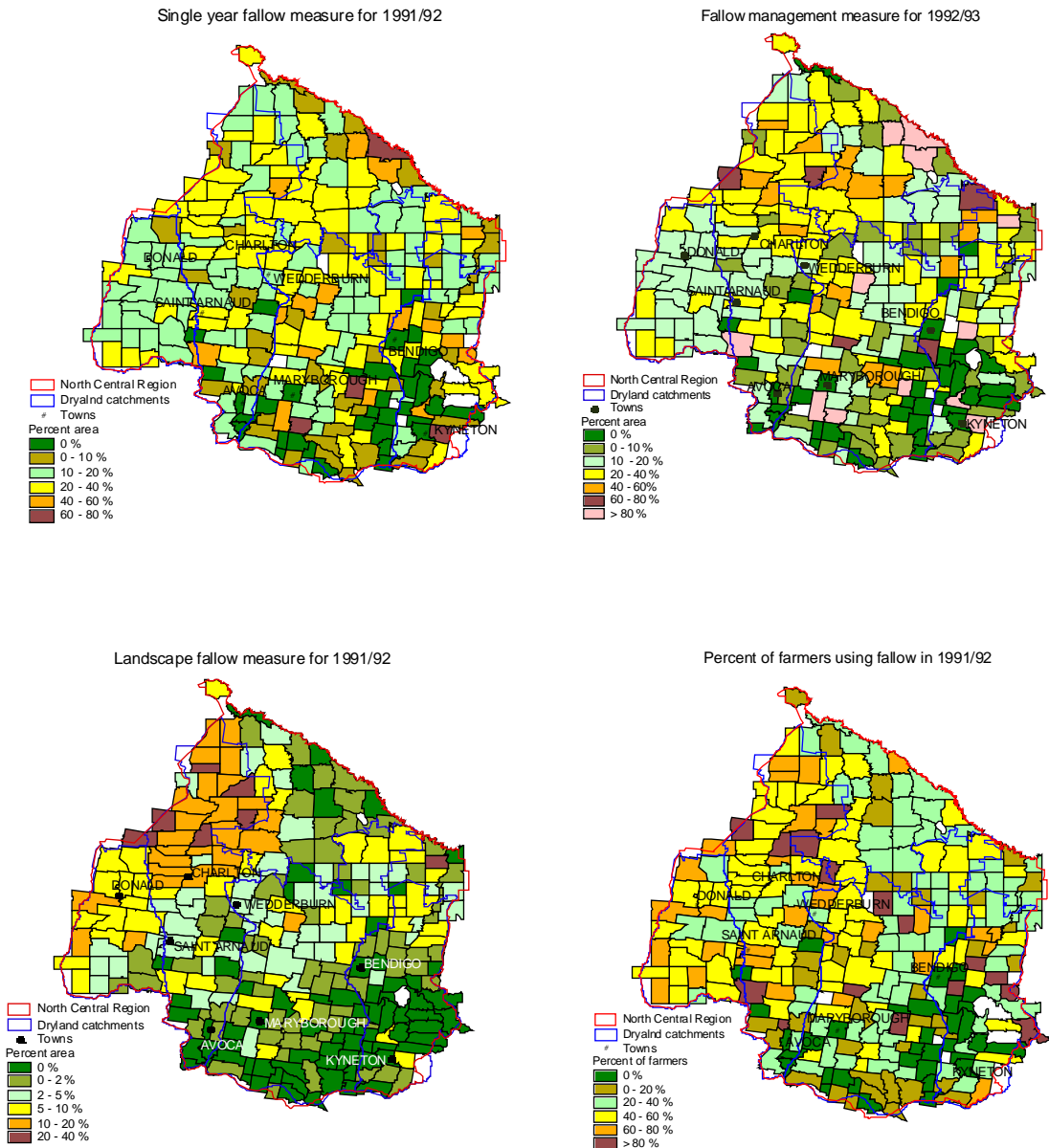
### 3.2.5 1995 Agriculture Victoria baseline salinity control survey (Luke, Karunaratne & Barr 1995)

The baseline survey on salinity management practices in North Central Victoria collected the information on types of fallow used and time of commencement of fallow in individual cropped paddocks. This information was sampled according to true random selection procedures. Data was gathered on the use of fallow in the 1992/93 and 1993/94 seasons, and on crop sown or intended to be sown in 1993/94 and 1994/95. During these seasons there was a marked swing away from grazing towards cropping in response to continued low wool prices and a rise in crop prices. This illustrates the volatility of the single season fallow measure which was 18 percent in 1993/94 but would have only been 3 percent in 1994/95 based upon stated cropping intentions.



This low figure is due, in part, to farmer decisions to fallow a large area of land in 1993/94, leaving little area to be fallowed in 1994/95. There may have also been some social desirability influencing statements of future cropping intentions.

The more reliable fallow management measure revealed that 30.6 percent of crop for the 1993/94 season was grown on fallow. Two-thirds of this was fallowed by cultivation and one-third with chemicals. The area of crop land left under long fallow (fallow commenced between September and December) was reported as 6 percent.



Source: Australian Bureau of Statistics (1991/92, 1992/93)

**Figure 21** Fallow management measures for the North Central Region (1991/92)

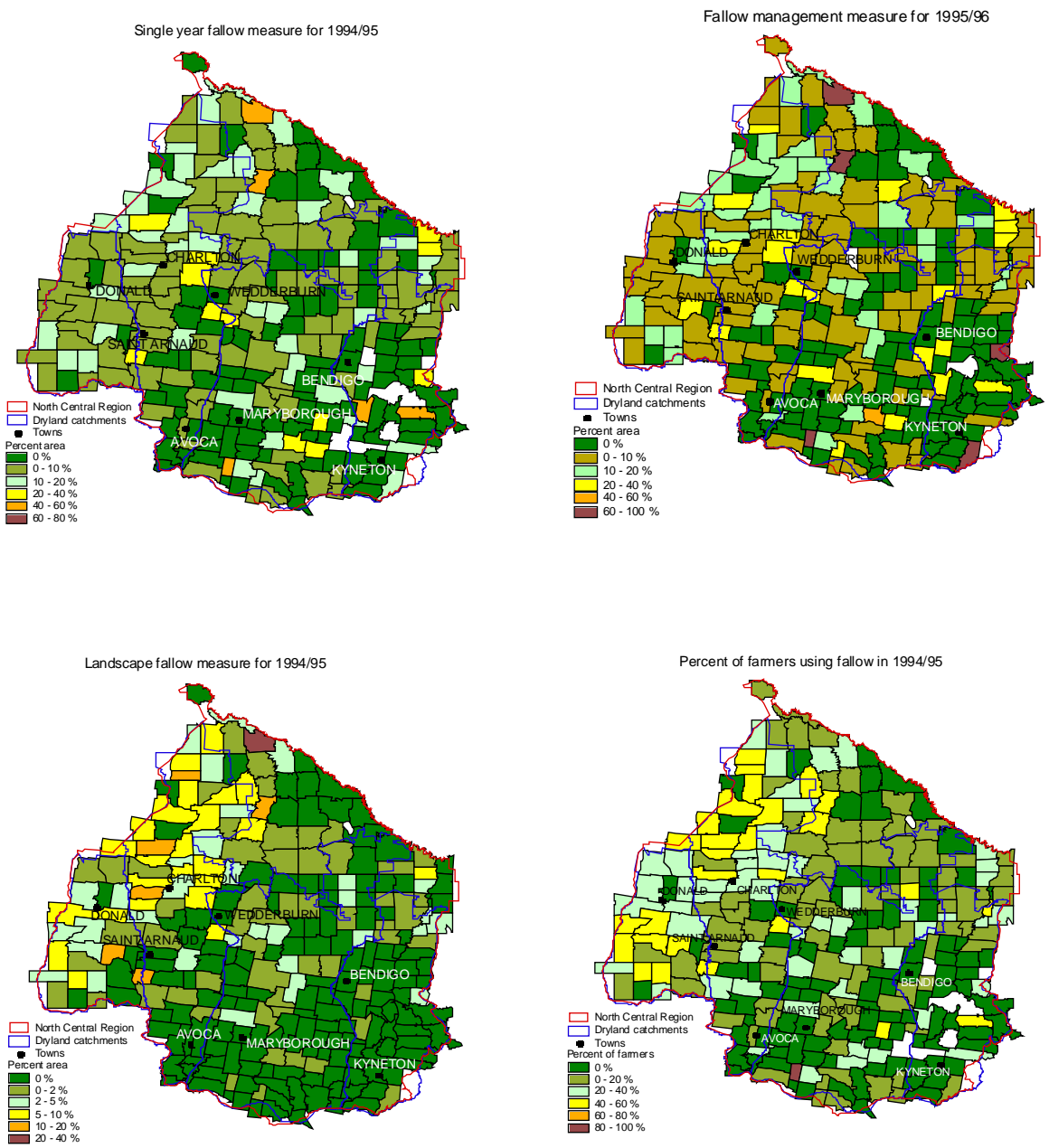
### 3.2.6 1994/95 Australian Bureau of Statistics

