A BASELINE OF ADOPTION OF CONSERVATION CROPPING - MALLEE REGION

August 2001

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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 Mallee Region of Victoria.

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

- Cultivation: There was a trend towards fewer cultivations during the 1980s. Recent data suggests a trend back to conventional cultivation in the early 1990s as a response to concerns over root disease and pest infestations. Since the 1994/95 season there has been a gradual return to minimum tillage. This trend has not been sufficient to displace conventional tillage as the most common form of crop preparation in the Mallee.

- Fallow: Existing fallow data for the 1980s are inconsistent. Mail surveys show a gradual reduction in fallow usage through the late 1980s. The Mallee transect survey shows a slight trend towards the increased use of long fallow during a similar period. ABS data shows a significant reduction in the use of long fallow during the early 1990s. Usage of fallow remained unchanged in mid 1990s, but there was a strong move away from cultivation to chemical fallow.

- Stubble retention: Transect data shows lower rates of burning and an increased use of stubble retention since the 1980s. More recent data from the ABS shows that ten percent of stubble areas are consistently burnt each season. This is undertaken by a minority of 5-7 percent of farmers. Incorporation is the favoured stubble management method.

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1 THE MALLEE REGION

1.1 Sustainability in the Mallee

The Mallee is a semi-arid area of 4.3 million hectares, almost one-fifth of the area of Victoria. The average annual rainfall varies from about 400 mm/yr in the south to less than 250 mm/yr in the north-west. About 60 percent of the yearly average rainfall is from May to October. Since the 1950s the fallow/wheat/pasture rotation has been the basis of Mallee farming. This system was designed to maximise the storage of the infrequent rainfall of the Mallee, and is premised on the belief that prevention of grass growth during the fallow season would facilitate the storage of rain water in the soil profile. Thus the following year's crop could utilise two seasons' rainfall. The proof of the success of this system lay in the clear yield superiority of crops grown after a fallow. However, the long fallow system of production is now believed responsible for two major threats to the sustainability of Mallee farming: wind erosion and soil salinity.

The typical Mallee farm is a patchwork of dune and flat landforms. The soils of the dunes are sandy, with low fertility and weak structure. They are many times more erosive than the clay soils between the dunes. Just one cultivation will significantly increase the potential for wind erosion in the wrong weather conditions. The flats between the dunes are of two soil types. The normal dune flat is a sandy loam soil. The box flat, so named because of the original tree cover, is a heavier clay soil. The flats have a comparatively low erosion risk.

Ideally, farmers would farm the dunes and the flats differently. The dunes would be cropped to barley or rye with little or no ploughing. The flats produce better wheat and are better able to withstand cultivation. Sometimes the combination of long narrow dunes and flats makes it difficult to farm the dunes and flats by different methods. Soil erosion has been caused by farming the dunes with management strategies which are only appropriate to the flats. Weed control through tillage leaves soils exposed to the wind. Wind erosion is worst during drought, years such as the seasons of 1944/45, 1966/67 and 1982/83. The wind erosion risk may be reduced by minimising tillage and leaving significant stubble cover on fallowed paddocks. Options to minimise tillage include blade ploughs which kill weeds by disturbing roots without disturbing the soil surface, and chemical fallow which kills ground cover, but leaves the dead weeds and stubble to hold the soil in place (Mallee Dryland Community Salinity Working Group 1993; Mallee Regional Catchment Strategy 1997).

Long fallow also contributes to a rising watertable. Fallow agriculture, practised as insurance against low rainfall, accelerated the rise. The long fallow of paddocks helped conserve about 20 percent of winter rainfall, but in wet seasons, most of the winter rainfall percolates down beyond the root zone of wheat and other cereals, recharging the watertable. The Mallee experiences major watertable 'shocks' after particularly wet seasons. The watertable jumps dramatically and then slowly declines until the next wet year. While the wet years of the 1970s reduced soil erosion, they raised the watertable.

The resultant salting affected production on low areas between dunes. More significantly, it contaminated farm dams. The most obvious solution is to reduce the use of fallow in the farming system, particularly on the sandier dunes (Mallee Dryland Community Salinity Working Group 1993). Taken to its fullest extent, this style of farming is called continuous cropping, and is based on the premise that the claimed advantages of fallow rotations are based upon root disease, not water storage. The relative benefits of this system are often underestimated because the lost year of production during the fallow season is not taken into account. Fallow is replaced with grain legume crops which are free of pasture species, thus allowing the farmer to gain the benefits of a crop and a year without root disease hosts. However, the issue of fallow has long been a contentious matter in the Mallee and few farmers in the past have been prepared to abandon it (Mallee Salinity Management Discussion Paper 1992).

