

**A BASELINE OF ADOPTION OF  
CONSERVATION CROPPING - NORTH EAST  
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 East Region of Victoria.

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

- **Cultivation:** A large increase in the number of adopters of conservation tillage in the 1980s. The early 1990s saw no increase in the number of adopters, as adopters consolidated their use of minimum tillage and minimal tillage and put progressively smaller areas under conventional tillage. During the mid 1990s there was a small swing away from direct drilling.
- **Fallow:** There was a large drop in the use of fallow during the 1980s and early 1990s. There remains a core of committed fallowers. These are predominantly in the lower rainfall areas in the north-west of the region.
- **Stubble retention:** There was a minor trend towards stubble retention during the late 1980s and early 1990s. This trend reversed in the late 1990s with increases in the use of stubble burning. Burning is still a favoured practise for most farmers. Trash farmers are a minority of about 20 percent.
- **Pasture in the cropping cycle:** Reported in the accompanying report on Adoption of pasture management practices in North East Region (Karunaratne & Barr 2001).
- **Lime application:** One in five farmers applied lime. An average of 34 tonnes of lime per farm was reported in the region.
- **Herbicide use:** There were significant increases in the use of herbicides since the early 1980s. These are associated with a move from cultivation fallow to chemical fallow.



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# A BASELINE OF ADOPTION OF CONSERVATION CROPPING - NORTH EAST REGION

August 2001

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## 1 THE NORTH EAST (AND GOULBURN/BROKEN) REGION

### 1.1 Sustainability in the North East Region

Cropping in the Goulburn/Broken and North East Region of Victoria is not the dominant activity that it is in the North West Region of Victoria. Cropping is concentrated in a small region bounded by Benalla, Rutherglen, Tocatui and Shepparton East. This area lies across the boundary between two Landcare regions, the Goulburn/Broken and the North East. Cropping in these two regions is presented in this report. Cropping intensity in this area in 1993/94 and 1994/95 is shown in Figures 2 and 3 respectively.

Within this region cropping is predominantly part of mixed farming operations. Most cropping takes place on duplex soils. There are small areas of higher quality soils, particularly around Dookie (Figure 1).

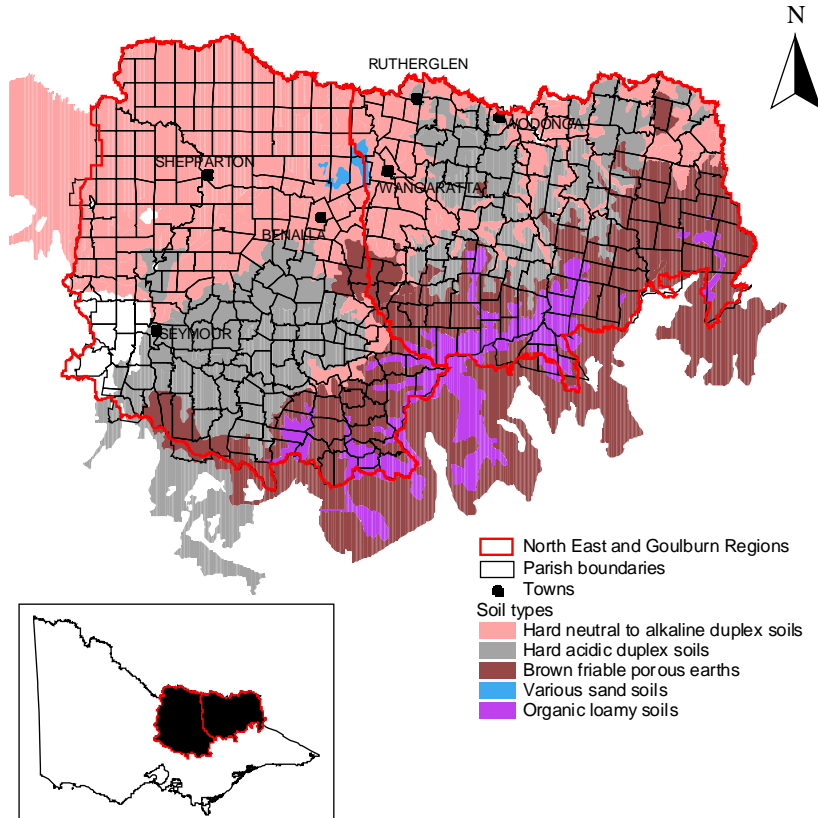
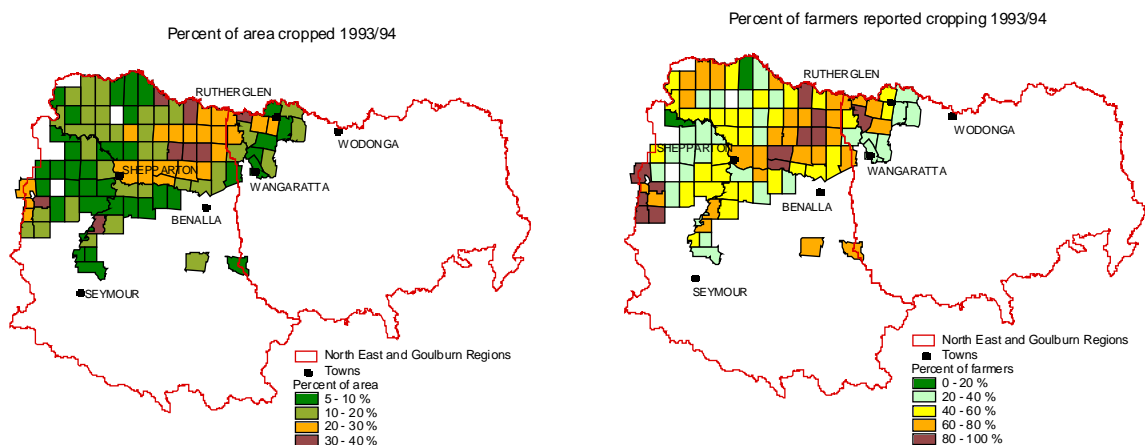
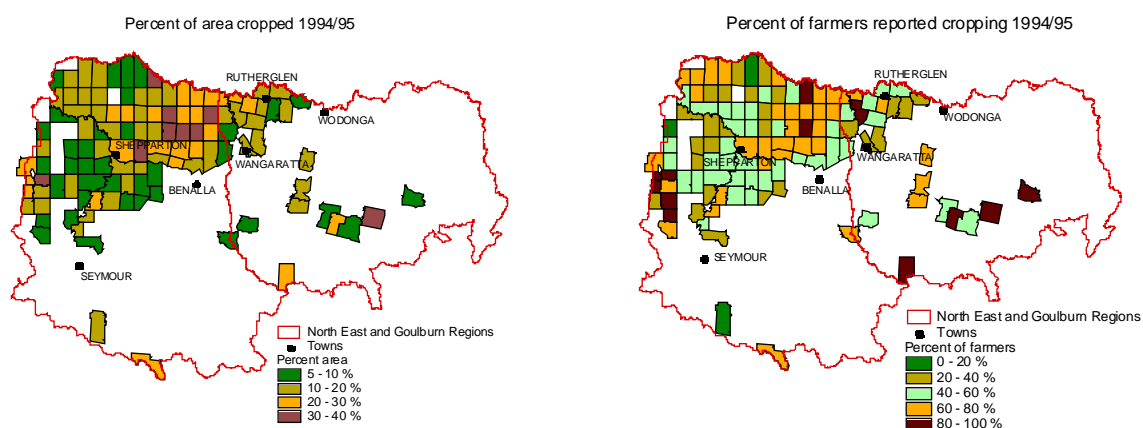


Figure 1 Soil types in north-east Victoria



Source: Australian Bureau of Statistics (1993/94)

**Figure 2** Intensity of cropping in the North East Region (1993/94)



Source: Australian Bureau of Statistics (1994/95)

**Figure 3** Intensity of cropping in the North East Region (1994/95)

The sustainability issues for croppers in the region relate predominantly to soil structure decline and soil acidification. Water erosion and soil fertility decline are related, but lower priority issues. As with other cropping regions of the state, conservation cropping is seen as the major strategy to address soil structure and erosion problems. The North East Regional Landcare Plan (1993) has a stated objective of obtaining the adoption of conservation cropping on all cropping farms in the region by the year 2000. Importance is also placed on the adoption of strategies to minimise the acidification of soils. These strategies include the maintenance of perennial pastures and the liming of soils.

North-east Victoria is the home of conservation cropping in the state. Conservation cropping was first introduced by the then Rutherglen Research Farm in the 1960s. A combination of suitable soils and higher than average rainfall (which placed a premium on timeliness to avoid waterlogging) ensured the earliest adoption of minimum tillage and direct drilling was by farmers in this region (Barr & Cary 1992).

## 1.2 Indicator practices

The following practices have been selected as indicators of the extent of adoption of sustainable cropping practices in the North East Region.

1. Cultivations used to sow a crop
2. Use and length of fallow
3. Adoption of stubble retention practices
4. Use of soil conditioners, particularly lime application
5. Use of lucerne and other legumes in crop rotation cycle
6. Use of herbicides
7. Perception of seriousness of erosion and salinity

The first five practices are generally accepted as being most likely to minimise the adverse impacts of cropping activities on the state of the soil resource (North East Landcare Plan 1993; Goulburn Broken and North East Regional Catchment Strategies 1997). The authors are not suggesting 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 sixth indicator, herbicide use, will clearly be more 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 the seriousness of soil structure decline and acidification. This is an indicator of awareness rather than resource condition. Awareness of degradation generally is not 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

It is ironic that whilst the North East Region is a relatively minor area of crop production in the state, there is such a relative wealth of data on the adoption of sustainable cropping practices. This reflects the long history of interest by the regions' agricultural scientists in the development of conservation cropping techniques.

### 2.1 Farmer attitudes to minimum tillage in northern Victoria (Whitaker 1977)

A study of farmers' attitudes to adoption of minimum tillage in northern and north east Victoria was carried out as part of a diploma course in agricultural extension at the University of Melbourne. This study sent mail surveys to a random sample of 76 farmers in the Yarrawonga and Numurkah districts of the North East Region and Raywood in north central Victoria. A further 24 questionnaires were sent to farmers known to be adopters of minimum tillage. The response rate was 27 percent (Whitaker 1977). Data was not available for reanalysis.

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

A mail survey of Victorian grain growers was conducted by the then Ballarat College in 1984 in order to investigate the use of cultivation and cropping practices and farmers' perceptions of, and attitudes to, these practices. The survey included three shires predominantly in the Goulburn/Broken catchment: Shepparton, Benalla and Yarrawonga. The survey was mailed to

310 croppers in these shires. There were 87 responses, a response rate of only 28 percent, far lower than surveys in the North Central and Mallee Regions (Harvey *et al.* 1985). Data was not available for reanalysis.

### **2.3 Ballarat College conservation cropping survey (Harvey *et al.* 1990)**

The Ballarat College survey was repeated in 1989, and sent only to those who responded to the initial survey. This was designed to measure any changes in farmers' attitudes and the degree of adoption of these practices. The response rate was 44 percent (Harvey *et al.* 1990). The low response rate indicates a need for caution in interpreting the results of these studies. Data was not available for reanalysis.

### **2.4 Monitoring SoilCare in north-east Victoria (Cary, Wilkinson & Ewers 1989)**

The SoilCare program was developed jointly by the Department of Agriculture and the Department of Conservation and Natural Resources (DCNR) to overcome the limitations of the conservation cropping demonstrations established by DCNR throughout the mid 1980s. This involved SoilCare discussion groups and farmer-driven demonstrations on paddocks to solve cropping problems (specified by the groups) and provide farmers with more understanding of the benefits of conservation cropping techniques. A program was implemented to review the outcomes of the SoilCare program by monitoring the perceptions of soil degradation and the conservation cropping behaviour of grain growers in the north east. This included a personal interview survey of 146 randomly selected cropping farmers in 1989. The survey area extended from Colbinabbin in the west, Nagambie in the south, Rutherglen in the north-east to Picola in the north. The response rate to this survey was over 90 percent (Cary, Wilkinson & Ewers 1989; Ewers 1990). Data was available for reanalysis.

### **2.5 Monitoring SoilCare in north-east Victoria (Wilkinson & Cary 1993)**

The University of Melbourne repeated its SoilCare study in 1992. The same respondents were approached to be interviewed a second time. Of the 146 families interviewed in 1989, 130 were reinterviewed in 1992. There were seven refusals and nine subjects who no longer cropped. Of the 130 interviews, 119 were with the same family member interviewed in 1989. The survey was redesigned to seek detailed information on the management options used in each cropped paddock on each farm. This research design makes this one of the most accurate and robust measures of changing cropping practices ever undertaken in Australia (Wilkinson & Cary 1993). Data was available for reanalysis.