In 1994/95 a much improved format of the fallow question was asked in the ABS farm census (see Appendix 2). This question specified time of fallow as 'before Christmas' and classified fallow into mechanical, chemical or pasture topping.

This shows that use of fallow has reduced by more than half during the three years from 1992 to 1995 (Table 8). The results also show that the area under cultivation fallow is over four times larger than the area fallowed using a herbicide. This can be compared with future data to measure the expected trend away from cultivated fallow towards chemical fallow. Spatial distribution of adoption levels in each parish for 1994/95 season is shown in Figure 22. The spatial variation in fallow adoption in the 1991/92 ABS data is no longer as evident.

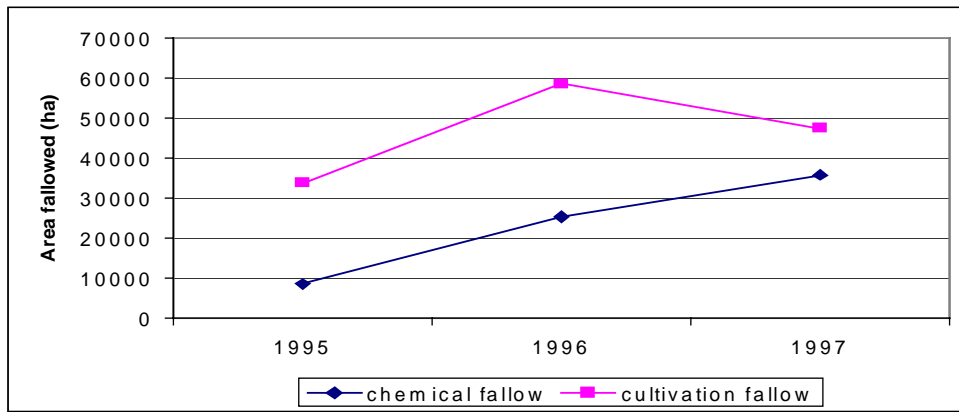
### 3.2.7 1995/96 Australian Bureau of Statistics

The 1994/95 format of the fallow question was repeated in the 1995/96 farm census. The only modification was to specify the cut-off date as 31 December rather than as Christmas. This set of data shows an increase in the use of fallow compared to the huge reduction in 1994/95. These measures of fallow remained unchanged during the following season. Therefore the dramatic change in the use of fallow in 1994/95 may have been mainly due to poor seasonal conditions experienced in 1994/95. Since the change in format of the fallow question in 1994/95, the measure of fallow adoption rate has been calculated by adding the number of farmers using both chemical and mechanical fallow. This may overestimate the adoption rates if some farmers are adopting both techniques. However, in practice most farmers tend to adopt only one of these practices. Despite this difference in calculating the rates, the adoption of fallow has significantly declined during the period from 1992 to 1996. This reduction is mainly to the south and south-east of Charlton, while north of Charlton showed higher adoption rates. There is also a clear trend away from cultivated fallow and towards more use of chemical fallow. Both the area under chemical fallow and the number of farmers adopting chemical fallow have increased at a higher rate compared to cultivated fallow (Figures 23 and 24). The spatial variation in fallow adoption was again similar to the pattern shown in 1991/92 with higher fallow management measures to the north of Charlton and lower to the west of Donald (Figure 25). Higher fallow management measures in 1995/96 compared to single year fallow measures in the north-west of the region indicates a trend away from cropping enterprises during the 1996/97 season.



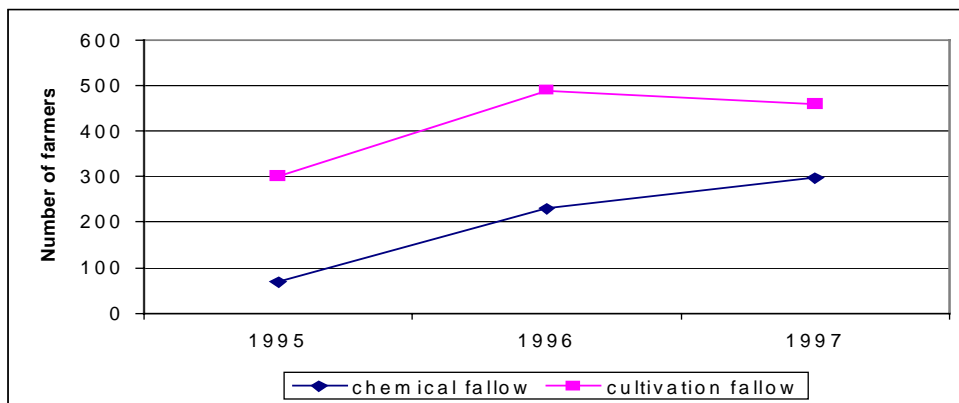
Source: Australian Bureau of Statistics (1994/95, 1995/96)

**Figure 22** Fallow management measures for the North Central Region (1994/95)



Source: Australia Bureau of Statistics 1994/95-1996/97

**Figure 23** Area under cultivation and chemical fallow in the North Central Region (1995-97)



Source: Australian Bureau of Statistics (1994/95-96/97)