Long fallow and cultivation are also seen as contributing to the acceleration of the loss of organic matter and nutrients from Mallee cropping soils. The possible solution to these problems would seem to lie in longer or better quality pasture phases during the cropping rotation.

1.2 Indicator practices

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

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

The first four indicator practices are generally accepted as being most likely to minimise the adverse impacts of cropping activities on the state of the soil resource (Mallee Salinity Management Plan Discussion Paper 1992; Mallee Regional Landcare Plan 1993; Mallee Regional Catchment Strategy 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 final indicator is perception of soil degradation. This is an indicator of awareness rather than resource condition. Awareness of degradation 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).

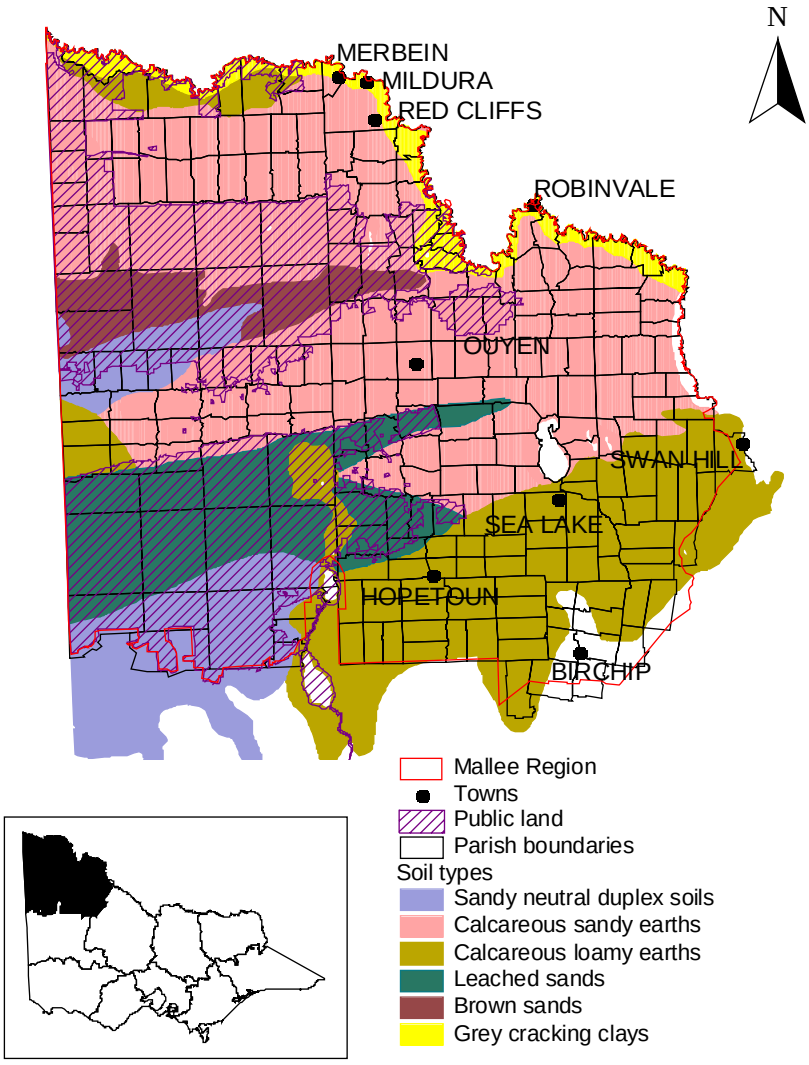
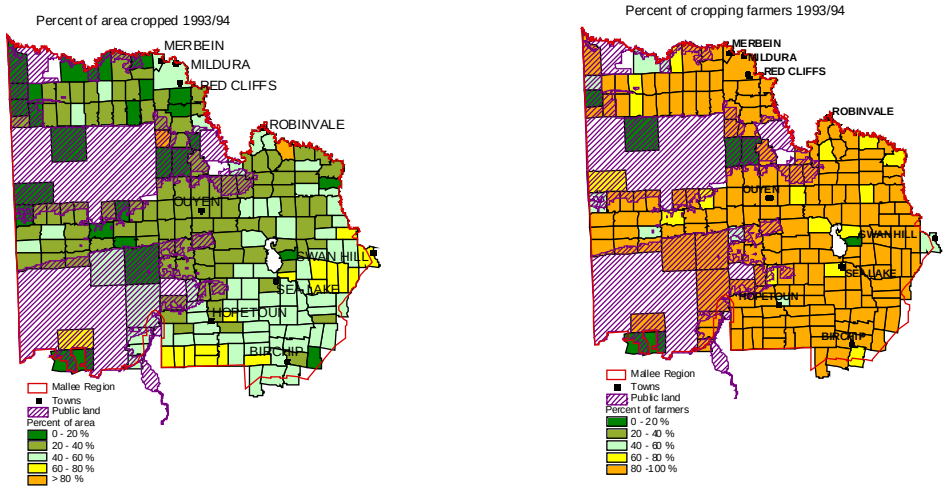
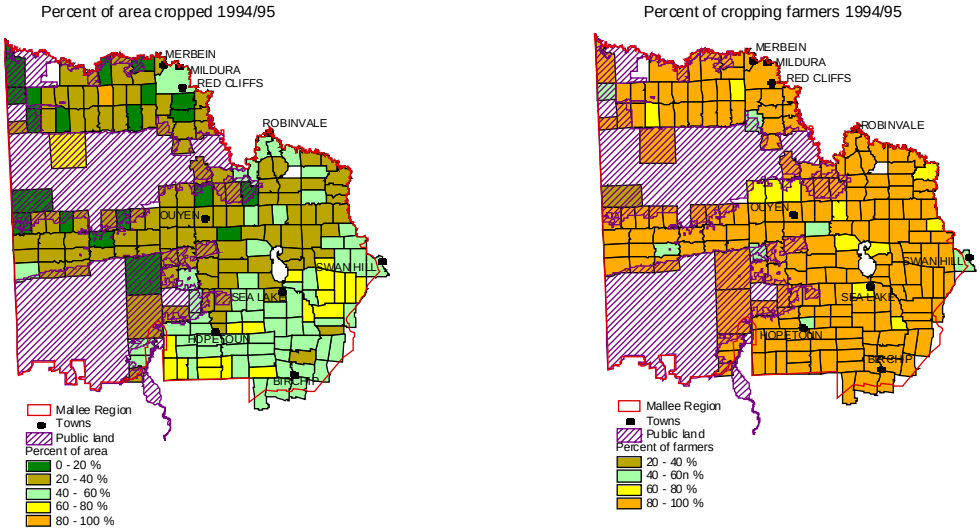