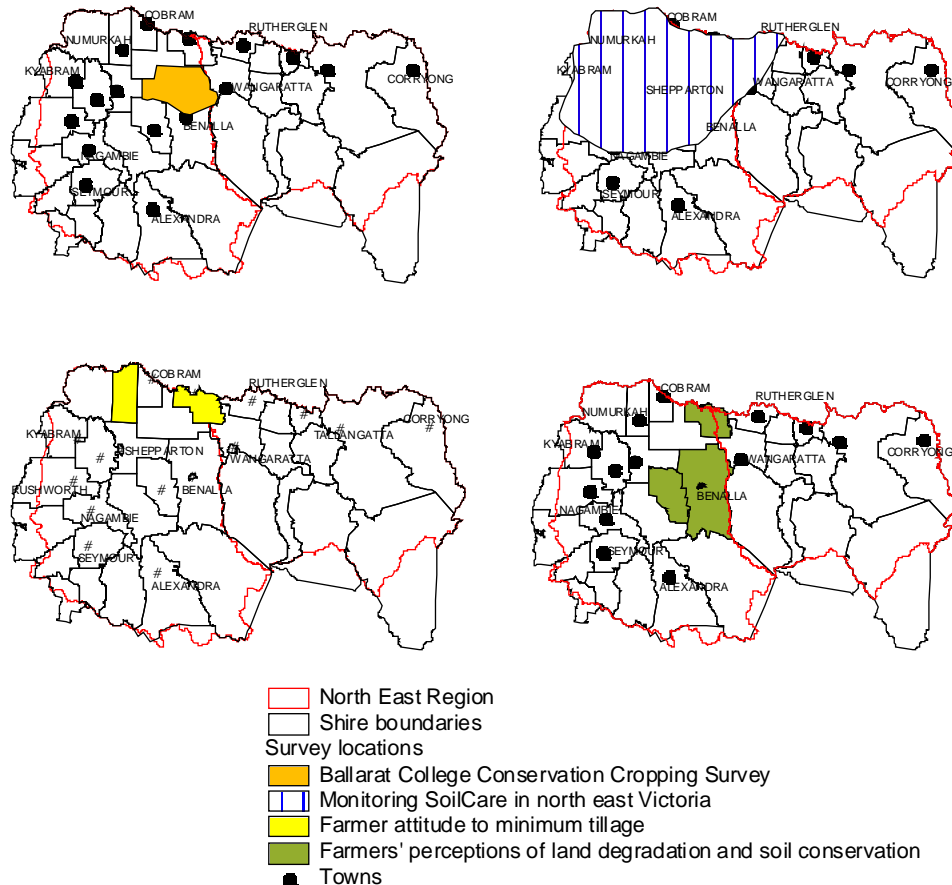
### **2.6 A study into farmers' perceptions of land degradation and soil conservation (Cocks 1993)**

Fiona Cocks, a Bachelor of Agricultural Economics student at the University of New England, undertook a study of attitudes to conservation cropping in the region. She sent mail questionnaires to 300 farmers in the region bordered by Benalla, Violet Town and Yarrowonga. She received a response rate of 43 percent. The survey concentrated on group membership and perceptions of degradation. There was one simple question on the adoption of tillage methods. Because of the low response rate and simplicity of questions, this is of marginal use only in setting a baseline measure of adoption. However, the study does give some insights into the reasons for adoption and non-adoption of conservation methods in general (Cocks 1993). Data was not available for reanalysis.

### **2.7 Australian Bureau of Statistics**

The Australian Bureau of Statistics (ABS) farm census is distributed annually to all Australian farming businesses which 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, degradation perception, soil ameliorants, fertiliser use and pastures. Commencing in

1993/94 census, questions have covered cultivation practice and use of stubble retention. Data from the ABS farm census is normally available in aggregated form at state or local government area. As part of this project data was purchased disaggregated at parish levels. As parishes are significantly smaller than local government areas, the ABS data was reaggregated according to catchment and soil type boundaries.



**Figure 4** Location of cropping adoption studies in the North East Region

### 3 MEASURING CONSERVATION CROPPING PRACTICES

#### 3.1 Cultivation

##### 3.1.1 Farmer attitudes to minimum tillage in northern Victoria (Whitaker 1977)

Whilst there was no direct measure of the adoption of minimum tillage in the Whitaker study, the recorded incidence of minimum tillage was extremely low. All of the randomly sampled croppers were classified as non-adopters. Only 24 percent of the randomly sampled farmers knew of anyone who had grown a crop using minimum tillage techniques (Whitaker 1977).

##### 3.1.2 1984 Ballarat College survey (Harvey *et al.* 1985)

The Ballarat College study of 1984 reported the time of first cultivation of cropped land. This was reported separately for land cropped in the previous year and land not cropped in the

previous year. The results show a clear trend towards direct drilling in the seven years since the Whitaker study. Fifty percent of farmers reported they first cultivated their previously cropped land after the autumn break. More than half of the respondents reported they first cultivated at least some of their land going into crop from pasture after the autumn break. Cultivation after the autumn break is minimum tillage cultivation. Over 50 percent of respondents to the survey had at least partially adopted minimum tillage between 1977 and 1984. Making the most conservative (and unlikely) assumption that all the non-respondents to the survey had not adopted minimum tillage, then the lowest possible adoption rate for minimum tillage was 17 percent.

The time of first cultivation was closely related to the number of cultivations. In 1984 the study reported the cultivation frequency on land first cultivated before October as between two and six, with four as the modal frequency. Whereas the land first cultivated after autumn break was cultivated to a lesser extent with two as the modal number of cultivations (Harvey *et al.* 1985).

### 3.1.3 1989 Ballarat College survey (Harvey *et al.* 1990)

The adoption rate figures from the second Ballarat College study revealed a continuing trend towards direct drilling and away from minimum tillage in the management of paddocks coming into cropping from a pasture phase. For paddocks going into a second or later cropping phase, there was an adoption trend away from traditional tillage to direct drilling, and to a lesser extent towards minimum tillage. Overall the adoption rate for direct drilling in season 1988/89 was measured at 26 percent (Table 1 & Table 2). This dramatic increase in adoption of direct drilling is consistent with the increase in sales of minimum tillage herbicides in Australia which grew from a very low base in 1984 to almost \$80 000 000 in 1989 (Ewers 1990).

**Table 1** Time of first cultivation of land cropped in the previous year (North East Region)

	1989 (% farmers)	Change from 1984
As soon as possible after harvest	21	-29
After autumn break	53	+9
Did not cultivate at all	26	+20

Source: Harvey *et al.* (1990)

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

Timing	Percent of farmers <sup>1</sup>		Percent of area <sup>2</sup>	
	1989	Change from 1984	1989	Change from 1989
Before Oct 1 <sup>st</sup>	22	-4	50	0
Between Oct - Christmas	16	-8	67	-22
Between Christmas – autumn break	22	-34	50	0
After autumn break	38	-18	100	+28
Not cultivated	34	+11	100	+82

Source: Harvey *et al.* (1990)

<sup>1</sup> Percentage 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.

### 3.1.4 Monitoring SoilCare in north-east Victoria (Cary, Wilkinson & Ewers 1989)

The University of Melbourne measured the mean number of cultivations in 1989 at 2.5, down from 3.3 in 1986 ( $p < .01$ ) (Table 3). This cultivation measure was a farmer estimate of average cultivation over all cropped paddocks. The University of Melbourne study also found 47 percent of farmers described themselves as adopters of direct drilling. This study, however, did not measure adoption on a paddock by paddock basis, so a true adoption measure for the season could not be calculated. It is possible some of those who described themselves as direct drilling adopters may not have used direct drilling in the 1988/89 season. The true measure of adoption lies somewhere between 47 percent of self described adopters of direct drilling and the 22 percent of farmers who reported direct drilling all their crops during the 1989 season.

The greater response rate to the University of Melbourne 1989 study enables some basic evaluation of the accuracy of the 1989 Ballarat College study. It is difficult to reconcile the University of Melbourne measures with the 26 percent adoption of direct drilling as measured in the Ballarat College study during the same period. One conclusion could be that the Ballarat College sample was biased against adopters by a differential response rate, although past experience would suggest that the bias could be expected to be in the other direction. These difficulties emphasise the need for care in the framing of questions designed to measure adoption of a practice as complex as conservation cropping.

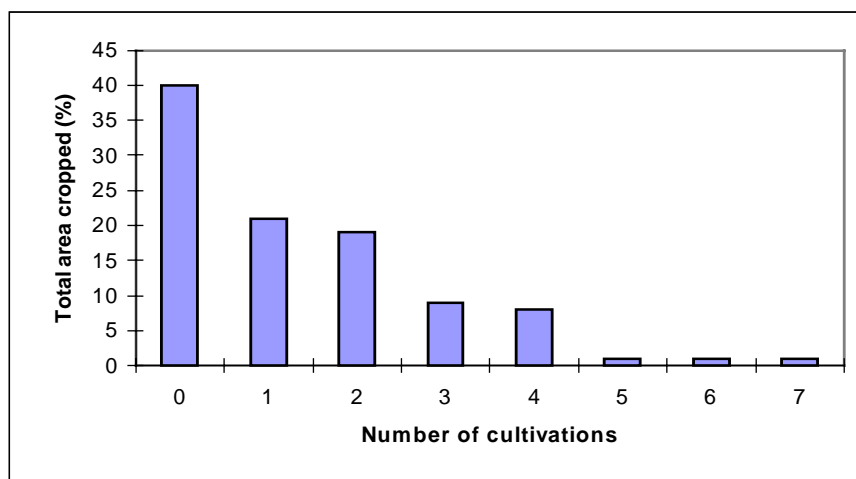
### 3.1.5 Monitoring SoilCare in north-east Victoria (Wilkinson & Cary 1993)

In the light of the difficulties of measurement observed in the 1989 surveys, the 1992 University of Melbourne study was totally redesigned to obtain as accurate as possible a measure of the adoption of conservation cropping. In contrast to the 1989 study, the measures of cultivation were calculated from detailed paddock level data. The results showed that the trend towards lesser cultivation continued between 1989 and 1992. The mean number of cultivations fell again to 1.7. The change in measurement method might account for some of the change, but this is unlikely, as farmer estimates of cultivation in 1989 would be more likely to underestimate the number of cultivations because of social desirability factors. Despite the fall in the average cultivations, the adoption rate for direct drilling was only slightly higher than in 1989 at 61 percent. Most of this increase seems to be accounted for by the attrition of non-adopters from the sample. The number of new adopters since 1989 was balanced by the number of disadopters in the same period. Attrition of non-adopters is consistent with the finding of this study that adopters of direct drilling are more likely to be specialist croppers. The period 1989-92 saw low wheat prices and it is probable that the nine farmers who were not interviewed in 1989 because they had given up cropping, were non-adopters of direct drilling. What appears to have happened is that adopters of direct drilling and minimum tillage have consolidated their position. The detailed paddock data from this survey showed 40 percent of the crop area was direct drilled and another 40 percent was sown using minimum tillage (one to two cultivations) (Figure 5).

**Table 3** Mean number of cultivations in 1986, 1989 and 1992.

Number of cultivations	1986	1989	1992
0 - 1	13	29	48
2 - 3	45	45	45
4 or more	44	28	8
Mean number of cultivations	3.3	2.5	1.7

Source: Wilkinson and Cary (1993)



Data source: Wilkinson and Cary (1993)

**Figure 5** Cultivation management in north east Victoria

### 3.1.6 A study into farmers' perceptions of land degradation and soil conservation (Cocks 1993)

The Cocks study in 1992 also measured the self reported adoption rate for direct drilling at 59 percent. This is not significantly different to the result of the University of Melbourne study in 1992.

### 3.1.7 1993/94 Australian Bureau of Statistics

The next available data on the extent of tillage in the North East Region is that reported in the 1993/94 and 1994/95 farm census data provided by the Australian Bureau of Statistics. A question on the census asked farmers the area of crop land sowed with conventional tillage, minimum tillage and direct drilling (see Appendix 1).

As cropping in the north-east is concentrated in the northern half of the region, the shires in this area were selected for the analysis of the census data. The parish data in these shires showed the total tillage area exceeding the total crop area in almost all parishes with low cropping intensities, giving high adoption rates of direct drilling. This may be due to the inclusion of sown pasture area by the farmers in these parishes when responding to the question on tillage methods. Hence, the parishes with less than 5 percent of land under cropping was eliminated from this analysis to minimise the problem of overestimating direct drilling on crop land.

ABS farm census data shows that 30 percent of the area was direct drilled and that direct drilling was adopted by only 20 percent of farmers (Table 4).

Conventional tillage is most dominant in the north and north-east part of the Goulburn region, where less than 20 percent of the area is under crop. Direct drilling and minimum tillage was mostly adopted in areas with greater cropping intensity to the south-east (Figures 6, 7 & 8). This is consistent with the findings of Ewers (1990) who mapped the results of the 1989 University of Melbourne study.

**Table 4** Cultivation techniques used by cropping farmers in the North East Region (1993/94)

	Direct drilling	Minimum tillage	Conventional
% area	30	25	45
% farms	20	20	59

Source: Australian Bureau of Statistics (1993/94)

**Calibrating the ABS data:** There are a number of quite different data sets presented above. Direct comparison is in many cases difficult, but possible if a few assumptions are made.

Firstly, the work of Harvey *et al.* (1985, 1990) can be compared if the following assumptions are made:

- Adoption of minimal tillage and direct drilling is easier on land cropped the previous year. The percentage of farmers adopting minimum tillage and direct drilling on land cropped the previous season will be similar to the overall number of farmers adopting these practices on any part of their land.
- Minimum tillage is defined in the ABS farm census as 'limited cultivation, using herbicides for weed control'. This management strategy will be adopted by those farmers who choose to cultivate after the autumn break. Cultivation before this period will be mostly conventional cultivation relying on the plough for significant weed control.

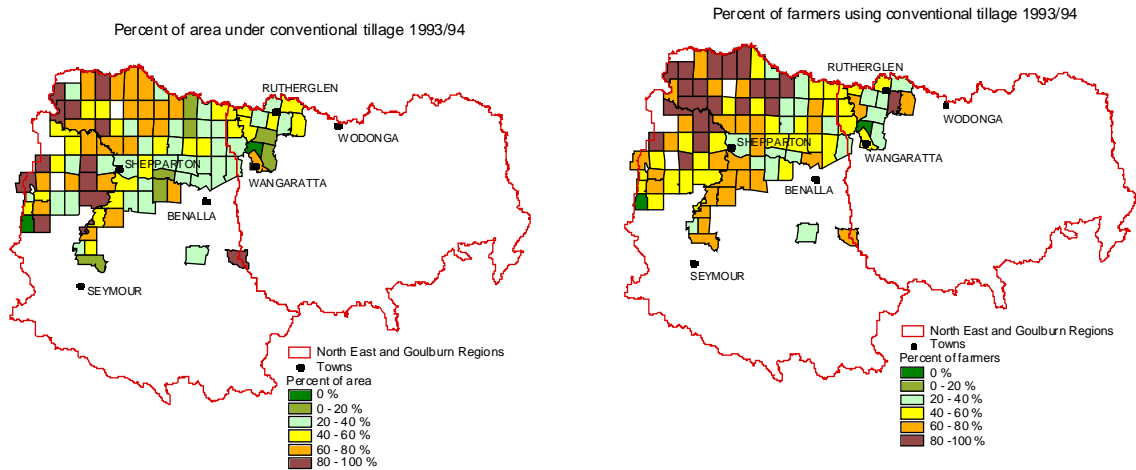
It must also be assumed there is a major difference between self described adoption measures and actual practices.