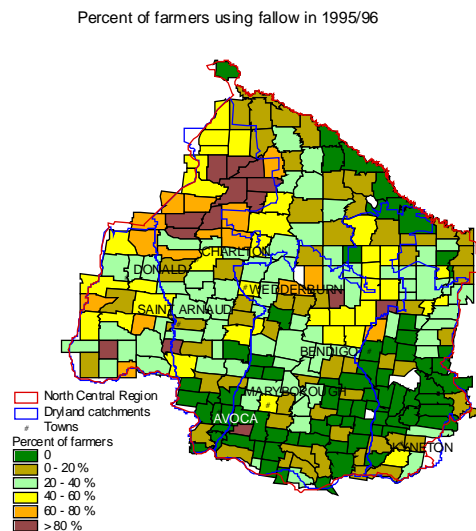
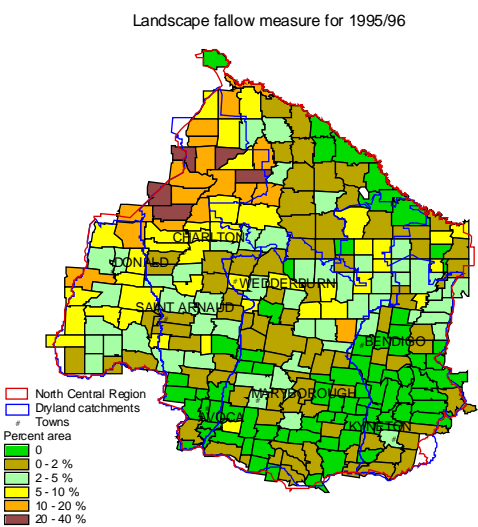
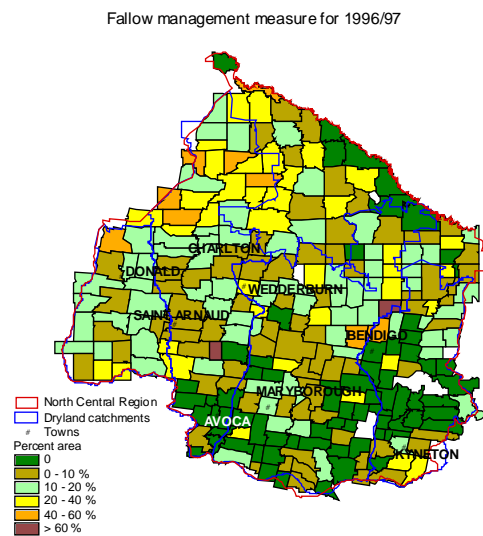
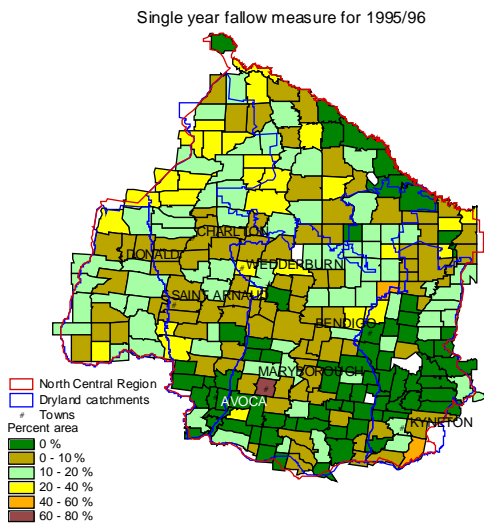
**Figure 24** Number of farmers using cultivation and chemical fallow in the North Central Region (1995-97)

### 3.2.8 1996/97 Australian Bureau of Statistics

The 1995/96 format for the fallow question was repeated again in the 1996/97 farm census. The overall use of fallow did not significantly change during this period. However, the difference between the area under cultivation fallow and chemical fallow has further reduced with more farmers using herbicides on fallowed areas rather than cultivating the same (Figures 23 and 24).

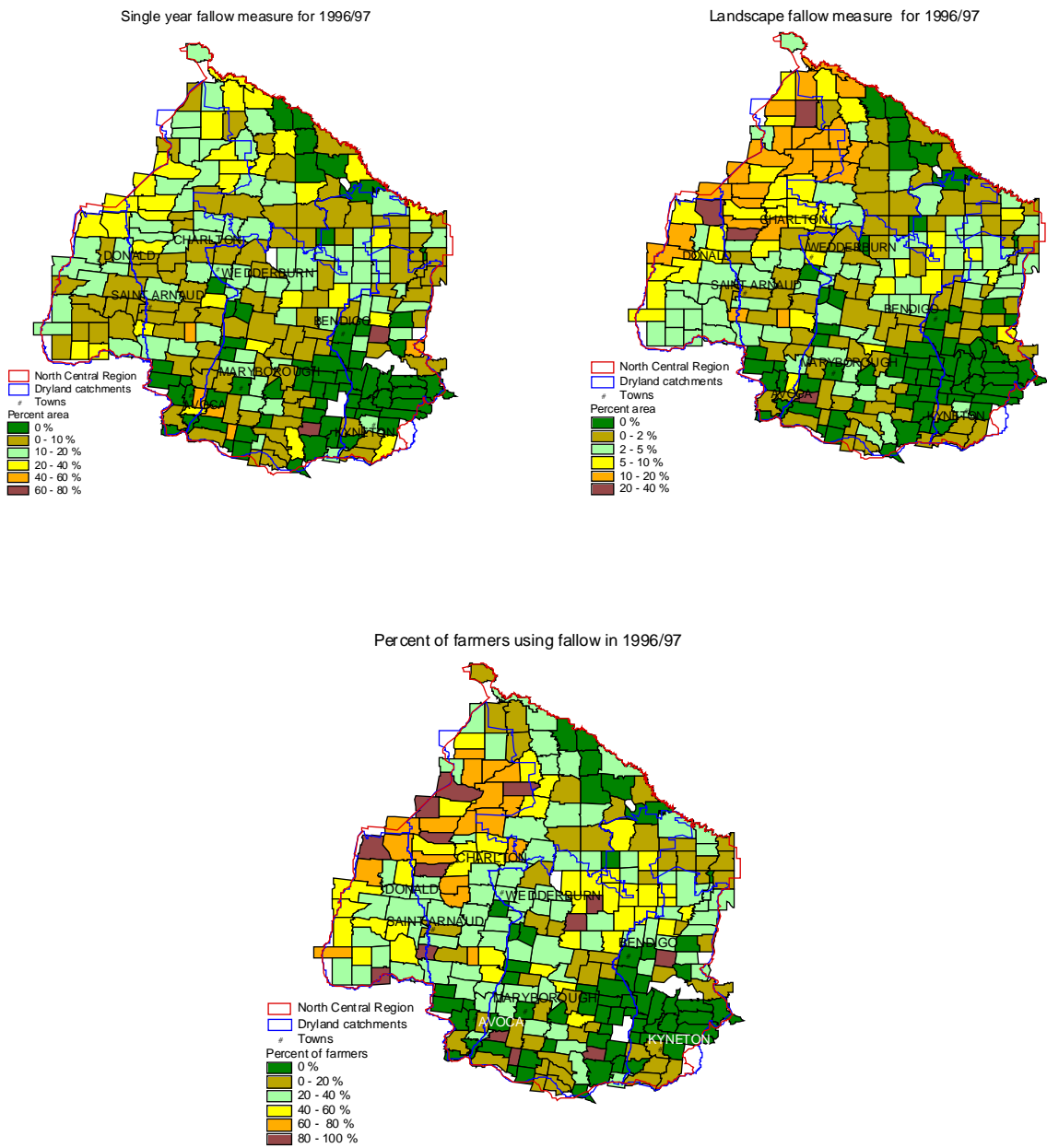
**Table 8** Measures of fallow usage in the North Central Region (1984-1997)