Figure 1 Soil types in the Mallee Region



Source: Australian Bureau of Statistics (1993/94)

Figure 2 Cropping intensity in the Mallee Region (1993/94)



Source: Australian Bureau of Statistics (1994/95)

Figure 3 Cropping intensity in the Mallee Region (1994/95)

2 DATA SOURCES AVAILABLE

2.1 Ballarat College conservation cropping survey (Harvey *et al* 1985, 1990)

The experience of the 1982/83 drought prompted the Soil Conservation Authority to begin a conservation cropping campaign across the wheat-belt, with particular focus on the Mallee. The new approach was to shift away from an emphasis on problem dunes and

towards whole farm management practices to prevent erosion (such as the conservation cropping techniques of stubble retention, chemical fallow and no till seeding). 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 Ballarat College in 1984 in order to investigate the use of cultivation and cropping practices and farmers' perceptions of, and attitudes to, these practices. This survey was repeated in 1989 by sending surveys to 255 respondents from the same sample in order 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; namely north-west, central and north-east.

The sample for the North West Region included respondents from the then shires of Lowan, Mildura, Walpeup and Wycheproof. This study is flawed by the poor response rates achieved. In 1984 only 36 percent of farmers responded to the 668 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 53 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. Findings of these studies related to the reasons for adoption or non-adoption are likely to be more reliable.