These results demonstrate the distinct trends in adoption of direct drilling over the past two decades. It appears the 1980s saw a dramatic swing away from conventional tillage and minimum tillage in north-east Victoria, with a strong rise in adoption rates of direct drilling. In the 1990s there has been a slowing of adoption rates, with few new adopters. However, the University of Melbourne study suggests adopters of direct drilling have shown increasing commitment to direct drilling as greater areas of crop are put in using this technology.

The results also demonstrate a moderate degree of correlation between the University of Melbourne 1992 results and the ABS figures obtained in the following year. The ABS data finds a smaller area of direct drilling and a larger area of conventionally tilled crops. This suggests that a reasonable degree of confidence can be taken in the ABS data on direct drilling for this region, (with the form of question used in the 1993/94). As in other regions, it is clear the definition of minimum tillage has been ambiguous to north-east farmers. It is hoped that with the reformatting of the question, this ambiguity will be eliminated from the data.

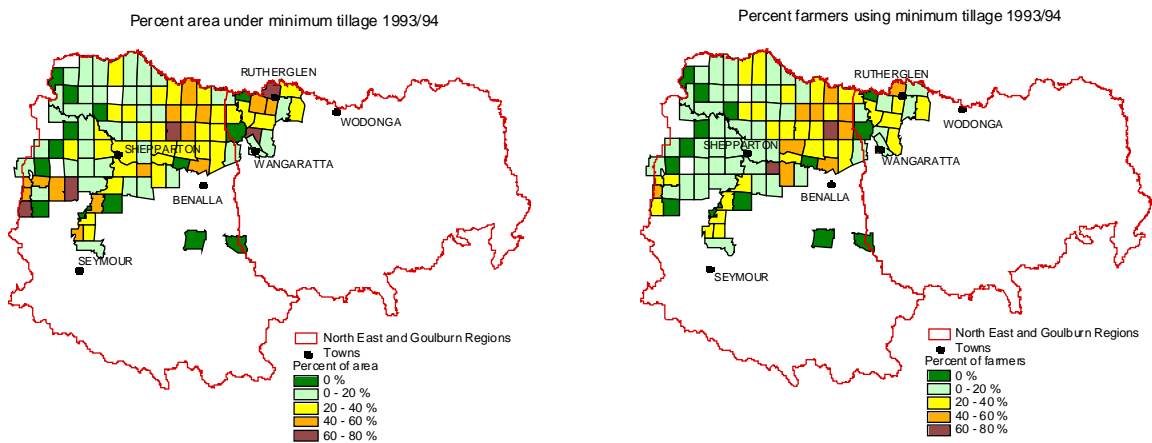
**Table 5** Measures of cultivation practice in the North East Region (1977-94)

	Whitaker 1977	Ballarat College 1984	Uni of Melb 1986	Ballarat College 1989	Uni of Melb 1989	Uni of Melb 1992	Cocks 1993	ABS 1994
Mean cultivations			3.3		2.5	1.7		
Crop area direct drilled (%)						39		30
Crop area minimum tilled (%)						23		25
Crop area conventionally tilled (%)						38		45
Farmers self described direct drill adopters (%)	0				60	61	59	
Farmers used direct drilling in season (%)	0	23		34				20
Farmers used direct drilling on all crops (%)					21	19		



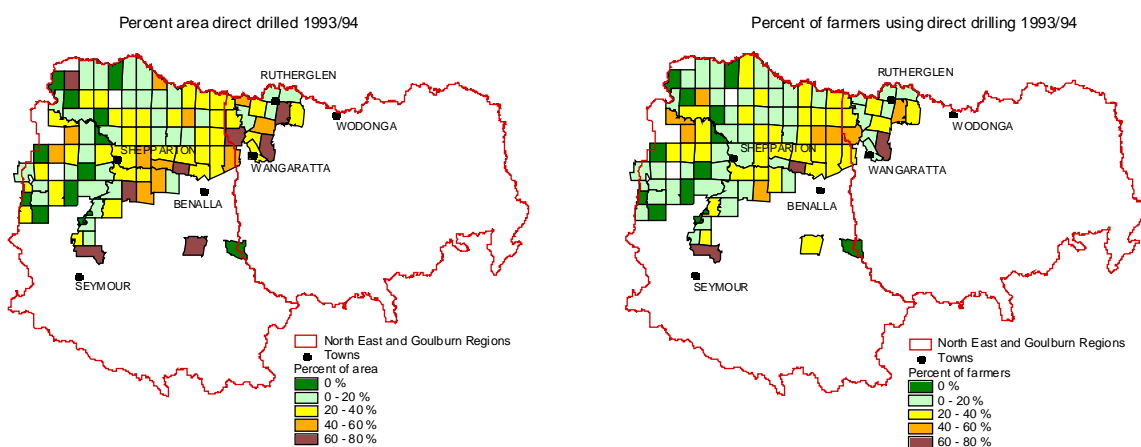
Source: Australian Bureau of Statistics 1993/94

**Figure 6** Adoption of conventional tillage in the North East Region (1993/94)



Source: Australian Bureau of Statistics 1993/94

**Figure 7** Adoption of minimum tillage in the North East Region (1993/94)



Source: Australian Bureau of Statistics 1993/94

**Figure 8** Adoption of direct drilling in the North East Region (1993/94)

### 3.1.8 1994/95 Australian Bureau of Statistics

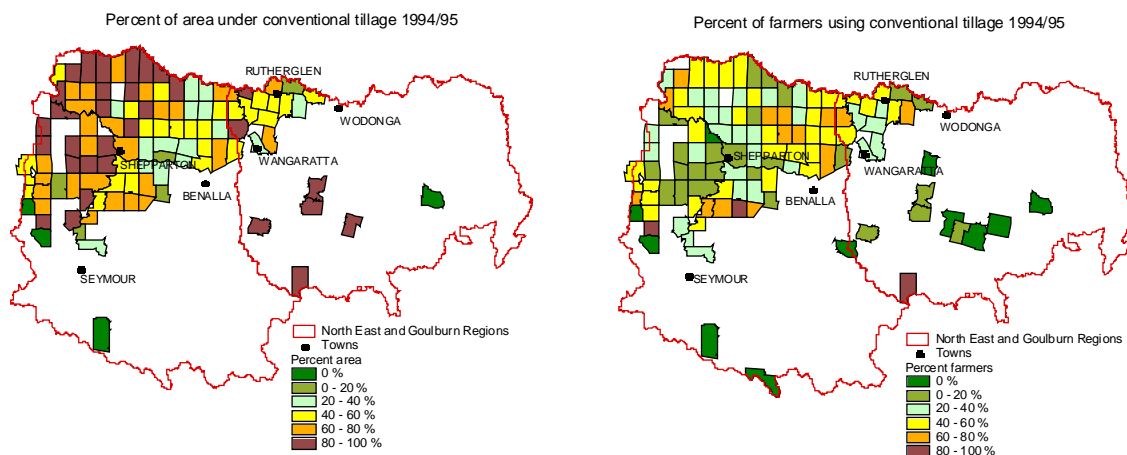
An amended format of the tillage question was included in the 1994/95 farm census (see Appendix 1). This eliminates some of the ambiguity of the term 'minimum tillage' by explicitly referring to the number of cultivations. There may still, however, be some room for differing interpretations of the 'one pass sowing'.

There was a decrease in area of direct drilling and its adoption rates during 1994/95 which could be attributed to wet seasons and farmer concern for controlling weeds and pests. The reported reduction in crop land sown with minimum tillage and the increase in conventional tillage cannot be directly compared with 1993/94 measures due to the differences in the questions (Table 6). Geographical distribution of adoption levels in the 1994/95 season was similar to the patterns shown in 1993/94 (Figures 9, 10 & 11).

**Table 6** Cultivation techniques used by north east cropping farmers (1994/95)

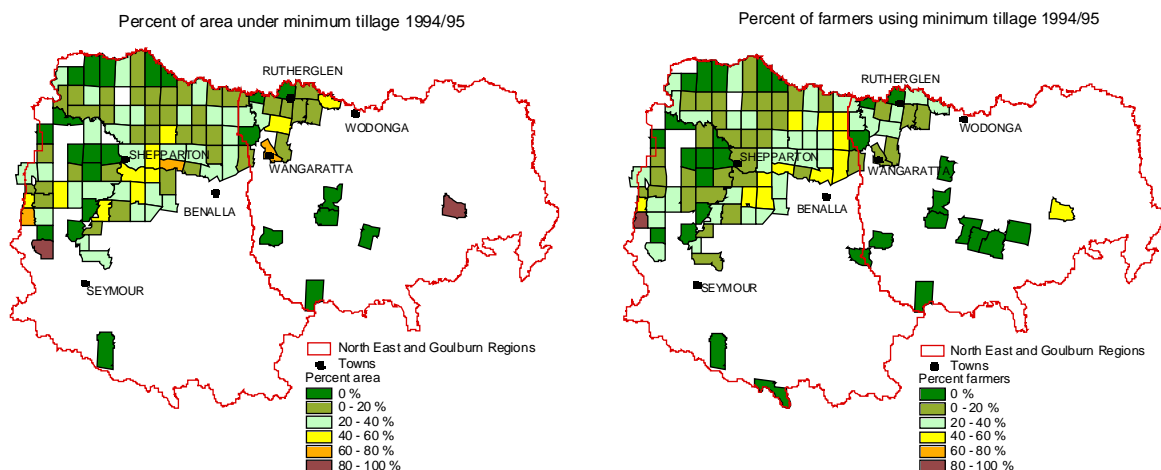
	Direct drilling	Minimum tillage	Conventional
% area	25	22	53
% farms	11	15	31

Source: Australian Bureau of Statistics (1994/95)



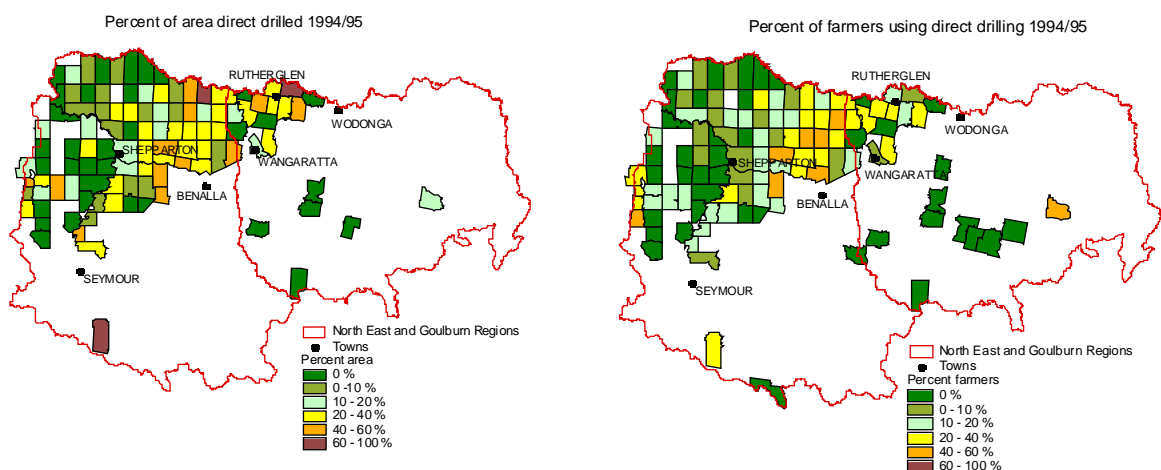
Source: Australian Bureau of Statistics (1994/95)

**Figure 9** Adoption of conventional tillage in the North East Region (1994/95)



Source: Australian Bureau of Statistics (1994/95)

**Figure 10** Adoption of minimum tillage in the North East Region (1994/95)



Source: Australian Bureau of Statistics (1994/95)

**Figure 11** Adoption of direct drilling in the North East Region (1994/95)

### 3.1.9 1995/96 Australian Bureau of Statistics

In 1995/96 the ABS repeated the 1994/95 format of the tillage question. There was a slight variation to the definition of limited cultivation. The number of cultivations used to measure the minimum tillage was changed from one in the 1994/95 question to one or two cultivations in 1995/96 (see Appendix 1). This restricts the possibility of direct comparisons for conservation cropping and minimum tillage measures between the two years. The percentage of crop land sown with direct drilling has increased by 1 percent during this year while the percentage of farmers direct drilling their crops remained unchanged (Table 7). The spatial distribution of adoption levels in each parish for 1995/96 season is shown in Figures 12, 13 & 14).