Fallow measure	1984 Hurley	1989 Harvey	1989-92 SoilCare	1992 ABS	1994 Luke et al.	1995 Luke et al.	1995 ABS	1996 ABS	1997 ABS
Landscape (% area)				6.4	5.8		2.4	4.7	4.7
Single year (% area)			28	20	18	3	8.0	13.3	13
Fallow management (% area)				22.1	30.6		8.2	16	
Adoption (% farmers)	34	17	68	40	57	16	17.3	31	33



Source: Australian Bureau of Statistics 1(1995/96, 1996/97)

**Figure 25** Fallow management measures for the North Central Region (1995/96)



Source: Australian Bureau of Statistics (1996/97)

**Figure 26** Fallow management measures for the North Central Region (1996/97)

### 3.3 Stubble Management

#### 3.3.1 1984 Ballarat College survey (Harvey *et al.* 1985)

Stubble management methods used by farmers are quite complex. Most times the stubble is managed by a combination of practices, such as grazing and mulching, or grazing, mulching and retaining stubble. This complexity makes it difficult to measure the areas of stubble treatment within the simple format of a single question in mail surveys, such as used by Harvey *et al.* (1985). Their work reports on adoption rates, for example, the proportion of farmers who used each technique. In 1984 burning was by far the most utilised stubble handling technique at 91 percent (Table 9). Grazing was adopted by 67 percent of farmers. Only 10 percent of farmers reported leaving any stubble standing or incorporating stubble. More detailed studies of stubble handling show that many of those who adopt stubble retention use the technique on only part of their farm (Luke, Karunaratne & Barr 1995; Wilkinson & Cary 1993). It can be concluded that the area of crop land where stubble was retained was significantly less than 10 percent in 1984.

#### 3.3.2 1989 Ballarat College Survey (Harvey *et al.* 1990)

The Harvey *et al.* (1990) study clearly indicates a reduction in the use of stubble burning and a move towards grazing and retaining or incorporating stubble between 1984 and 1989 (Table 9). The most common combinations of different stubble management practices identified are shown in Table 10.

**Table 9** Adoption of stubble management methods in the North Central Region (percent of respondents)

Treatment	1989	Change from 1984
Grazed	80	+13
Burned	61	-30
Baled	21	+10
Fallowed	15	+2
Left or ploughed in	29	+19
Prickled chained	1	*
Other	17	

\* Data for 1984 was not available

Source: Harvey *et al.* (1990)

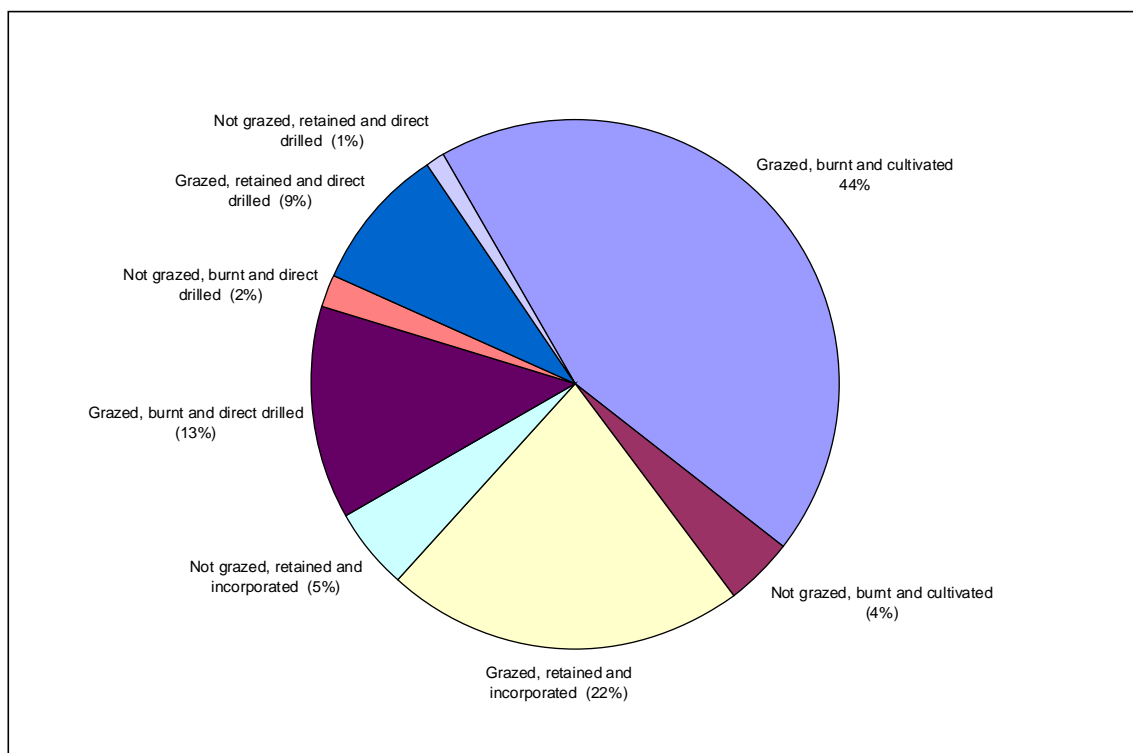
**Table 10** Adoption of most common combinations of stubble management in the North Central Region ( percent of respondents)

Treatment	1989	Change from 1984
At least some left or ploughed in	30	+20
Grazed and burned	42	-9
Grazed not burned	18	+12
Burned not grazed	8	-22
Other	2	

Source: Harvey *et al.* (1990)

### 3.3.3 1995 Agriculture Victoria baseline salinity control survey (Luke, Karunaratne & Barr 1995)

The Luke, Karunaratne and Barr (1995) study collected detailed data on stubble treatment of individual paddocks. This enabled a degree of sophisticated analysis comparable to the Melbourne University study of conservation cropping in the Warracknabeal Shire (Karunaratne, Barr & Wilkinson 2001). From one perspective, adoption of stubble retention was high. Fifty-two percent of farmers practised some form of stubble retention on part of their farm. This is a major increase since the 1980s. However, a different picture emerges when areas of complex stubble treatments are considered. Nearly half of the area (45 percent) was still conventionally cropped (stubble burnt and soil cultivated), 27 percent was incorporated, and 15 percent was burnt and direct drilled. Only 10 percent was trash farmed (stubble neither burnt nor cultivated). Most of this land was grazed as a stubble management tool. In order to obtain more specific stubble management methods these areas were further divided according to whether or not the stubble was grazed prior to each of the management techniques. This shows that only 3 percent of cropping farmers have adopted full trash farming defined as no grazing, burning or cultivation. This was practiced only on 1 percent of the cropping land. Figure 27 shows the proportion of stubble area treated under each of these management regimes.