2.2 Mallee transect study (1986-89)

The Department of Conservation and Natural Resources conducted a drive-by transect survey of Mallee crop land management and soil erosion in most years since 1978 (Anderson *et al*. 1991). Initially the survey covered only 100 paddocks, but since 1986 the sample size has been 800 paddocks. The study measured use of fallow, stubble management and extent of erosion. Since 1986, the study has been based upon the shires in the land systems of Boigbeat, Central Mallee, Millewa, Tempy and Culgoa. By avoiding the problems of mail surveys, the adoption measure of this survey may be treated with some confidence. Only limited data from this study has been published.

2.3 Australian Bureau of Statistics

The Australian Bureau of Statistics (ABS) farm census is distributed annually to all Australian farming businesses meeting 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, 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. 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.

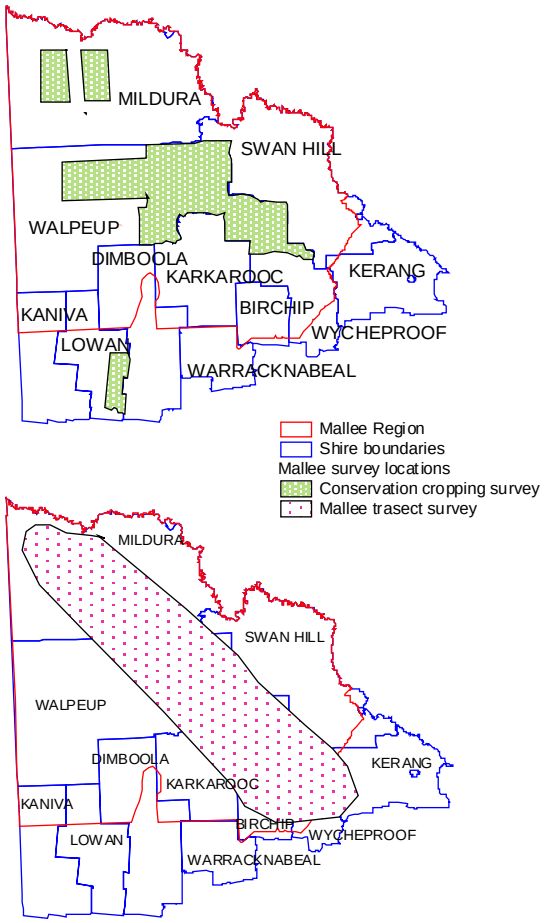


Figure 4 Location of Mallee cropping adoption studies

3 MEASURING CONSERVATION CROPPING PRACTICES

3.1 Cultivation

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

In 1984 the Ballarat College study measured the range of cultivation frequency per cropped paddock in the Mallee as between one and nine, with five as the mode. Given the distribution of cultivation frequencies reported in other studies, it is reasonable to conclude that the mean cultivation frequency would have been approximately five.

The Harvey *et al*. study of 1984 also reported the time of first cultivation for cropped land. The time of first cultivation was closely related to the number of cultivations. The area cultivated at each specific time of first cultivation was reported separately for land cropped in the previous year and land not cropped in the previous year.

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

The second Ballarat College study did not report on the number of cultivations, but did report again on the time of first cultivation. The results of the 1989 survey and the changes from 1984 measures were reported separately for land cropped in the previous year and land not cropped in the previous year. The results show a clear trend towards minimum tillage amongst those who responded to the survey, but no increase in direct drilling frequency (Table 1 & 2).

In 1984 half of the respondents predicted an increased use of minimum tillage in future years. However, this prediction is not fully evidenced in the results of the 1989 survey. There was an 11 percent increase in the percentage of farmers adopting minimum tillage. The difference may be explained in part by the tendency to take an overly positive view of one's future behaviour, and also by the observation of researchers elsewhere that those who are already using some minimal tillage or direct drilling techniques on their paddocks are the most likely to claim they will be increasing their use of these techniques in the future (Wilkinson & Cary 1993). There was an increase in the area of minimum tillage, measured at 7 percent.

Table 1 Timing of first cultivation for land not cropped in the previous season (Mallee Region)

Timing	Percent of farmers [1]		Percent of area [2]	
	1989	Change from 1984	1989	Change from 1984
Before Oct 1st	81	-11	62	-5
Between Oct - Christmas	36	-10	26	-1
Between Christmas – autumn break	42	-5	33	+3
After autumn break	44	+11	33	+7
Not cultivated	5	+3	20	-1

Source: Harvey *et al*. (1990)

[1] 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.

[2] 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.