### 3.1.10 1996/97 Australian Bureau of Statistics

In 1996/97 the ABS repeated the 1995/96 form of the tillage question to overcome the definitional problems of the questions in the previous years. This allows a direct comparison of these two sets of data. In contrast to the previous year, both the percentage of farmers direct drilling crops and the percentage of direct drilled area have declined during this year. The

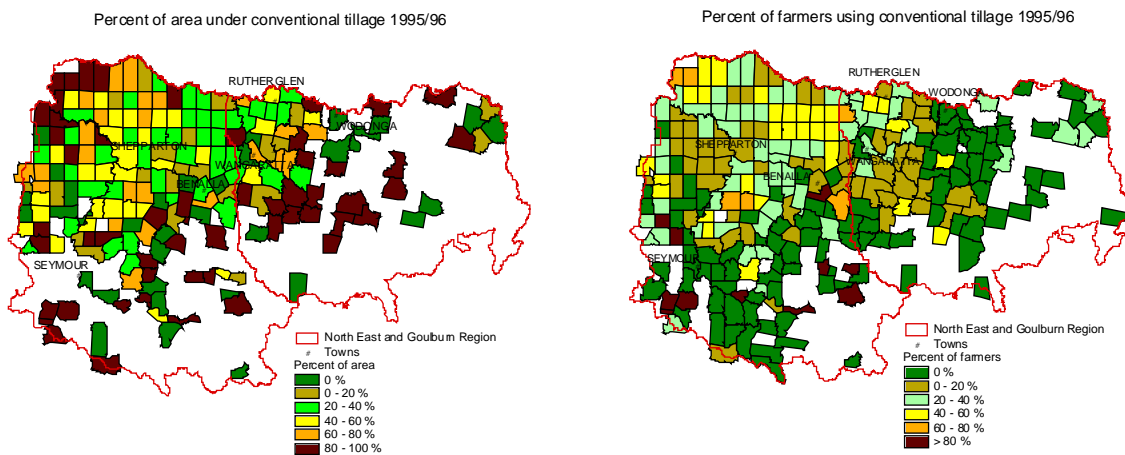
percentage of crop area cultivated more than twice increased marginally while there was a significant increase in the trend towards the adoption of minimum tillage (Table 7).

Figures 15 and 16 show the trends in adoption of different tillage methods on crop land in the north east region from 1993/94 to 1996/97. Both the percentage of crop area direct drilled and the percentage of farmers direct drilling their crops decreased by 10 percent between 1994 and 1997. The impact of wording changes in the definition of 'limited cultivation' should be taken into consideration when interpreting these trends for conventional and limited cultivation. The variations in conventional and limited cultivation measures in 1994/95 is likely a result of this change in the definition. However, there is a trend towards minimum cultivation by north-east cropping farmers.

**Table 7** Cultivation techniques used by farmers in the North East Region (1993/94-1996/97)

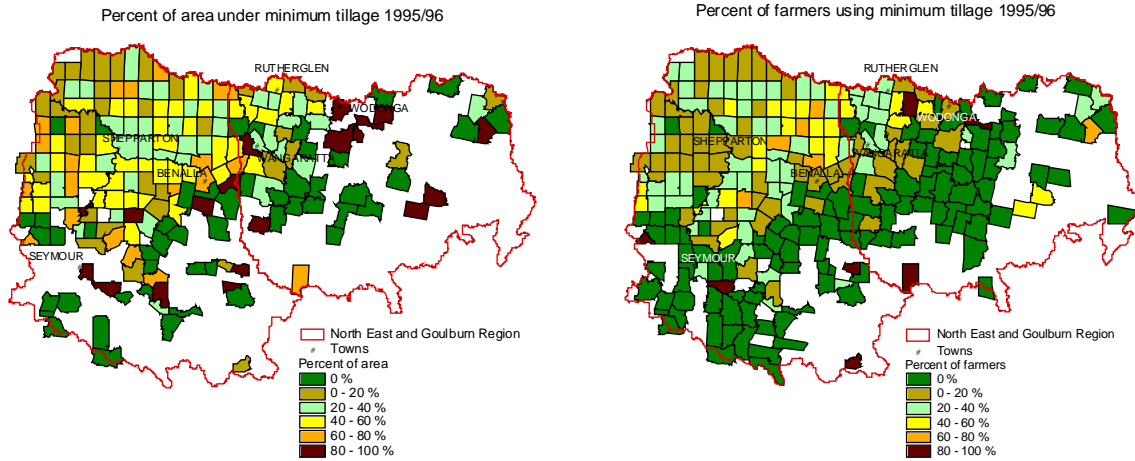
Year	Conventional tillage		Minimum tillage		Direct drilling	
	% farmers	% area	% farmers	% area	% farmers	% area
1993/94	58.8	45.1	20.1	24.6	20.0	30.3
1994/95	31.0	53.3	14.8	22.3	10.8	24.4
1995/96	23.0	38.4	21.0	35.9	11.1	25.7
1996/97	22.3	39.5	22.5	39.7	9.2	20.8

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



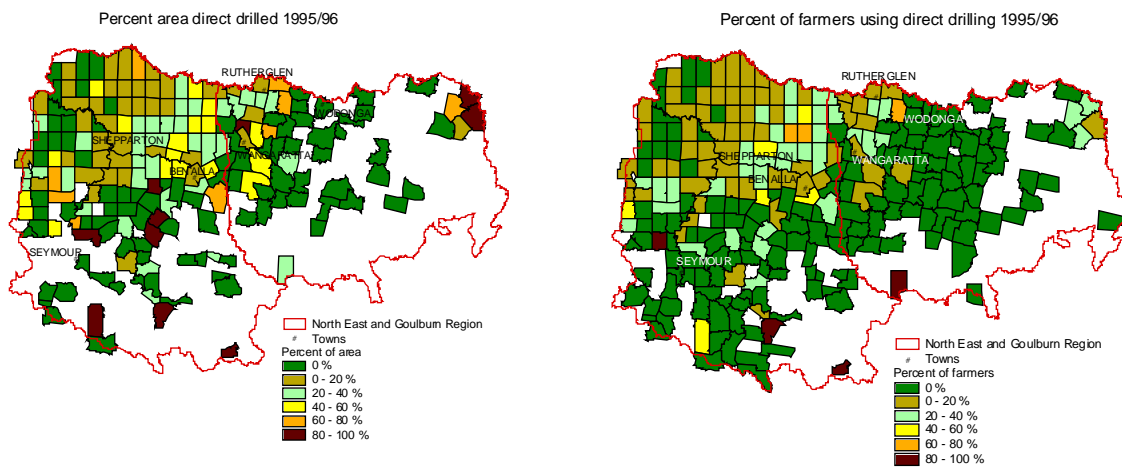
Source: Australian Bureau of Statistics (1995/96)

**Figure 12** Adoption of conventional tillage in the North East Region (1995/96)



Source: Australian Bureau of Statistics (1995/96)

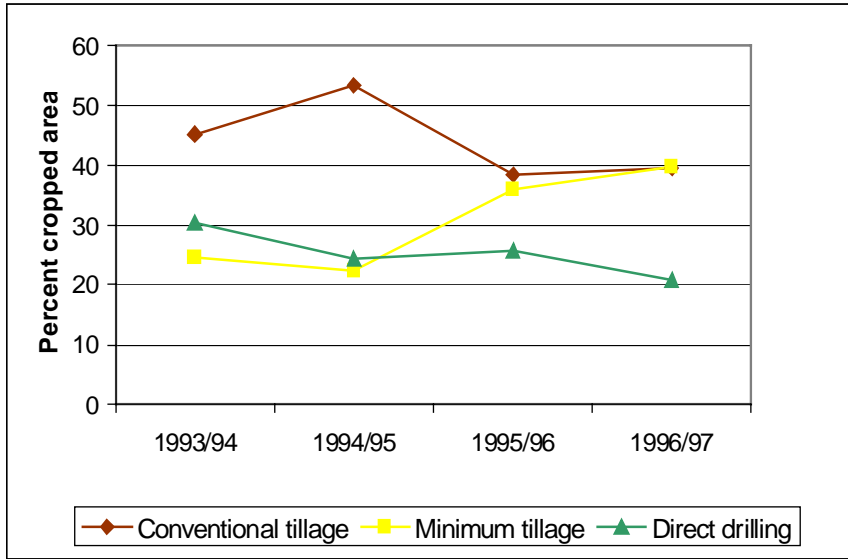
**Figure 13** Adoption of minimum tillage in the North East Region (1995/96)



Source: Australian Bureau of Statistics (1995/96)

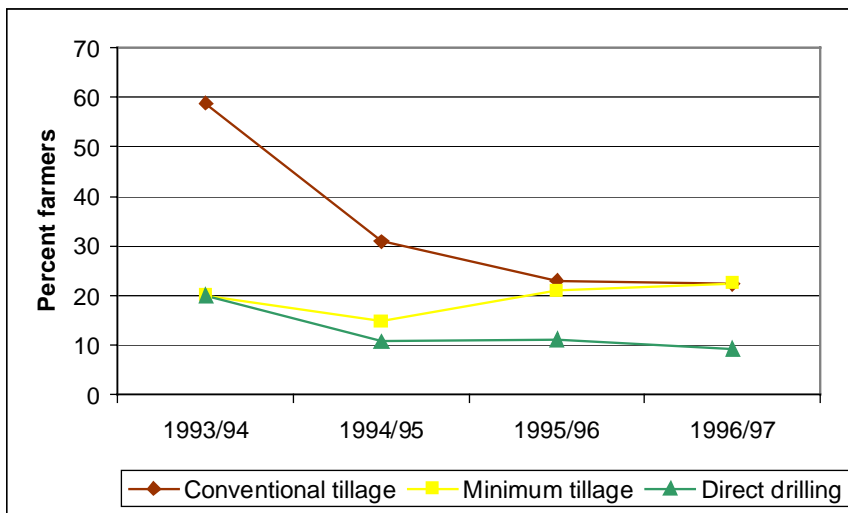
**Figure 14** Adoption of direct drilling in the North East Region (1995/96)





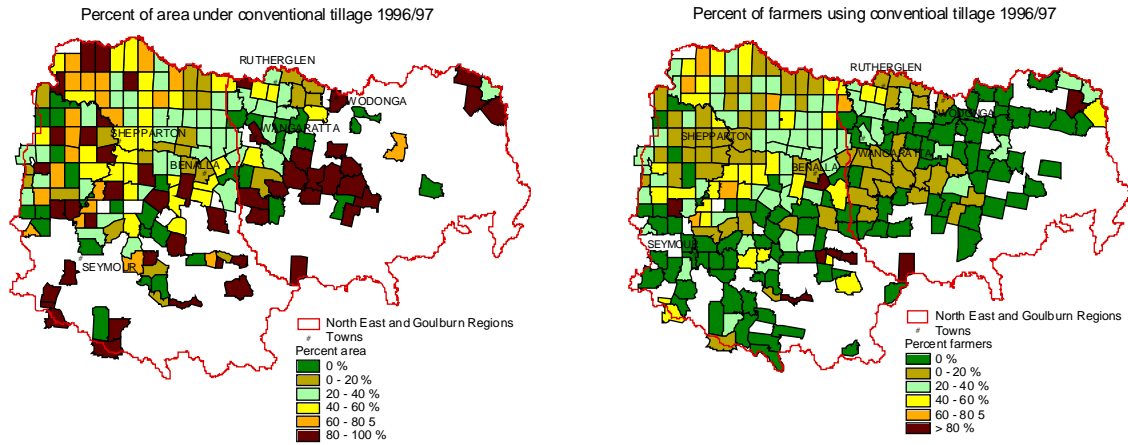
Source: Australian Bureau of Statistics (1994/95-1996/97)

**Figure 15** Cultivation techniques used by farmers (percent area) in the North East Region (1993/94-1996/97)



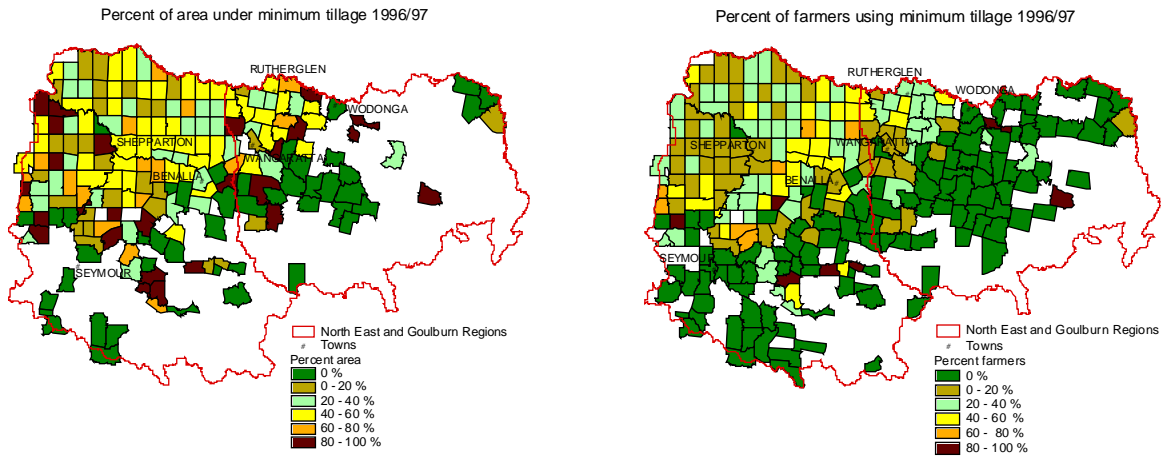
Source: Australian Bureau of Statistics (1994/95-1996/97)

**Figure 16** Cultivation techniques used by farmers (percent farmers) in the North East Region (1993/94-1996/97)



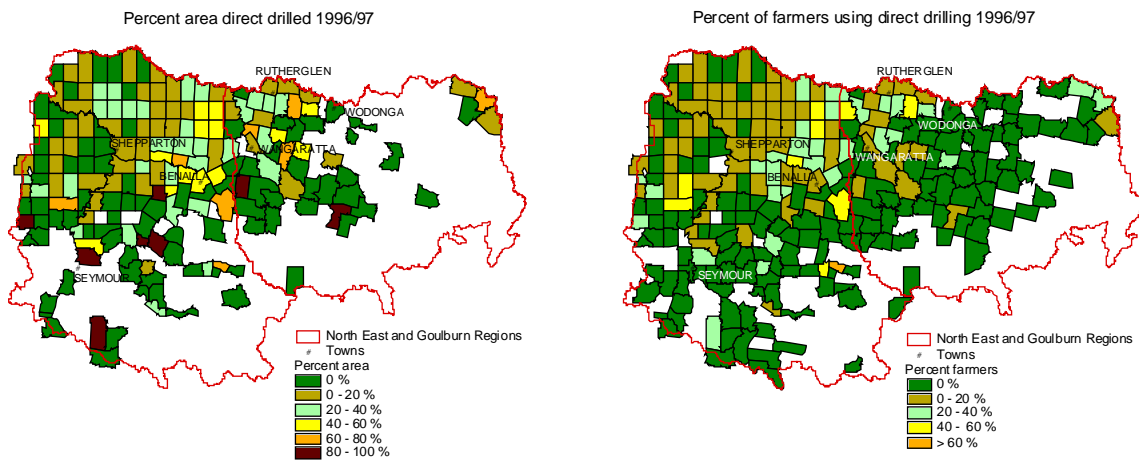
Source: Australian Bureau of Statistics (1996/97)

**Figure 17** Adoption of conventional tillage in the North East Region (1996/97)



Source: Australian Bureau of Statistics (1996/97)

**Figure 18** Adoption of minimum tillage in the North East Region (1996/97)



Source: Australian Bureau of Statistics (1996/97)

**Figure 19** Adoption of direct drilling in the North East Region (1996/97)

### 3.1.11 Barriers to the adoption of direct drilling

The University of Melbourne survey provides information on what farmers see as the barriers to the adoption of direct drilling in the North East Region. The perceived advantages of direct drilling, in order of importance were:

- Saves fuel and money-73 percent ( $\pm 4.5$ )
- Improves soil-70 percent ( $\pm 4.5$ )
- Saves time-66 percent ( $\pm 4.6$ )
- Better trafficability-37 percent ( $\pm 4.4$ )
- Conserves moisture-17 percent ( $\pm 3.7$ )
- Increases yield-8 percent ( $\pm 2.2$ )

Perceived advantages in time, fuel, improved soil and trafficability are the most influential in the decision of farmers as to whether to use minimal cultivation or direct drilling. Farmers using conventional tillage methods are least likely to agree with these advantages. Beliefs about benefits for the soil are not related to the extent of adoption of direct drilling or minimum tillage.