Source: Agriculture Victoria baseline survey (1993)

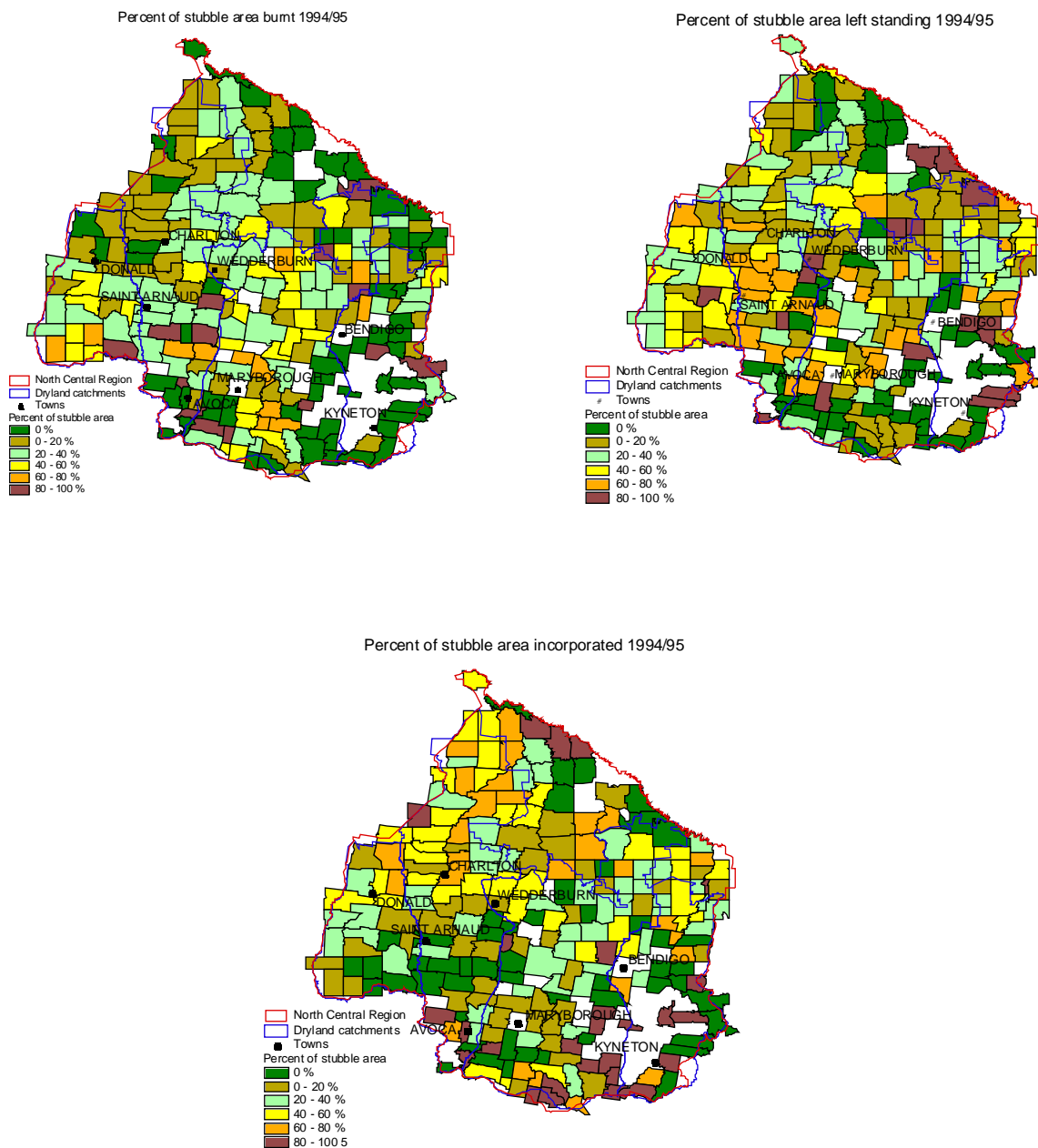
**Figure 27** Proportion of area under different stubble management regimes

### 3.3.4 1994/95 Australian Bureau of Statistics

In 1994/95 the ABS included a stubble management question in their farm census (Appendix 3). This asked farmers to report the area of cropping land on which the different crop stubble techniques were used.

In aggregate, 22 percent of the stubble area were burnt by 25 percent of cropping farmers (Table 11). This practice was commonly used by the farmers in the southern cropping zone of the region, with about 40 percent of their stubble being burnt in many parishes (Figure 28). Over one-third of the stubble was incorporated in to the soil while another one-third was left standing. Stubble mulching was minimal in the region.





Source: Australian Bureau of Statistics (1994/95)

**Figure 28** Stubble management methods used by farmers in the North Central Region (1994/95)

### 3.3.5 1995/96 Australian Bureau of Statistics

In the following year the ABS asked a modified stubble retention question (see Appendix 3). There were three major differences between this and the question used the previous year. This new question included grazing and baling as a separate category of stubble handling. The question also included an instruction to include each area only once. This was to overcome the possibility of double counting of areas in the previous year's question. It is quite possible that different techniques were used on the one area of stubble (e.g. mulching and incorporating). Finally, the question applied to crop and pasture stubbles prior to sowing, rather than to crop stubbles as in the previous year. There may be some difficulties in making comparisons with data

from the previous year. This is explored in the report A Baseline of Adoption of Conservation Cropping-Wimmera Region (Karunaratne, Barr & Wilkinson 2001).

The percentage of farmers burning or mulching their stubble has not significantly changed during the period between 1994/95 to 1995/96. The percentage of farmers burning stubble declined by two percent while the area of stubble burnt increased by three percent. This increase was mainly to the south of St Arnaud and south-west of the Wedderburn area (Figure 29). Incorporation and retention of stubble were significantly reduced, while heavy grazing or baling of stubble was used as the main stubble management technique by 19 percent of cropping farmers on 18 percent of their stubble area. Hence, it may be that some farmers reporting incorporation or stubble retention the previous year, have used these together with grazing, while only a small area was grazed in combination with burning or mulching.