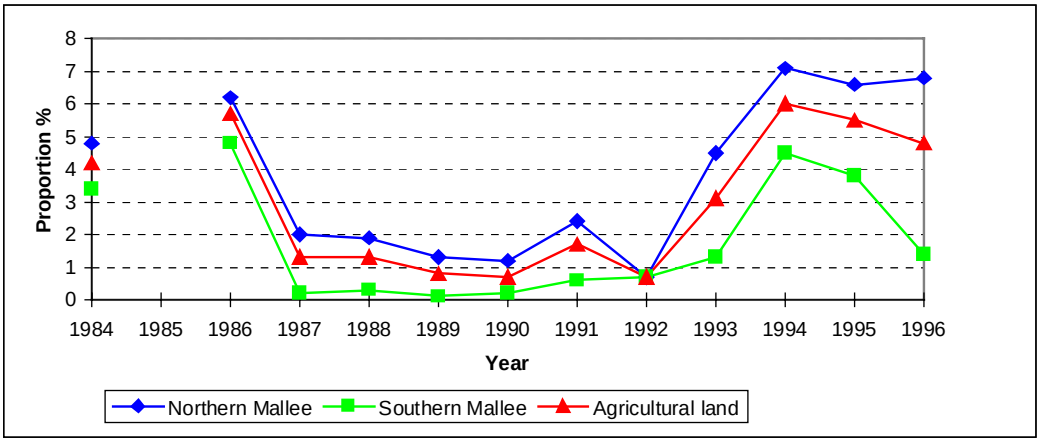
Table 2 Time of first cultivation of land cropped in the previous year (Mallee Region)

Time of first cultivation	1989 (% farmers)	Change from 1984
As soon as possible after harvest	32	-8
After autumn break	42	+7
Did not cultivate at all	26	+1

Source: Harvey *et al.* (1990)

3.1.3 Mallee Regional Catchment Strategy (data from Mallee transect survey)

The Mallee Regional Catchment Strategy highlights the degree of erosiveness on northern and southern sands of the Mallee, based on the results of the Mallee transect survey. Erosiveness is an outcome of both land management and weather conditions. The use of herbicides to control weeds and the reductions in cultivation due to the promotion of soil conservation in the 1980s, resulted in a period of low erosiveness in the time between 1987-1992. A realisation of the role of cultivation in both the control of root diseases and mouse plagues led to a resurgence of bare fallow by cultivation. This resulted in higher levels of erosion in the 1990s during the dry season of 1993/94 (Figure 5).



Source: Mallee Regional Catchment Strategy (data source: Mallee transect survey 1984-1996)

Figure 5 Proportion of land eroding in northern and southern Mallee in autumn (1984-1996)

3.1.4 1993/94 Australian Bureau of Statistics

The next available data on the extent of tillage in the Mallee is that reported in the 1993/94 farm census data provided by the Australian Bureau of Statistics (ABS). A question on the census asked farmers to report the area of crop land sown with conventional tillage, minimum tillage and direct drilling. This question was asked in the year that the Mallee transect survey detected a significant increase in the proportion of paddocks eroding. The format of the question is shown in Appendix 1.

Although not directly comparable to the work of Harvey *et al*. (1995) some useful comparisons can occur 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.