The perceived major disadvantages of direct drilling were:

- Increased chemical use-38 percent ( $\pm 4.5$ )
- Poor emergence-27 percent ( $\pm 4.5$ )
- Need proper machinery-26 percent ( $\pm 4.5$ )
- Poor seed bed/unsuitable soil-22 percent ( $\pm 3.6$ )
- Lower yields-13 percent (3.4)

Concern over chemical use does not differ between those who do or do not use direct drilling. The best predictor of non-adoption of direct drilling is concern over emergence and soil crusting.

## 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 tendency to use fallow as a management tool, and changes in the relative balance between cropping and grazing in mixed farms. There are three measures of fallow which 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 fallowing practice, and changes in the balance between crops and grazing on mixed farms. This measure best indicates the potential impact of fallow on watertable recharge 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 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 the 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 further complicated by the differing lengths of fallow. Traditionally, long fallow is land which is cultivated prior to the harvest season. This land is out of crop production for a season. Land which 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.

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

The Ballarat College survey in 1984 reported that 50 percent of their sample cultivated their land as soon as possible after harvest, where as 50 percent of the land not cropped in the previous season was under long fallow (Harvey *et al.* 1985).

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

The second Ballarat College survey in 1989 recorded a large drop in the utilisation of fallow. Only 21 percent of the farmers reported cultivating as soon as possible after harvest (Harvey *et al.* 1990).

### 3.2.3 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'. This question is possibly ambiguous. Clearly farmers will have interpreted the question as including long fallow by the use of the word 'spelled'. However, there is a possibility of some farmers including short fallow and others not including it.

According to the ABS data, fallow was utilised by 25 percent of farmers. A fallow management measure for 1992/93 was constructed using the results of the 1991/92 and 1992/93 censuses, and the single year crop/fallow percentage constructed using single year data for 1991/92 season. Both gave a similar result. Both these measures scored 17 percent for the region (Table 8). Highest use of fallow was in areas with less cropping intensities (Figure 20). It should be noted that only the parishes with more than 5 percent cropping intensity was considered when computing these measures. This finding is consistent with the University of Melbourne study which found that conservation cropping was most likely to be adopted by specialist croppers.

### 3.2.4 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 the time of commencement of fallow as 'before Christmas' and classified fallow according to whether it was mechanical, chemical or pasture topping.

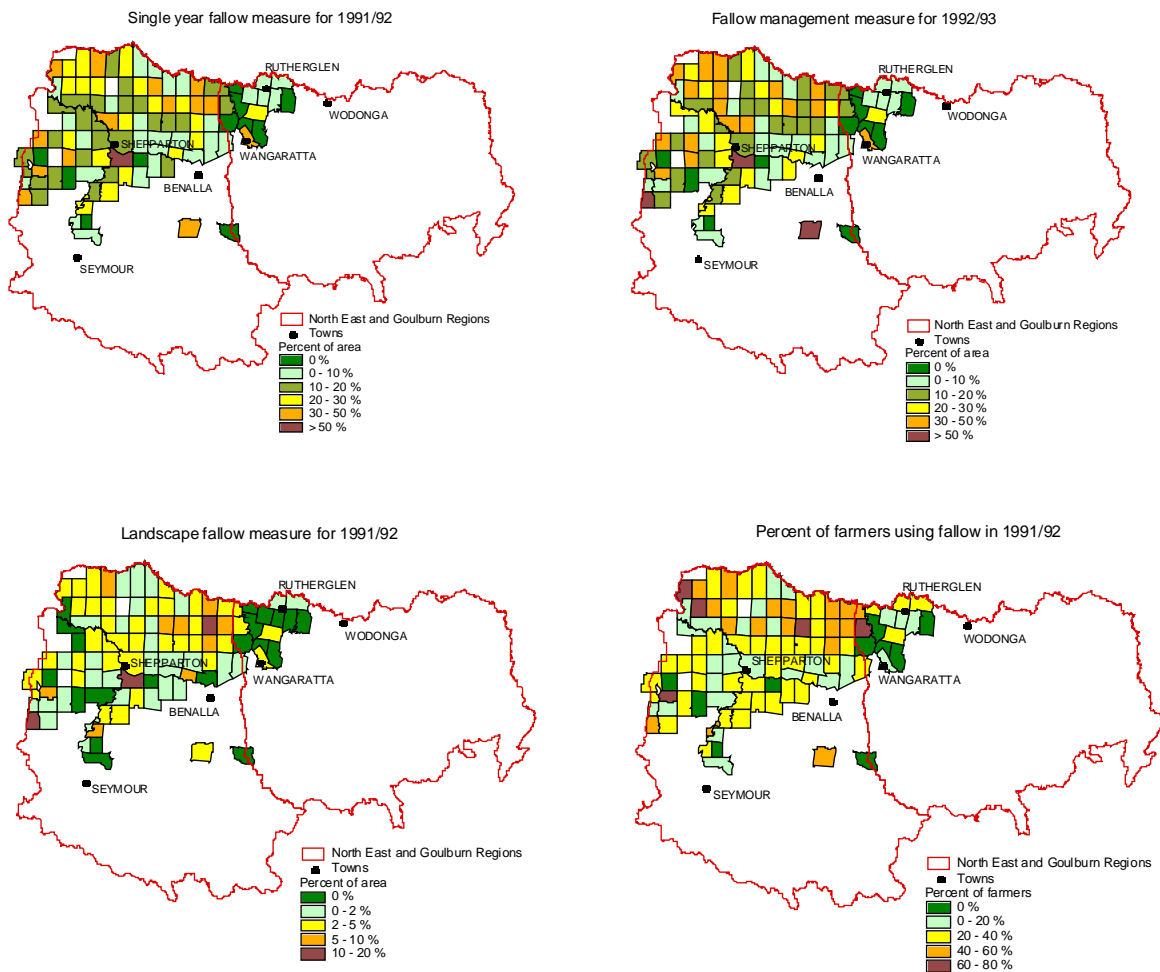
The results show that the use of fallow has reduced by more than half during the three years from 1992 to 1995 (Table 8). This measured change, in practice, may be in part caused by changes in question format. The area under cultivation fallow is about ten times larger than the

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 the 1994/95 season is shown in Figure 21.

**Table 8** Measures of fallow usage in the North East Region (1992-1995)

Fallow measures	ABS (1991/92 )	ABS (1994/95)
Fallow adoption rate	25	8.6
Single year fallow (%)	17	5.8
Management fallow (%)	17	5.6
Landscape fallow (%)	1.4	0.4

Source: Australian Bureau of Statistics (1991/92, 1994/95)



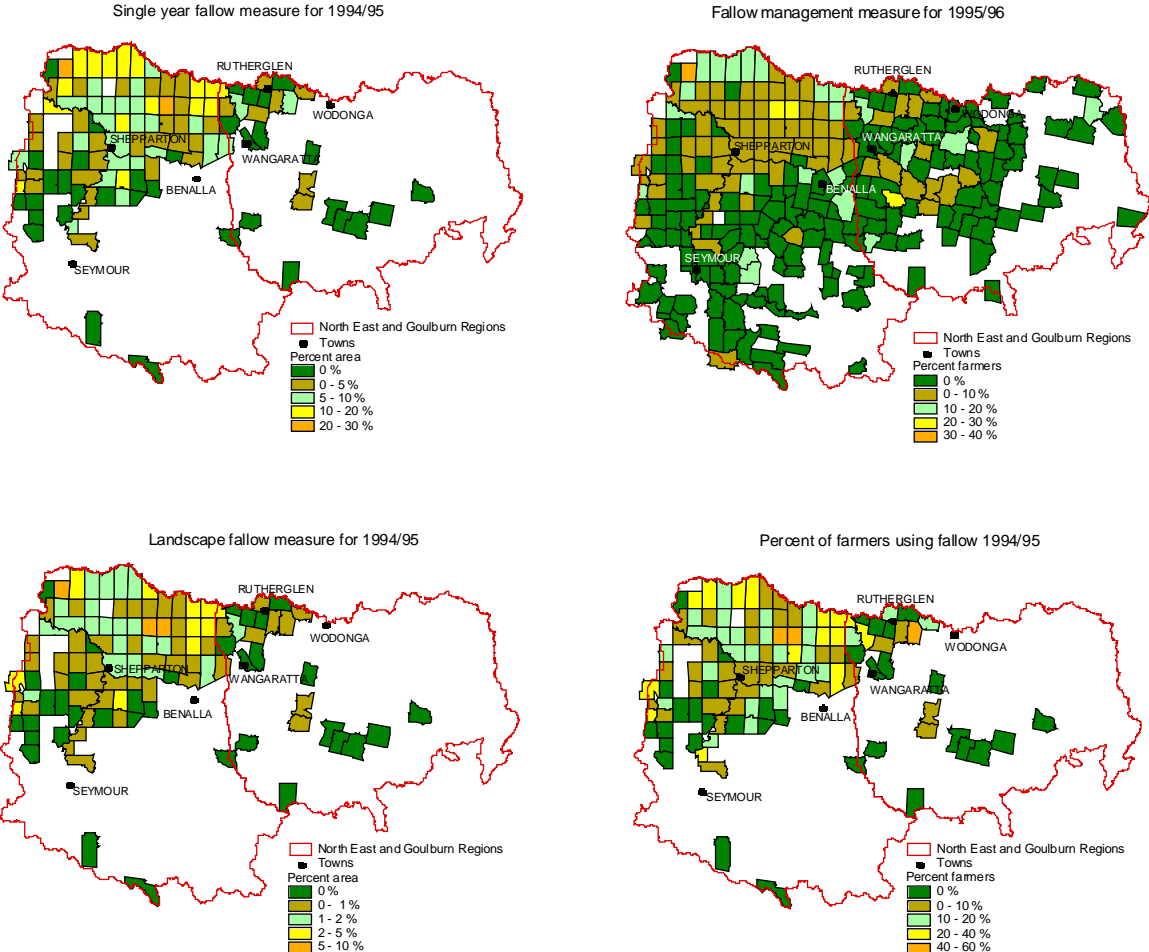
Source: Australian Bureau of Statistics (1991/92-1992/93)

**Figure 20** Fallow management measures for the North East Region (1991/92)

### 3.2.5 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 commencement of fallow cut off date as 31 December rather than as Christmas. This should make little difference to the data. Reasonable comparison should still be possible between this and the preceding year's data. The area fallowed almost doubled during that period, with 11 percent of the crop area being fallowed by 13 percent of the cropping

farmers. There was no significant variation between the single year fallow and fallow management measure, with 12 percent of the crops in 1996/97 sown into land fallowed in the 1995/96 season (Table 9). There is also a trend away from cultivation fallow toward more use of chemical fallow. The area under chemical fallow and the farmers adopting chemical fallow increased by about six and four times respectively, while the area under cultivated fallow only doubled during this year (Figures 22 and 23). The spatial variation in fallow adoption is shown in Figure 24.