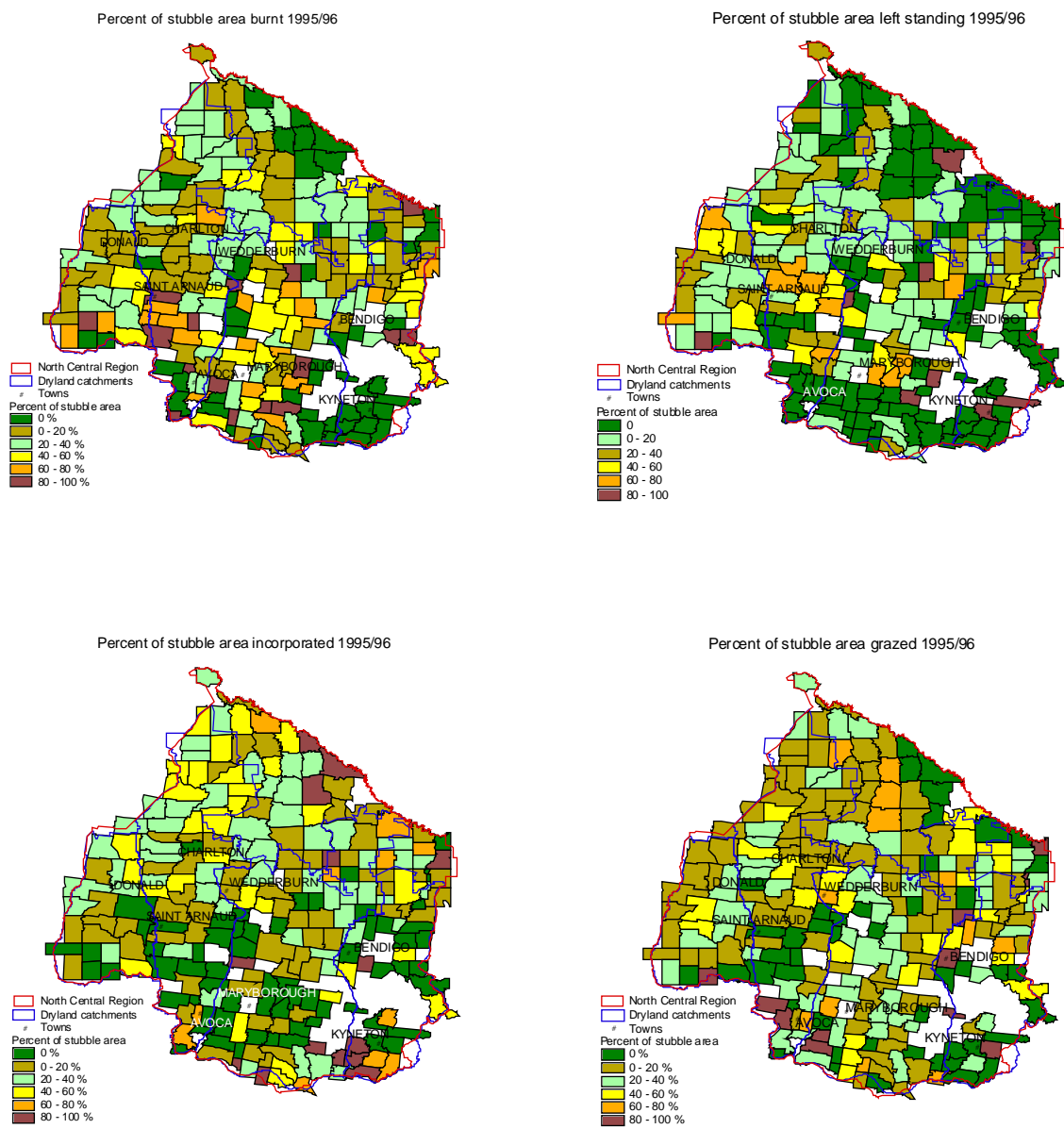
### 3.3.6 1996/97 Australian Bureau of Statistics

In the following year the ABS asked the same stubble retention question. This survey indicated an increase in the use of stubble burning used on 32 percent of the stubble area by 31 percent of the cropping farmers. The use of stubble retention did not change during this year, while both the percentage of stubble area incorporated and the farmers incorporating stubble declined. Stubble grazing is mainly reported in low cropping areas (Figure 30). Mulching was still the least favoured method of stubble management in the region, practised by 75 percent of cropping farmers on only 11 percent of stubble area.

**Table 11** Adoption of stubble management in the North Central Region (1995-97)

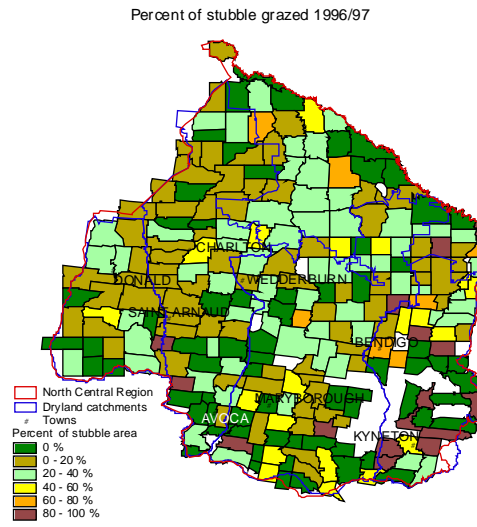
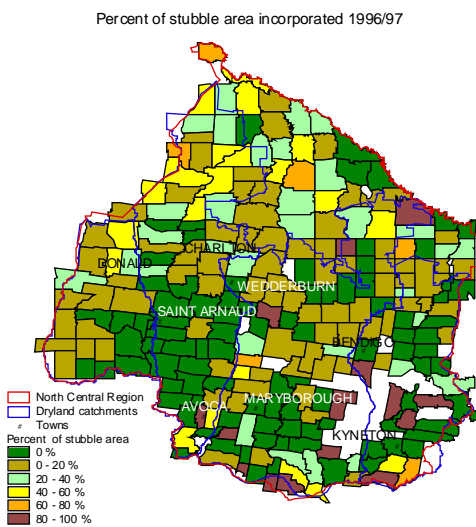
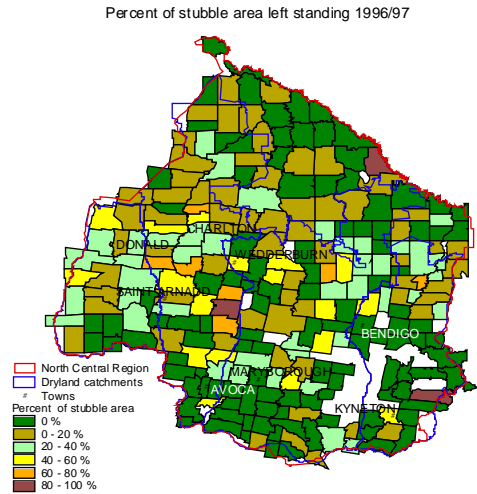
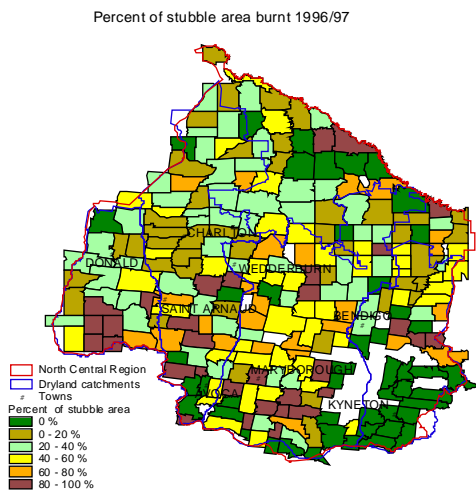
	Burn		Incorporated		Mulched		Left standing		Grazing/Baling	
	% area	% farmers	% area	% farmers	% area	% farmers	% area	% farmers	% area	% farmers
1994/95	22	25	37	26	7	7	34	22		
1995/96	25	23	24	18	9	6	24	14	18	19
1996/97	32	31	17	13	11	7	23	13	16	18

Source: Australian Bureau of Statistics (1995-1997)



Source: Australian Bureau of Statistics (1995/96)

**Figure 29** Stubble management techniques used by farmers in the North Central Region (1995/96)



Source: Australian Bureau of Statistics (1996/97)

**Figure 30** Stubble management techniques used by farmers in the North Central Region (1996/97)

### 3.4 Pasture within the crop cycle

There are three reasons to measure the integration of pastures within the cropping cycle. One is the contribution of legumes to nitrogen replacement. Interpretation of the status of the nutrient cycle also requires data on the application of fertilisers and the types of crops grown. The second reason to monitor pasture usage is the contribution of deep rooted perennials to the reduction of recharge. This is principally through the growing of lucerne based pastures. The third is the contribution of pastures in general to the maintenance of soil organic matter.