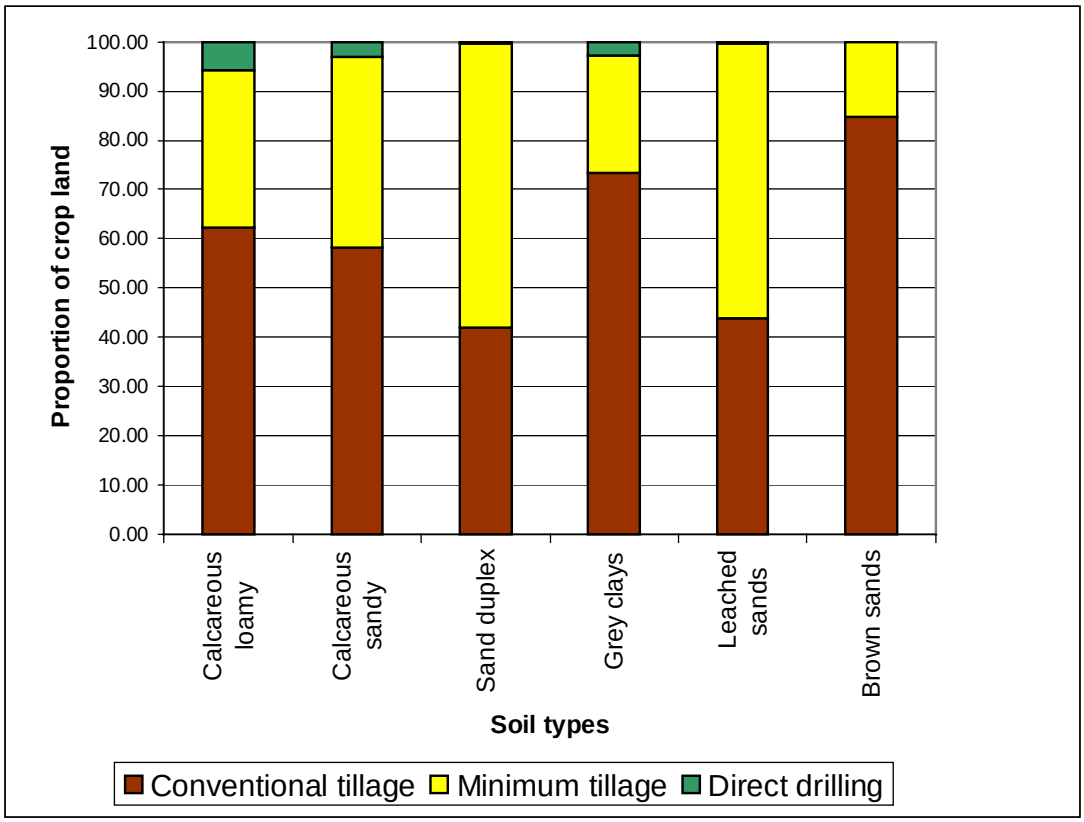
These comparisons quickly reveal significant discrepancies between ABS and the Ballarat College survey measures of direct drilling and minimum tillage. The Ballarat College survey measured 26 percent of farmers direct drilling some paddocks in 1989, but the ABS census measured only 6 percent. There is little reason to believe there has been a dramatic retreat in the area of crop land direct drilled between 1989 and 1994. The Mallee transect study suggests that the retreat in practice occurred in the years following 1994. The conclusion drawn is that in the 1984 and 1989 Ballarat College sample surveys, response rates were much higher from farmers using conservation cropping methods than from farmers who conventionally tilled.

Table 3 Cultivation techniques used by Mallee cropping farmers (1993/94)

	Direct drilling	Minimum tillage	Conventional tillage
% area	4	37	59
% farms	6.3	28	47

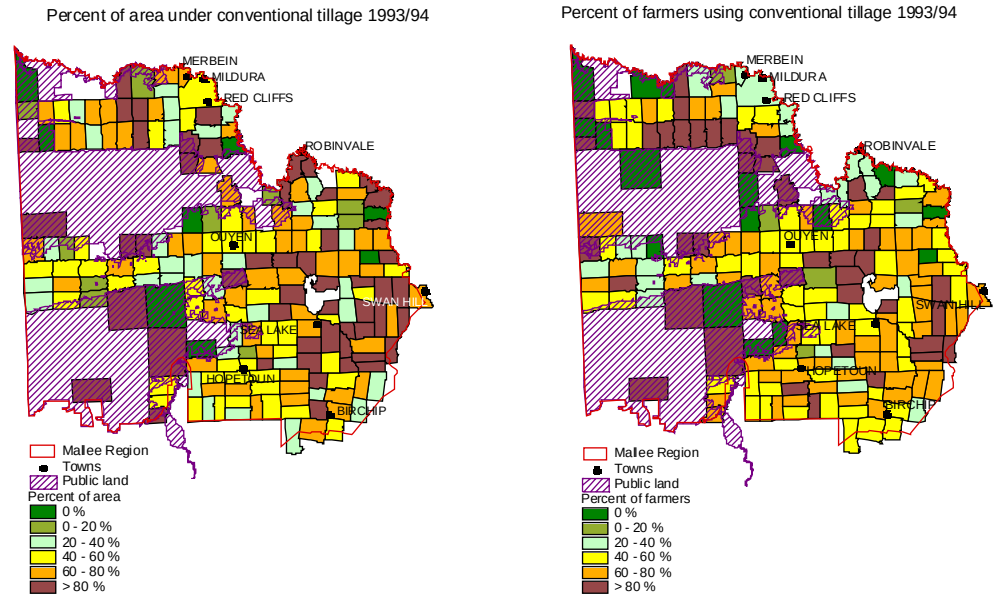
Source: Australian Bureau of Statistics (1993/94)