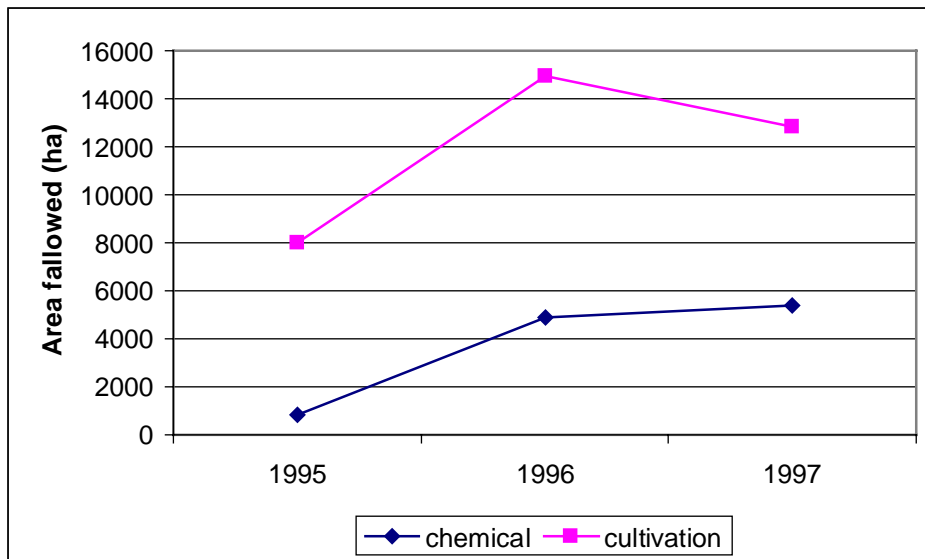
Source: Australian Bureau of Statistics (1994/95-1995/96)

**Figure 21** Fallow management measures for the North East Region (1994/95)

**Table 9** Measures of fallow usage in the North East Region (1995/96-1996/97)

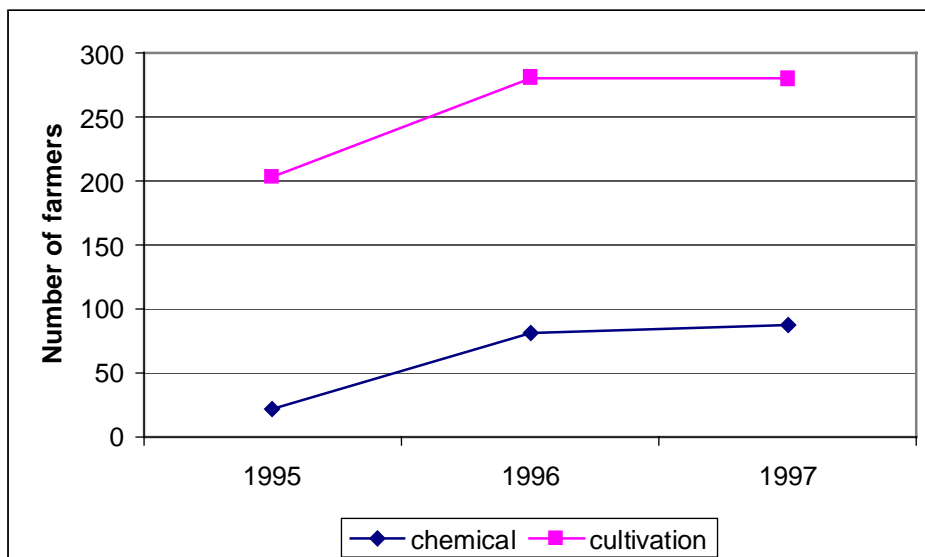
Census year	Fallow adoption rate (%)	Single year fallow (%)	Fallow management (%)	Landscape fallow (%)
1995/96	12.8	10.9	11.9	1.0
1996/97	13.2	9.6		0.9

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



Source: Australian Bureau of Statistics (1994/95-1996/97)

**Figure 22** Area under cultivation and chemical fallow in the North East Region (1995-1997)

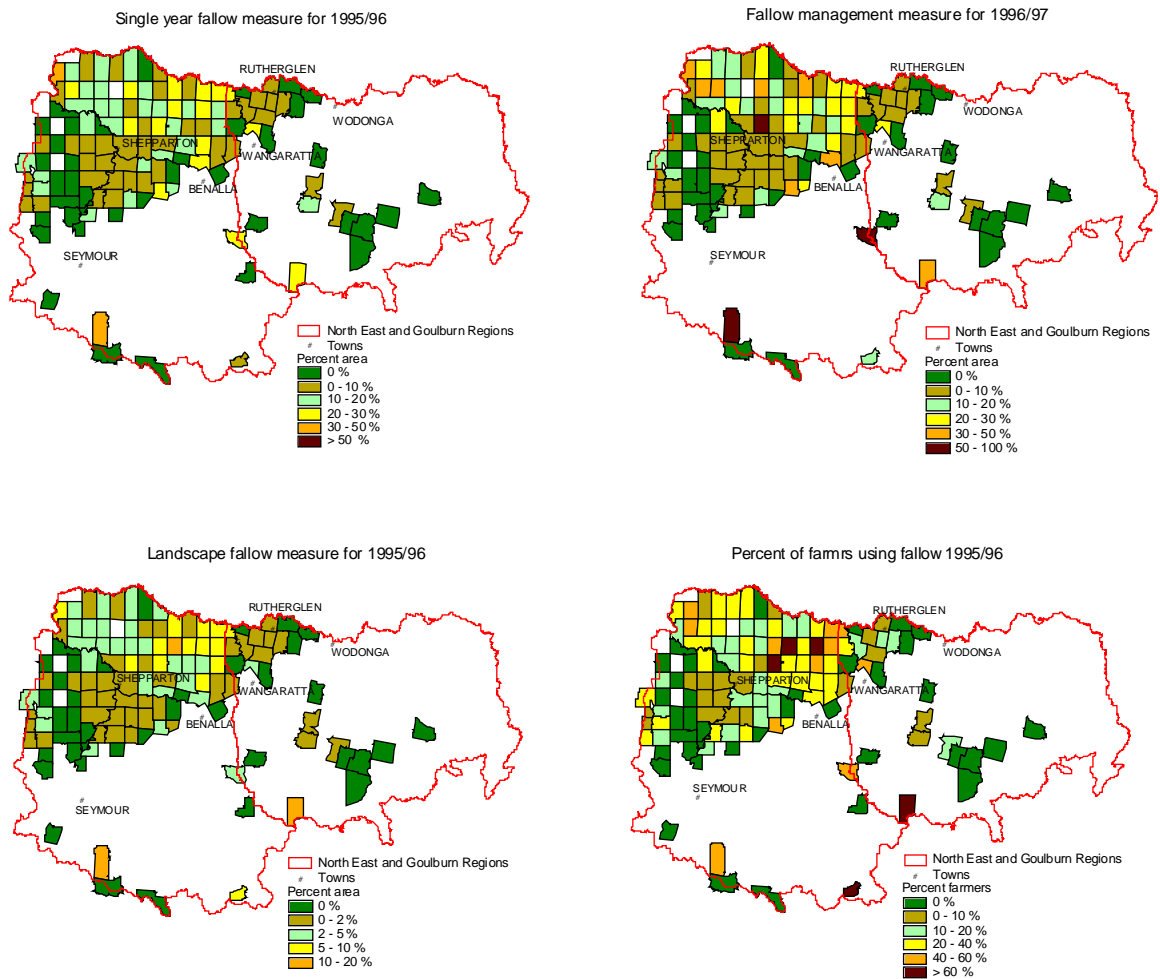


Source: Australian Bureau of Statistics (1994/95-1996/97)

**Figure 23** Number of farmers using cultivation and chemical fallow in the North East Region (1995-1997)

### 3.2.6 1996/97 Australian Bureau of Statistics

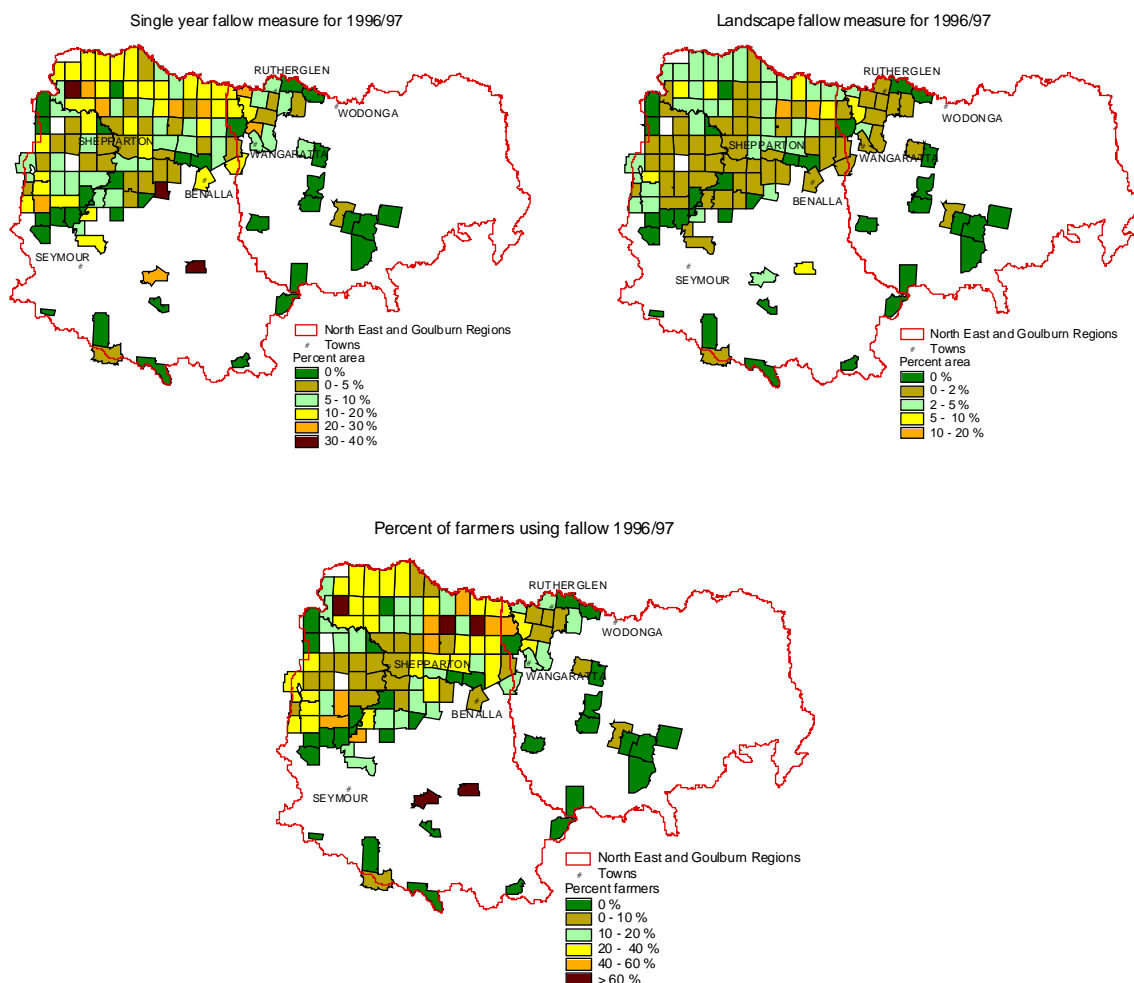
The 1995/96 format of the fallow question was repeated again in the 1996/97 farm census. The overall use of the fallow remained unchanged during this season, fallow being used by 13 percent of the cropping farmers on 10 percent of their crop land. However, the difference between area under cultivated fallow and chemical fallow has further reduced, with an increase in both the area and the farmers using chemicals on fallow, and a decrease in the use of cultivation fallow compared to the previous year (Figures 22 and 23). Spatial distribution of the adoption of fallow is shown in Figure 25.



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

**Figure 24** Fallow management measures for the North East Region (1995/96)





Source: Australian Bureau of Statistics (1996/97)

**Figure 25** Fallow management measures for the North East Region (1996/97)

### 3.3 Stubble management

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 as used by Harvey *et al.* (1985 & 1990). However, University of Melbourne explored this complexity in the development of their 1992 survey schedule. This survey collected detailed data on stubble treatment of individual paddocks.

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

The first available data on stubble handling are in the 1985 Ballarat College study (Harvey *et al.* 1985). Burning was used by over 90 percent of farmers, and grazing by over 70 percent. Only 10 percent left any stubble standing. Note these are adoption measures, not area measures.

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

The 1989 Ballarat College survey (Harvey *et al.* 1990) clearly indicates a reduction in the use of stubble burning and a move towards retaining and/or incorporating stubble between 1984 to 1989. The number of farmers burning stubble fell by 26 percent and the number of farmers retaining stubble on at least part of their property rose to one-third of farmers surveyed (Table 10). Farmers also showed a positive attitude to increasing the rate of adoption of stubble retention in the future. The most common combinations of different stubble management practices identified are shown in Table 11.

**Table 10** Adoption of stubble management methods in the North East Region (percent of respondents)

Treatment	1989	Change from 1984
Grazed	69	-4
Burned	71	-26
Baled	14	+9
Fallowed	3	0
Left or ploughed in	34	+24
Prickled chained	9	*
Other	17	

Source: Harvey and Hurley (1990)

\*Data for 1984 were not available

**Table 11** Adoption of most common combinations of stubble management in the North East Region (percent of respondents)

Treatment	1989	Change from 1984
At least some left or ploughed in	35	+24
Grazed and burned	35	-30
Grazed not burned	9	+9
Burned not grazed	18	-4
Other	3	

Source: Harvey and Hurley (1990)

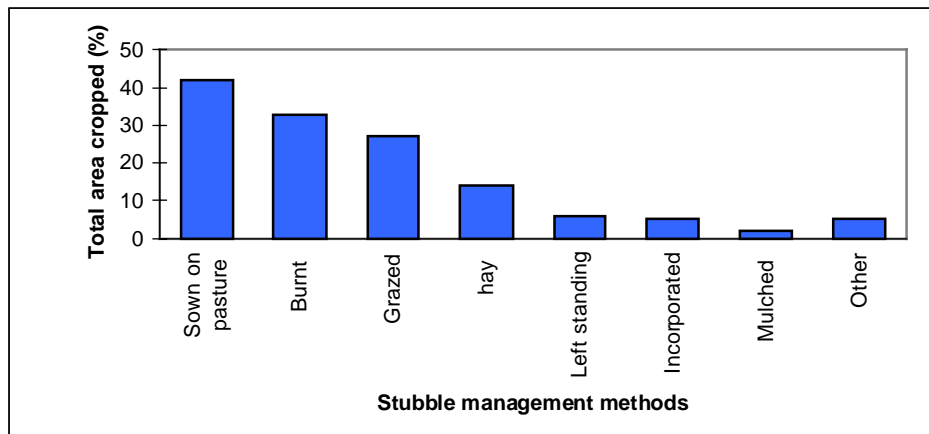
### 3.3.3 Monitoring SoilCare in north-east Victoria (Cary, Wilkinson & Ewers 1989)

In the University of Melbourne study (Cary, Wilkinson & Ewers 1989) the most predominant stubble management methods were burning and grazing. Stubble retention (defined as mulching, leaving standing or incorporating) was adopted by 21 percent of croppers.