The principal source of data on pasture usage is the ABS farm census. Pasture questions have had a chequered history on the farm census:

- 1982/83 to 1983/84: Area only of sown pasture, pure lucerne and native pasture.
- 1984/85 to 1989/90: Area and sowings of pure lucerne, pure clover or medic, other pure legumes, sown grasses only, legume and grass mix, native pasture.
- 1990/91: Area only of sown pasture, pure lucerne and native pasture.
- 1991/92 to 1992/93: Area only of pure lucerne, pure clover or medic, other pure legumes, sown grasses only, legume and grass mix, native pasture.
- 1993/94: Area and sowings of pure lucerne, other legumes, sown grasses only, lucerne and other pasture species mix, other legume and grass mix, native pasture.
- 1994/95: Question failed
- 1995/96: Area and sowings of pure lucerne, other legumes, sown grasses only, lucerne and other pasture species mix, legume and perennial grass mix, annual grasses and legumes excluding lucerne. Only sowing data was coded by the ABS.

The major variations in this list are:

- coverage of sowings and/or total areas;
- inclusion of legume/grass pastures; and
- separation of perennial from annual grasses and legumes.

This latter change was funded by the Department of Natural Resources and Environment.

The analysis of the adoption of lucerne pasture in cropping zones is reported in the accompanying report on Adoption of pasture management practices in North Central Region (Karunaratne & Barr 2001).

### 3.5 Use of herbicides

Use of herbicides is an important practice necessary for the implementation of conservation cropping practices. Therefore it is important to determine farmer attitudes towards the use of herbicides on cropping land.

The Harvey *et al.* studies (1985, 1990) show clearly the quick uptake of chemical control of weeds in the 1980s. By 1989 almost all grain growers had used herbicides on their crops at some stage. (Harvey *et al.* 1990) (Table 12). The number of farmers using herbicides and the area applied with knock down and post-emergent herbicides significantly increased within the five year period (Table 13). The significance of this change was illustrated in the Williamson (1993) survey where 90 percent of the farmers perceived using herbicides and pesticides as the most important management change for their cropping practice.

**Table 12** North Central farmer's use of herbicides (1984-89)

	Percent of farmers	
	1989	Change from 1984
Use at some stage	99	+6
Never used	1	-6

Source: Harvey *et al.* (1990)

**Table 13** Changes in use of different types of herbicides (1984-89)

Type	Percent of farmers		Percent median area	
	1989	Change from 1984	1989	Change from 1984
Knockdown	54	+34	42	+22
Pre-emergent	60	-3	48	0
Post-emergent	63	+5	50	+26
Spray topping	33		21	

Source: Harvey *et al.* (1990)

Factors such as reduced damage to soil and the flexibility permitted by herbicides had increased in importance in the comments of farmers in the 1989 survey. Longer grazing period and better weed control was also seen as advantages of using herbicides by an increased number of farmers in the region, while farmers seeing less fuel usage and saving of time as an advantage had decreased over time (Table 14). A similar pattern was observed in the 1993 SoilCare survey, with better weed control and less soil structure damage being the greatest advantages reported (Table 15) (Williamson 1993).

The health risk factor in using herbicides and the high cost were the main concern for farmers, while perceptions of the unpleasantness of working with herbicides also increased during this period. (Harvey *et al.* 1990) (Table 16). While the cost of herbicides was a major concern for farmers in the SoilCare groups, cost was not considered as a major limitation to direct drilling or minimum tillage (Williamson 1993) (Table 17).

**Table 14** North Central farmers' beliefs about the advantages of using herbicides (1984-89)

Advantages	Percent of farmers	
	1989	Change from 1984
Better weed control	83	+3
Less fuel	30	-30
Less time	21	-7
Allows longer grazing	29	+9
Less equipment needed	3	+1
Less wear on equipment	20	+5
Permits flexibility	39	+13
Less damage to soil	61	+13
	n = 87	

Source: Harvey *et al.* (1990)

**Table 15** Perceived advantages of using herbicides (1992)

Advantages	Percent farmers
Better weed control	79
Less damage to soil	79
Less fuel	48
Less time	30

Source: Williamson (1993)

**Table 16** North Central farmers' perceptions of the disadvantages of using herbicides (1984-89)

Disadvantage	Percent of farmers	
	1989	Change from 1984
Residual build up in soil	53	-4
Health risk	73	+18
Less grazing	46	-14
Lack of information	15	+2
Cost	65	-11
Unpleasant to work with	25	+11
Complicated to apply	7	+2
	n = 89	

Source Harvey *et al.* (1990)

**Table 17** Perceived disadvantages of using herbicides by farmers in the North Central Region (1993)

Disadvantages	Percent farmers
Cost	77
Residue build up	70
Human health risk	69

Source: Williamson (1993)

#### 4 RECOMMENDATIONS

The aim of this report is to provide baseline information and establish trends in adoption of conservation cropping practices in North Central Victoria. The information in this report is based on available research studies and provides reasonable trends in adoption of conservation cropping practices in the region during the last decade. The adoption rates estimated from 1994/95 ABS data provides reliable information and can be used as a baseline to monitor future adoption of these practices. A few amendments made to the set of questions on conservation cropping practices in the 1994/95 ABS census will provide improved data for monitoring the adoption rates of these practices.

The 1994/95 ABS tillage question provides valid data allowing estimation of the adoption of tillage practices. This question does not, however, provide the information to calculate the response rate to the question. Hence, a minor amendment to the question is recommended to overcome this problem. Asking farmers to report the total area prepared for crop will give the opportunity to estimate the response rate to the question.

The new recommended format for the tillage question is as follows:

#### ABS tillage question: cultivation for broadacre crops

<p><b>Include</b></p> <ul style="list-style-type: none"> <li>Each area once</li> </ul> <p>If different tillage methods were applied to the same area, report under that method involving most cultivation.</p>	<ul style="list-style-type: none"> <li><b>Area of holding to which the following number of cultivations were made for fallow weed control or seedbed preparation prior to sowing of broadacre crops</b></li> </ul> <p>Total area prepared for crop.....</p> <p><b>Method of crop preparation:</b></p> <p>More than one cultivation using discs, tines, ploughs, etc.....</p> <p>One cultivation immediately prior to sowing.....</p> <p>No cultivation .....</p>	<p>Hectares</p> <div style="border: 1px solid black; width: 100px; height: 20px; margin: 0 auto;"></div> <p>Hectares</p> <div style="border: 1px solid black; width: 100px; height: 80px; margin: 0 auto;"></div>
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A similar problem arises in the format of the stubble question. This question does not provide the information to calculate the response rate to the question. This cannot be calculated by adding responses in each stubble category, as farmers are likely to adopt more than one form of stubble management. This problem could be overcome by adding a new statement to the question, asking farmers to report the total area on which crop and pasture stubbles had to be managed prior to sowing crops and pastures.



The new recommended format for the stubble management question is as follows:

**ABS Stubble management question - season 1995/96**

**2c. Disposal of crop and pasture stubbles (trash) prior to sowing between 1 April 1995 and 31 March 1996**

- **Area of holding on which crop and pasture stubbles were handled by the following methods prior to sowing broadacre crops and pastures:**

Hectares

Area of holding on which crop and pasture stubbles were handled prior to sowing broadacre crops and pastures

**Note**

- Even if stubble was grazed or baled, report disposal methods used to prepare for next planting

**What area of these stubbles were managed by each of the following methods**

Hectares

Stubble removed by burning .....

Most stubble removed by baling, heavy grazing or fire harrowing.....

Stubble ploughed into the soil.....

Stubble was mulched.....