The ABS farm census data shows that large areas of the Mallee were still tilled conventionally in 1993/94. Direct drilling was rare. A third of the land is tilled with minimum tillage (Table 3). There was strong geographic variation in the adoption of direct drilling in the Mallee. Direct drilling was most common on loamy earths in the southern districts of Birchip and Wycheproof (Figure 6). It was also concentrated to a lesser extent in the Millewa district. There was virtually no adoption of direct drilling in the central Mallee. Minimum tillage was established in the south and in the districts surrounding Walpeup. There was very little adoption of minimum tillage or direct drilling in the eastern Mallee where conventional cultivation predominated (Figures 7 to 9). Figure 6 shows the adoption of minimum tillage and direct drilling on the major soil types of the Mallee. The small amount of direct drilling that did occur appeared to be mostly on the calcareous loams and sands.



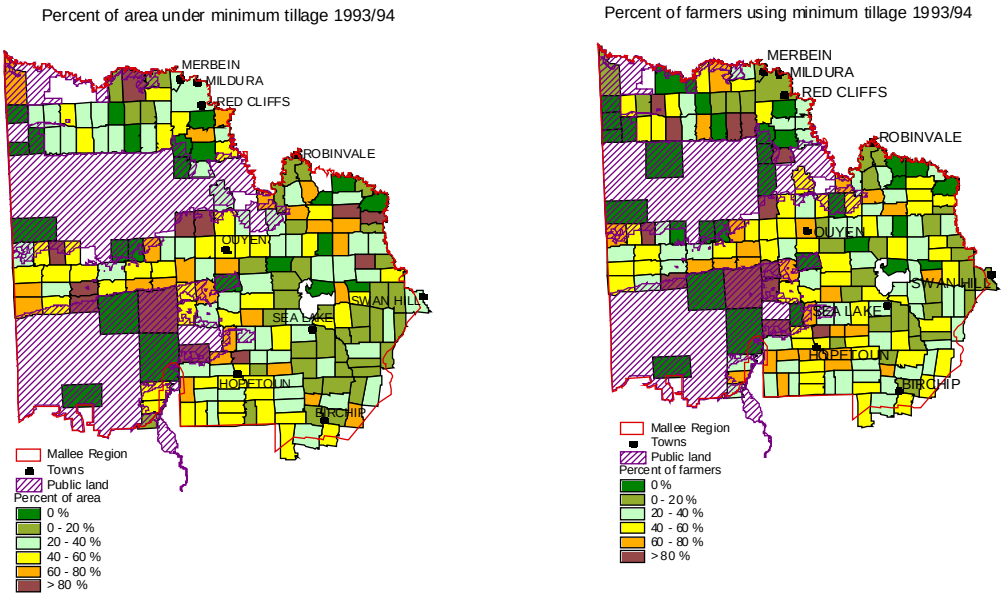
Source: Australian Bureau of Statistics (1993/94)

Figure 6 Proportion of tillage methods used on different soil types in the Mallee Region