### 3.3.4 Monitoring SoilCare in north east Victoria (Wilkinson & Cary 1993)

The first reliable measure of stubble retention is the 1992 University of Melbourne study (Wilkinson & Cary 1993). This highlighted how low the adoption of stubble retention really was in this region. The most common method of stubble retention was to crop only for a single year and then return to pasture (12 percent). Sixty-seven percent of farmers burnt all their stubble. Only 2 percent of farmers retained stubble in all paddocks. The same story is repeated in the areal measures. Fifty-seven percent of cropped stubbles were burnt. Eleven percent were left standing, 9 percent incorporated and 4 percent mulched. Stubble from grain legumes were retained more often than stubble from cereal crops where 10 percent of cereal paddocks were

sown into stubble, and 39 percent of grain legume paddocks were sown into stubble. This is similar to the trend in the Warracknabeal Shire where retention of grain legume stubble was more popular than retention of stubble from cereal crops (Karunaratne, Barr & Wilkinson 2001). More farmers cut stubble for hay or straw in 1992 than in 1989 (5 percent and 40 percent respectively) which could be seen as a step on the path to stubble retention.



Data source: Wilkinson and Cary (1993)

**Figure 26** Stubble management methods used in the North East Region in 1992

### 3.3.5 1994/95 Australian Bureau of Statistics

In 1994/95 the Australian Bureau of Statistics included a stubble retention question. This asked farmers to report the area of crop land on which the different crop stubble techniques were used. The format of this question is given in Appendix 3.

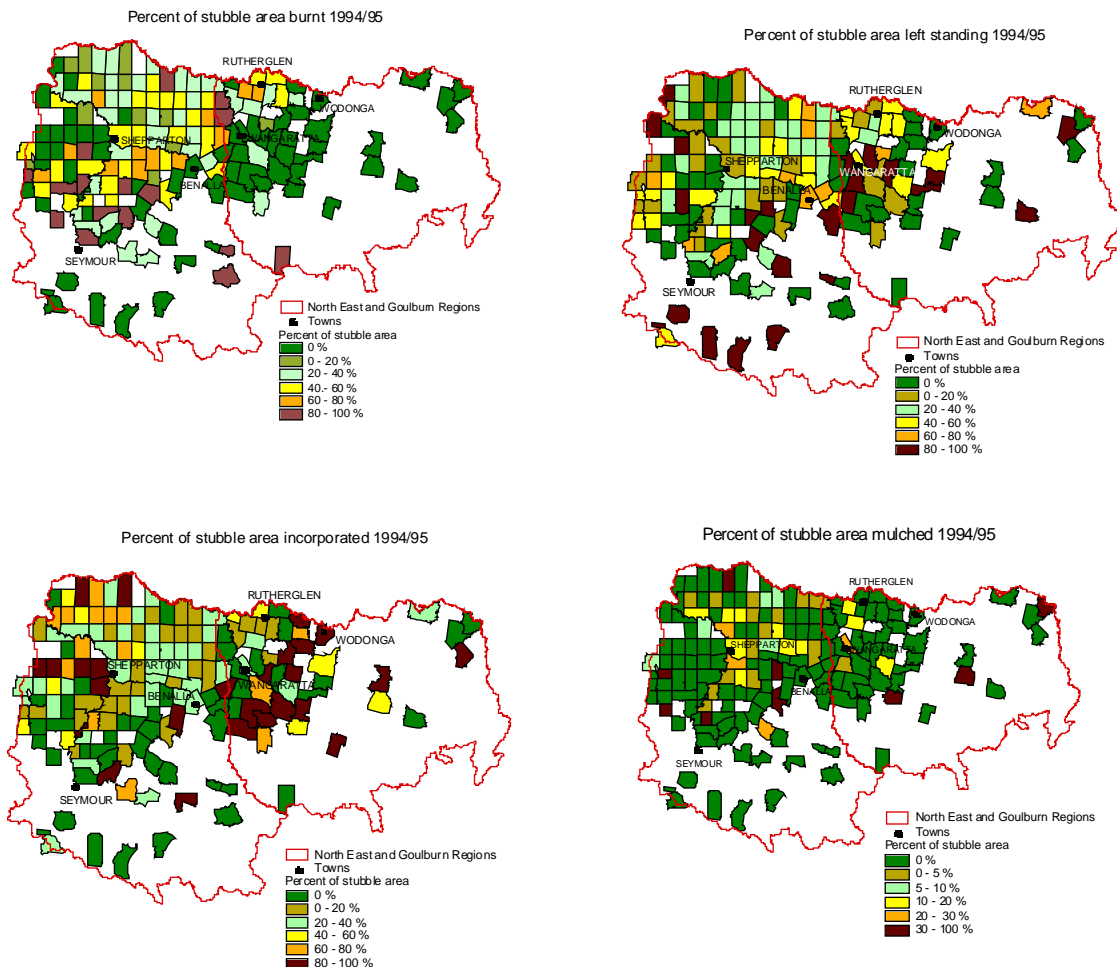
This question did not provide information on the number of cropping farmers answering the question. The maximum response rate to this question, (when the total multiple response to all stubble management techniques were added up) was only 36 percent. This means the actual response rate to the question is even lower than 36 percent and the resulting estimate of adoption rates are significantly lower than the true rate of adoption. For these measures, adoption rates have been increased by a pro rata factor to ensure that the total reported adoption rate for all stubble management practices equals 100 percent (Table 12).

Stubble burning was still widely used in the region, with 37 percent of the region's stubble being burnt by 36 percent of the farmers reporting stubble management. This was more common in the northern parts of the Goulburn and North East Regions (Figure 27). Stubble retention and incorporation was also widely used by cropping farmers in the region. Thirty-four percent of the stubble in the region was left standing while another 25 percent was incorporated into the soil (Table 12). This was more prevalent in areas with low cropping intensities (Figure 27).

**Table 12** Adoption of stubble management in the North East Region in 1994/95

	Burn		Incorporated		Mulched		Left standing	
	% area	% farmers	% area	% farmers	% area	% farmers	% area	% farmers
ABS measure	37	13	25	11	4	2	34	10
Using pro rata factor	37	36	25	31	4	5	34	28

Source: Australian Bureau of Statistics (1994/95)



Source: Australian Bureau of Statistics (1994/95)

**Figure 27** Stubble management methods used by farmers in the North East Region (1994/95)

### 3.3.6 1995/96 Australian Bureau of Statistics

In the following year the Australian Bureau of Statistics 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 years 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. It is evident that some farmers have considered both crop and pasture stubbles when responding to the stubble management question in 1994/95. There may be some difficulties in making comparisons with data from the previous year. This is explored in the accompanying report on the Wimmera Region (Karunaratne, Barr & Wilkinson 2001).

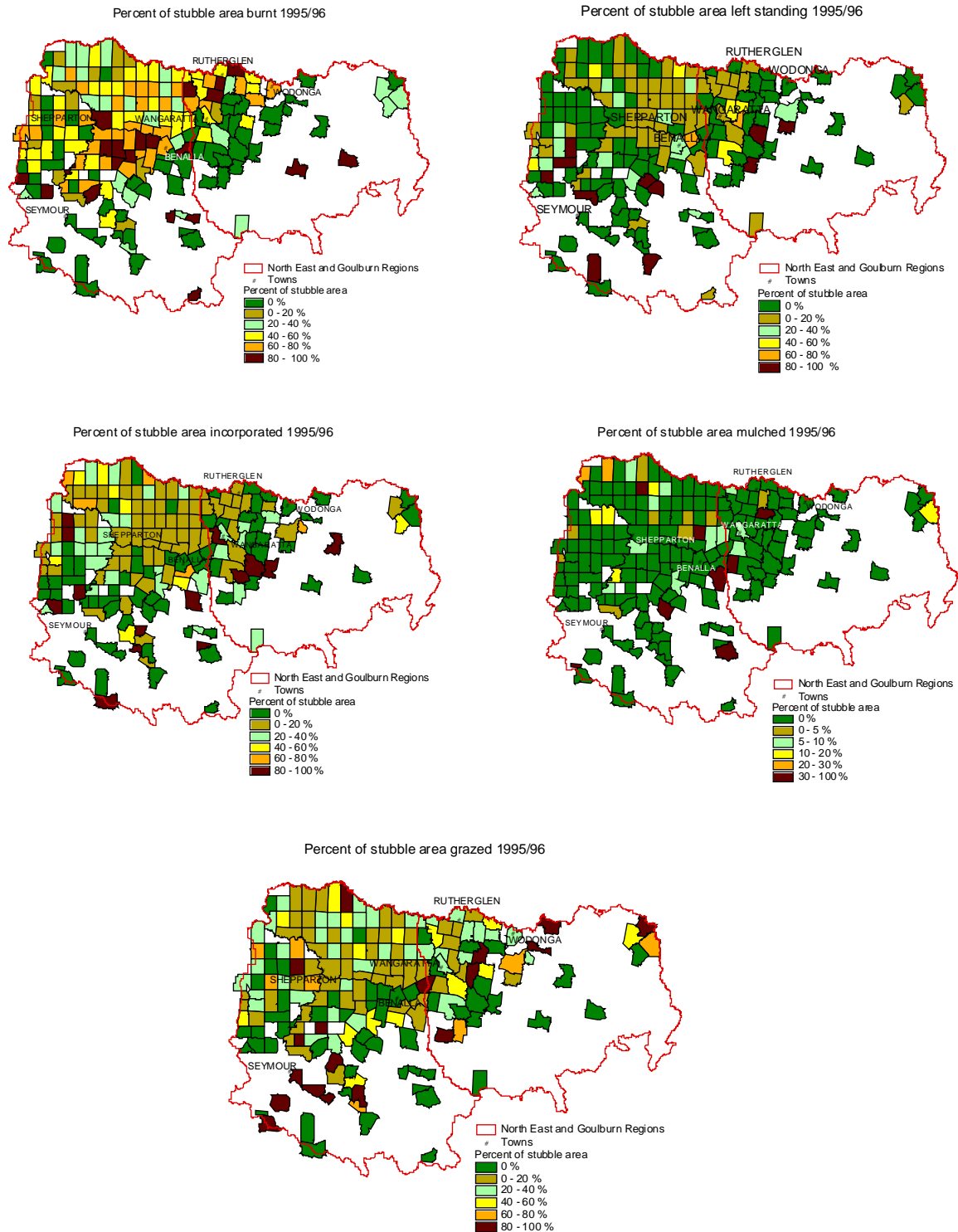
Measures for all methods of stubble management changed significantly during this year. Incorporation, retention and mulching of stubble were significantly reduced, while heavy grazing or baling of stubble was used as the main stubble management technique by 20 percent of the cropping farmers on one tenth 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. However, stubble burning had significantly increased and was still the most popular method of stubble handling; half the stubble area was burnt by 16 percent of the farmers (Table 13). This was mainly evident in the area between Shepparton and Benalla and to the north of the region around Rutherglen. Grazing was more popular in the southern part of the cropping area (Figure 28).

**Table 13** Adoption of stubble management in the North East Region (1995-1997)

	Burn		Incorporated		Mulched		Left standing		Grazing/baling	
	% area	% farmers	% area	% farmers	% area	% farmers	% area	% farmers	% area	% farmers
1994/95	37.0	13.2	24.8	11.2	4.4	2.1	34.0	10.1		
1995/96	50.9	16.3	13.0	8.3	2.8	1.4	13.2	5.0	20.0	10.7
1996/97	63.4	21.7	7.6	6.0	2.0	1.2	9.5	4.1	17.5	9.9

Source: Australian Bureau of Statistics (1995-1997)



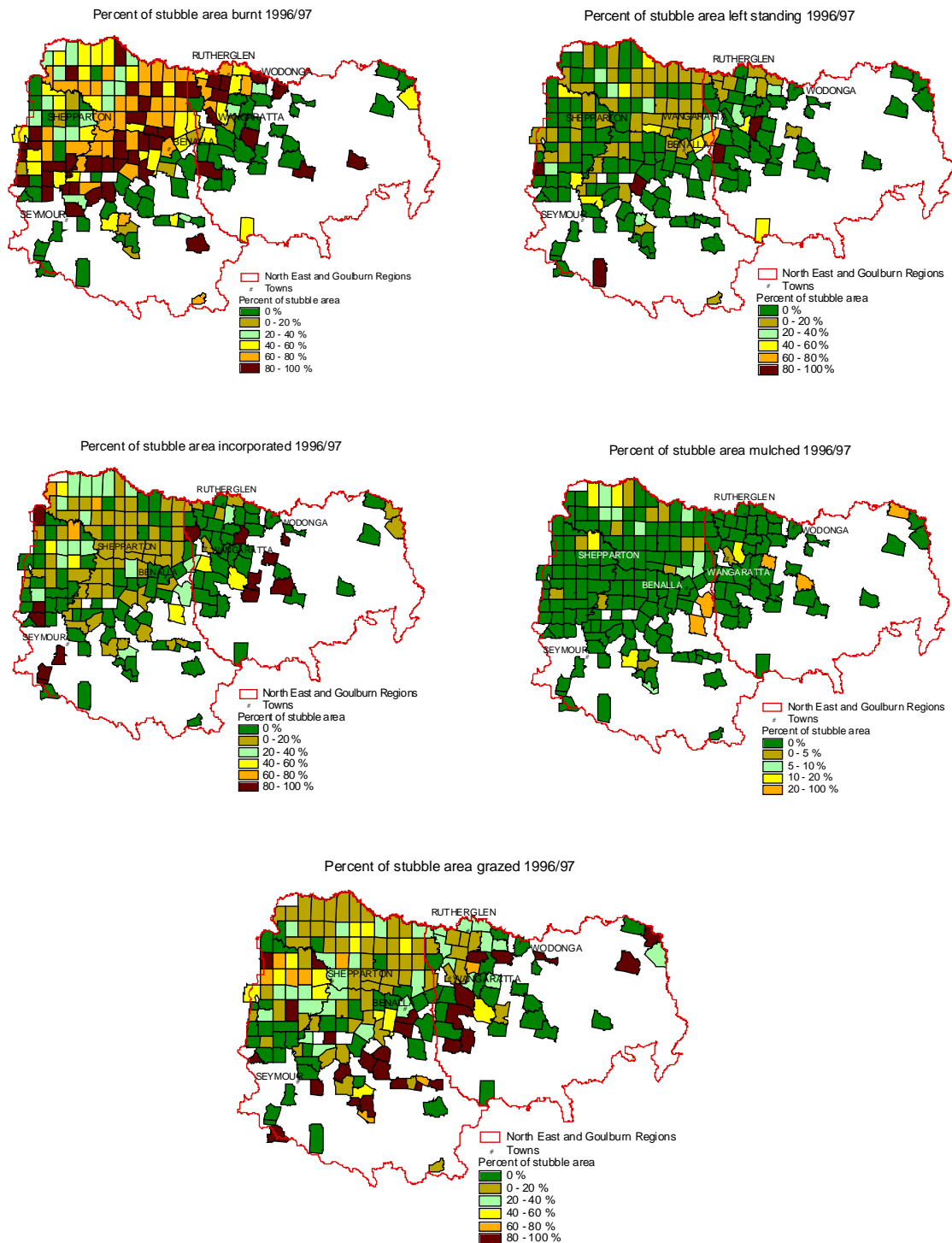
Source: Australian Bureau of Statistics (1995/96)

**Figure 28** Stubble management methods used by farmers in the North East Region (1995/96)

### 3.3.7 1996/97 Australian Bureau of Statistics

In the following year the Australian Bureau of Statistics asked the same stubble retention question. This survey indicated a trend towards the increased use of stubble burning. Stubble burning was utilised by 22 percent of the farmers on 63 percent of their stubble area. The use of all other techniques decreased during this year (Table 13). Mulching was still the least favoured

method of stubble management in the region. Spatial distribution of adoption of these practices is shown in Figure 29.