Stubble was left intact (no cultivation, crops/pasture direct drilled).....

The format of the fallow question in the 1994/95 ABS census provides reliable information to estimate the adoption of fallow management in the region. Hence, the same format can be used in future to estimate the measure of fallow management used in this report.

## 5 REFERENCES AND DATA SOURCES

- Australian Bureau of Statistics (1992-1997) Parish aggregated farm census data supplied to Agriculture Victoria
- Avoca Community Working Group (1992) Avoca Catchment Salinity Management Plan, Department of Conservation and Environment, Bendigo.
- Avoca-Loddon-Campaspe Regional Landcare Plan Working Group (1993) Avoca-Loddon-Campaspe Regional Landcare Plan.
- Barr, N.F. & Cary, J.W. (1992) Greening a Brown Land, Macmillan, Australia.
- Campaspe Community Working Group (1992) Campaspe Catchment Salinity Management Plan, Department of Conservation and Environment, Bendigo.
- Decade of Landcare Plan Steering Committee (1992) Victoria's Decade of Landcare Plan.
- Harvey, J.T., Hurley, F.T., Fitzgerald, B.C. & Oppenbeim, P.P., (1990) Cropping and Conservation: Changes in Cultivation Practices in Victorian Grain Growing Areas 1984-1989, Ballarat College of Advanced Education.
- Harvey, J.T., Hurley, F.T., Fitzgerald, B.C. & Oppenbeim, P.P., (1985) Cropping and Conservation: A Survey of Cultivation Practices in Victorian Grain Growing Areas. Ballarat College of Advanced Education.
- Karunaratne, K. & Barr, N. (2001) A Baseline of Adoption of Pasture Management Practices in North Central Region, Department of Natural Resources and Environment, Bendigo.
- Karunaratne, K., Barr, N. & Wilkinson, R. (2001) A Baseline of Adoption of Conservation Cropping Practices in Wimmera Region, Department of Natural Resources and Environment, Bendigo.
- Karunaratne, K, Barr, N. & Brown, M. (2001) Community attitudes to environmental issues: Statewide and Regional Overview, Department of Natural Resources and Environment, Bendigo.
- Loddon Community Working Group (1992) Loddon Catchment Salinity Management Plan, Department of Conservation and Environment, Bendigo.
- Luke, R., Karunaratne, K. & Barr, N. (1995) Salinity Control in North Central Victoria: A Measure of Farmers' Beliefs and Behaviours, Agriculture Victoria.
- North Central Catchment and Land Protection Board (1997) North Central Regional Catchment Strategy.
- Office of the Commissioner for the Environment (1991) Agriculture and Victoria's Environment, Government of Victoria.
- Rendell McGuckian (1996) Benchmarking Sustainable Farming Systems, Agriculture Victoria, Melbourne.
- Wilkinson, R.L. & Cary, J.W. (1993) Monitoring SoilCare in North East Victoria, School of Agriculture and Forestry, The University of Melbourne.

Williamson, J. (1993) Farmer Attitudes to Conservation Tillage Practices, and Annual and Perennial Pastures in North Central Victoria, Department of Conservation and Natural Resources, Victoria.

Working Group on Sustainable Agriculture (1991) Report of the SCA Working Group on Sustainable Agriculture, Australian Agricultural Council, CSIRO, East Melbourne.



**6 APPENDICES: AUSTRALIAN BUREAU OF STATISTICS FARM CENSUS QUESTIONS**

**Appendix 1 ABS tillage questions**

**ABS tillage question: tillage methods - season 1993/94**

<p><b>Include</b></p> <ul style="list-style-type: none"> <li>Each area once</li> </ul> <p>If different tillage methods were applied to the same area, report under that method involving most cultivation.</p>	<ul style="list-style-type: none"> <li><b>Area of holding to which the following tillage practices were applied:</b></li> </ul> <p>Conventional tillage (using only discs, tines or ploughs for fallow weed control or seedbed preparation) .....</p> <p>Minimum/reduced tillage (limited cultivation with some use of herbicides for fallow weed control) .....</p> <p>No tillage (No cultivation, fallow weed control by herbicide and direct drill or no tillage seeding) .....</p>	<p>Hectares</p> <div style="border: 1px solid black; width: 100px; height: 100px; margin: 0 auto;"></div>
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**ABS tillage question: cultivation for broadacre crops - season 1994/95**

<p><b>Include</b></p> <ul style="list-style-type: none"> <li>Each area once</li> </ul> <p>If different tillage methods were applied to the same area, report under that method involving most cultivation.</p>	<ul style="list-style-type: none"> <li><b>Area of holding to which the following number of cultivations were made for fallow weed control or seedbed preparation prior to sowing of broadacre crops</b></li> </ul> <p>More than one cultivation using discs, tines, ploughs, etc.....</p> <p>One cultivation immediately prior to sowing.....</p> <p>No cultivation .....</p>	<p>Hectares</p> <div style="border: 1px solid black; width: 100px; height: 100px; margin: 0 auto;"></div>
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**ABS tillage question: cultivation for broadacre crops - season 1995/96**

<p><b>Include</b></p> <ul style="list-style-type: none"> <li>• Each area once</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Area of holding to which the following number of cultivations were made for fallow weed control or seedbed preparation prior to sowing of broadacre crops</b></li> </ul>	<p>Hectares</p> <div style="border: 1px solid black; width: 100%; height: 100%;"></div>
<p>If different tillage methods were applied to the same area, report under that method involving most cultivation</p>	<p>More than two passes using discs, tines, ploughs, etc.....</p>	
	<p>One or two passes only prior to sowing.....</p>	
	<p>No cultivation (apart from actual sowing operation).....</p>	

**Appendix 2 ABS fallow questions**

**ABS fallow question - season 1994/95**

<b>Fallow land</b>	<ul style="list-style-type: none"><li><b>In preparation for this years' crop, how much land was in fallow before Christmas 1994 through the following preparations:</b></li></ul>	Hectares
	Pasture topping (preventing seed development by spraying herbicide at milky dough stage).....	<input type="text"/>
	Complete chemical fallow using knockdown herbicide only.....	
	Cultivation (with or without herbicide).....	

**Appendix 3 ABS stubble management questions**

**ABS stubble management question - season 1994/95**

**Disposal of crop stubble during season 1994/95**

**Note**

- Even if stubble was grazed or baled, report disposal methods used to prepare for next planting

• **Area of holding on which the following crop stubble techniques were used:**

Hectares

- Stubble was burnt.....
- Stubble was incorporated (farm machinery used to plough stubble into the soil).....
- Stubble was mulched (farm machinery used to chop or slash standing stubble into smaller lengths).....
- Standing stubble was left intact (no cultivation, crops sown by direct drilling).....

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**ABS stubble management question - season 1995/96**

**Disposal of crop and pasture stubbles (trash) prior to sowing between 1 April 1995 and 31 March 1996**

**Note**

- Include each area only once.
- Where stubbles were lightly grazed, report how the remaining stubble was handled.

• **Area of holding on which crop and pasture stubbles were handled by the following methods prior to sowing broadacre crops and pastures**

Hectares

- Stubble removed by burning.....
- Most stubble removed by baling, heavy grazing or fire harrowing .....
- Stubble ploughed into the soil .....
- Stubble was mulched .....
- Stubble was left intact (no cultivation, crops/pasture direct drilled).....

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