Source: Australian Bureau of Statistics (1996/97)

**Figure 29** Stubble management methods used by farmers in the North East 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 nature 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 analysed.

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. Analysis of this data is reported in the accompanying report on Adoption of pasture management practices in North East Region (Karunaratne & Barr 2001).

### 3.5 Use of soil ameliorants

#### 3.5.1 1987/88 to 1993/94 Australian Bureau of Statistics

There has been limited use of questions on soil ameliorants in the ABS census:

- 1987/88: Area and weight of gypsum, lime and dolomite applied
- 1990/91 to 1993/94: Total weight of soil ameliorants applied (i.e. combined weight for gypsum, lime and dolomite)

#### 3.5.2 1994/95 Australian Bureau of Statistics



In 1994/95 ABS census asked the farmers to report the weight of lime applied to pastures and crops. The format of this question is shown in Appendix 4.

The results show that a total of 31 825 tonnes of lime was applied to crops and pastures during the year 1994/95 by 930 farmers in the North East Region, with an average of 34 tonnes per farm. Higher lime usage is shown in northern half of the north-east and central part of Goulburn catchment running from Benalla to Seymour (Figure 30). Most of these parishes have strong or extremely acidic soils.

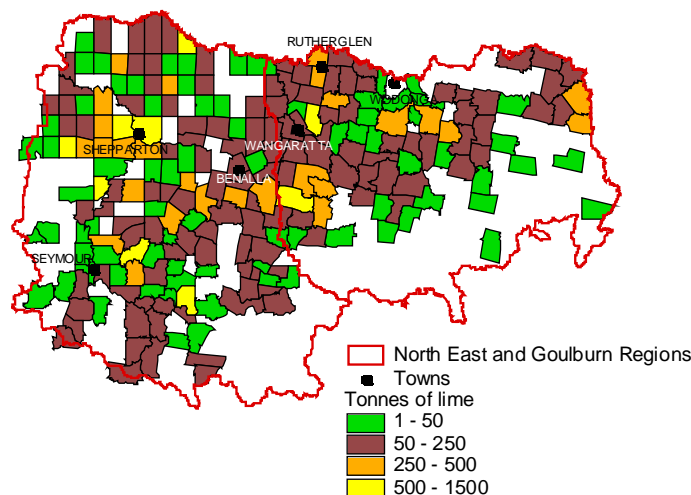
### 3.5.3 1995/96 Australian Bureau of Statistics

The 1995/96 ABS census asked the farmers to report the area and weight of gypsum, lime and dolomite applied to pastures and crops (Appendix 4). There was not much change in lime application in 1995/96. A total of 30 317 tonnes of lime was applied to crops and pastures by 773 farmers, with an average of 40 tonnes per farm. An average of 31 hectares per farm was treated with lime at a rate of 1270 kg per hectare (Table 14). Three hundred and seventy-seven farmers applied a total of 16 000 tonnes of gypsum on 8849 ha of crops and pastures as a remedial measure for physical soil problems.

**Table 14** Measure of soil conditioner application on crops and pastures in the North East Region (1995/96)

Measure	Lime	Dolomite (for acidity)	Dolomite (physical problems)	Gypsum (physical problems)
Area treated (ha)	23 822	2077	823	8849
Number of farmers using soil conditioner	773	75	30	367
Total Weight applied (tonne)	30 317	2593	921	15 753
Percent farm area treated	1.2	0.10	0.04	0.44
Percent farmers using soil conditioner	9.7	0.94	0.38	4.61
Average area treated per farm (ha)	30.8	27.7	27.4	24.1
Rate of application (tonnes/farm)	39.2	34.6	30.7	42.9
Rate of application (tonnes/ha)	1.27	1.25	1.12	1.78

Source: Australian Bureau of Statistics (1995/96)



Source: Australian Bureau of Statistics (1994/95)

**Figure 30** Total weight of lime applied to pastures and crops in the North East Region (1994/95)

### 3.5.4 Monitoring SoilCare in north-east Victoria (Cary, Wilkinson & Ewers 1989; Wilkinson & Cary 1993)

The Wilkinson and Cary (1993) study provides some basic data on lime application. It shows no change in the adoption of liming between 1989 and 1992. Only 22 percent of farmers applied lime on pasture or crops in 1992.

## 3.6 Use of herbicides

### 3.6.1 Ballarat College surveys (Harvey *et al.* 1985 & 1990)

Herbicides are an important component of conservation cropping practices, therefore it is important to determine farmer attitudes towards, and the use of, herbicides on cropping land.

The Harvey *et al.* (1985, 1990) studies show clearly the quick uptake of chemical control of weeds in the 1980s. By 1989 all grain growers surveyed in this study had used herbicides on their crops at some stage (Harvey *et al.* 1990) (Table 15). The number of farmers using herbicides and the area of knockdown herbicides applied significantly increased within the five year period (Table 16).

The late 1980s showed a change in attitude towards chemical use. Better weed control was the predominant reason for using herbicides, but soil conservation was increasingly cited as an additional justification for chemical use. Longer grazing periods and less wear on equipment were also seen as advantages of using herbicides by an increased number of farmers in the region (Table 17).

**Table 15** Use of herbicides by farmers in the North East Region (1984-89)

	1989 (percent farmers)	Change from 1984
Use at some stage	100	+3
Never used		-3

Source: Harvey *et al.* (1990)

**Table 16** 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	79	+63	77	+51
Pre-emergent	32	-21	40	+10
Post-emergent	65	-1	77	+33
Spray topping	41		49	

Source: Harvey *et al.* (1990)

**Table 17** North-east farmers' beliefs about the advantages of using herbicides (1984-89)

Advantages	Percent of farmers	
	1989	Change from 1984
Better weed control	76	-5
Less fuel	37	-12
Less time	24	-3
Allows longer grazing	16	+5
Less equipment needed	5	+2
Less wear on equipment	24	+5
Permits flexibility	32	0
Less damage to soil	68	+21

Source: Harvey *et al.* (1990)

Cost was still the most frequently nominated disadvantage of using herbicides in 1989. However, the health risk factor in using herbicides and the unpleasantness of working with them became a prominent concern for farmers throughout the 1980s (Table 18).

There was little change in attitudes to chemicals in the 1990s. The University of Melbourne study did not show a significant change in farmers' attitudes to chemical weed control and weed control using cultivation during the three year period of the study. In both years they showed a slightly more favourable attitude to cultivation (as a method of weed control) than to chemical methods.

**Table 18** North-east farmers' perceptions of the disadvantages of using herbicides (1984-89)

Disadvantage	Percent of farmers	
	1989	change from 1984
Residual build up in soil	55	+7
Health risk	68	+17
Less grazing	42	-18
Lack of information	8	+3
Cost	87	+6
Unpleasant to work with	21	+10

Source Harvey *et al.* (1990)

**4 RECOMMENDATIONS**

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

The 1994/95 format of the tillage question provides valid data to estimate the adoption of tillage practices. This question, however, does not provide information necessary to calculate response rate to the question. Hence, a minor amendment to the question is recommended to overcome this problem. Asking the farmers to report the total area prepared for cropping 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: 30px; 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 the occurrences 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**

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 1994/95 ABS census provides reliable information to estimate the adoption of fallow management in the region and can be used in future to estimate the measure of fallow management used in this report.

The 1995/96 ABS question on soil conditioner usage will provide useful information to monitor the application of soil conditioners to crops and pastures in the region.

## 5 REFERENCES AND DATA SOURCES

- Australian Bureau of Statistics (1992-1997) Parish aggregated farm census data supplied to Agriculture Victoria
- Barr, N.F. & Cary, J.W. (1992) *Greening a Brown Land*, Macmillan, Australia.
- Cary, J.W., Wilkinson, R.L. & Ewers, C.R. (1989) *Caring for the Soil on Cropping Lands*, School of Agriculture and Forestry, The University of Melbourne.
- Cocks, F. (1993) *A Study into Farmers' Perception of Land Degradation and Soil Conservation*, University of New England, Armidale.
- Ewers, C. (1990) *Innovation in Response to Environmental Degradation*, unpublished Masters thesis, School of Agriculture, University of Melbourne.
- Goulburn Broken Catchment and Land Protection Board (1997), *Goulburn Broken Regional Catchment Strategy*.
- Hamblin, A. (1990) *Sustainability: Physical and Biological Considerations for Australian Environments*, Bureau of Rural Resources working paper wp\WP/19/89
- 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 East Region*, Department of Natural Resources & Environment, Bendigo.
- Karunaratne, K., Barr, N. & Brown, M. (2001) *Community attitudes to environmental issues: statewide and regional overview*, Department of Natural Resources & Environment, Bendigo.
- Karunaratne, K., Barr, N. & Wilkinson, R. (2001) *A Baseline of Adoption of Conservation Cropping Practices in the Wimmera Region* Department of Natural Resources & Environment, Bendigo.
- North East Regional Catchment and Land Protection Board (1997), *North East Regional Catchment Strategy*.
- North East Regional Landcare Plan Working Group (1993) *North East Regional Landcare Plan*
- Office of the Commissioner for the Environment (1991) *Agriculture and Victoria's Environment*, Government of Victoria.
- Rendell McGuckian (1996) *Families, Farming and the Future: Business Performance Indicators for Farming Systems in the Wimmera and Mallee*, Agriculture Victoria, Bendigo.
- Whitaker, R.D. (1977) *Farmer Attitudes to Minimum Tillage in Northern Victoria*, University of Melbourne
- Wilkinson, R.L. & Cary, J.W. (1993) *Monitoring SoilCare in North East Victoria*, School of Agriculture and Forestry, The University of Melbourne.
- 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-left: 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-left: 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>More than two passes using discs, tines, ploughs, .....</p> <p>One or two passes only prior to sowing.....</p> <p>No cultivation (apart from the actual sowing operation).....</p>	<p>Hectares</p> <div style="border: 1px solid black; width: 100px; height: 100px; margin-left: auto;"></div>
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**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**

<b>Disposal of crop stubble during Season 1994/95</b>		
<ul style="list-style-type: none"> <li>• <b>Area of holding on which the following crop stubble techniques were used:</b></li> </ul>		Hectares
<p><b>Note</b></p> <ul style="list-style-type: none"> <li>• Even if stubble was grazed or baled, report disposal methods used to prepare for next planting</li> </ul>	Stubble was burnt.....	<div style="border: 1px solid black; width: 100%; height: 100%;"></div>
	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).....	

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

<b>Disposal of crop and pasture stubbles (trash) prior to sowing between 1 April 1995 and 31 March 1996</b>		
<ul style="list-style-type: none"> <li>• <b>Area of holding on which crop and pasture stubbles were handled by the following methods prior to sowing broadacre crops and pastures</b></li> </ul>		Hectares
<p><b>Note</b></p> <ul style="list-style-type: none"> <li>• Include each area only once.</li> <li>• Where stubbles were lightly grazed, report how the remaining stubble was handled.</li> </ul>	Stubble removed by burning.....	<div style="border: 1px solid black; width: 100%; height: 100%;"></div>
	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).....	

**Appendix 4: ABS lime questions**

**ABS lime question 1994/95**

**Lime used during year ended 31 March 1995**

*Note*

- For mixture of lime with fertilisers or other ingredients, give weight of lime only

Weight of lime applied to pasture and crops.....	Tonnes <input style="width: 100px; height: 20px;" type="text"/>
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**ABS lime question 1995/96**

**Soil conditioner usage between 1 April 1995 and 31 March 1996**

<i>Note</i>		Area	Total weight
<ul style="list-style-type: none"> <li>For mixtures of lime with other products, e.g. fertiliser, give weight of lime only</li> </ul>		Hectares	Tonnes
<i>Include</i>			
<ul style="list-style-type: none"> <li>All soil conditioners applied to pastures, broadacre crops and horticultural crops on the farm by ouu, contractors or others</li> </ul>	Lime used to correct or stabilise soil acidity (including crushed limestone and limesand products).....  Dolomite used to correct or stabilise soil acidity .....  Dolomite used to correct physical soil problems .....  Gypsum used to correct physical soil problems .....		