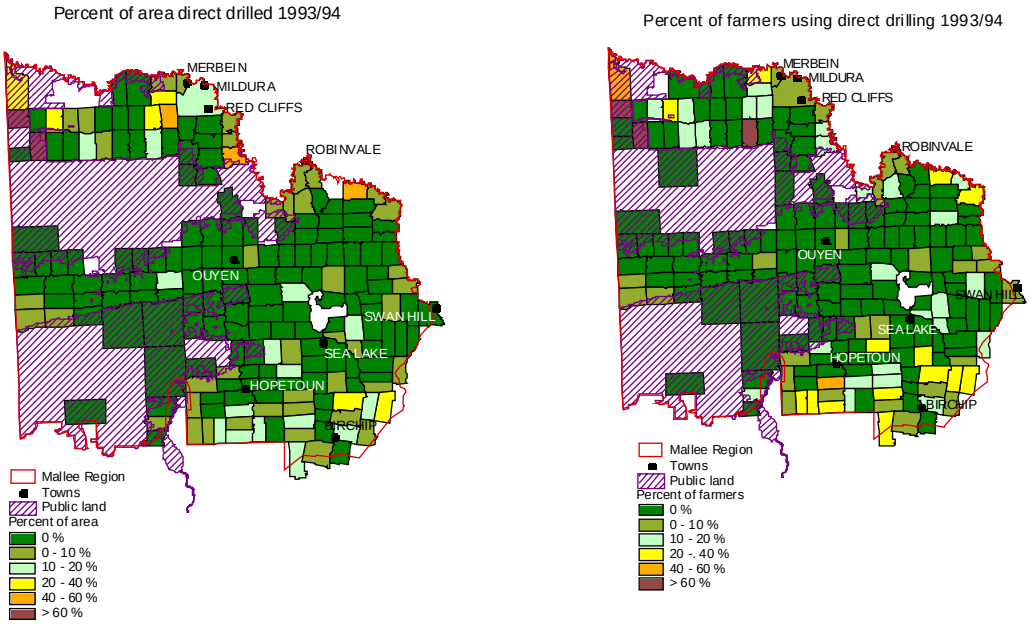
Source: Australian Bureau of Statistics (1993/94)

Figure 7 Adoption of conventional tillage in the Mallee Region (1993/94)



Source: Australian Bureau of Statistics (1993/94)

Figure 8 Adoption of minimum tillage in the Mallee Region (1993/94)



Source: Australian Bureau of Statistics (1993/94)

Figure 9 Adoption of direct drilling in the Mallee Region (1993/94)

3.1.5 1994/95 Australian Bureau of Statistics

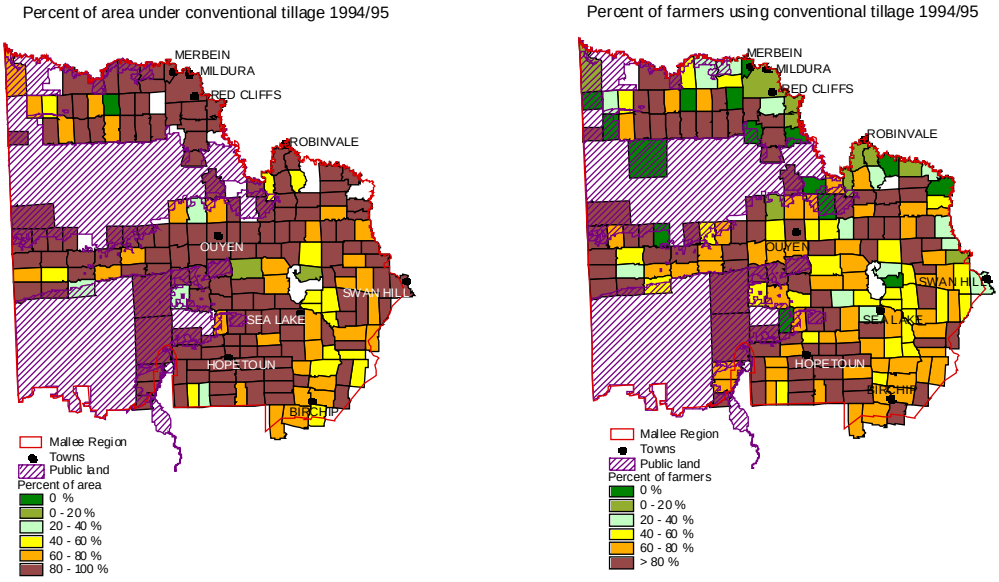
An amended format of the tillage question was included in the 1994/95 farm census (Appendix 1). This question clarifies some of the uncertainty regarding the interpretation of answers to the 1993/94 census.

There was a slight increase in the area direct drilled during the period between 1993/94 and 1994/95 while the percentage of farmers who direct drilled their crops dropped by 2 percent. The reported reduction in crop land sown with minimum tillage and the increase in the conventional tillage, cannot be directly compared with 1993/94 measures due to the differences in the questions (Table 4). The definition of minimum tillage is far more restrictive in the new question. Spatial distribution of adoption levels in each parish for 1994/95 season is shown in Figures 10, 11 and 12. Direct drilling is most common in the south-east around Birchip, but is uncommon in the remainder of the Mallee.

Table 4 Tillage practices in the Mallee Region (1994/95)

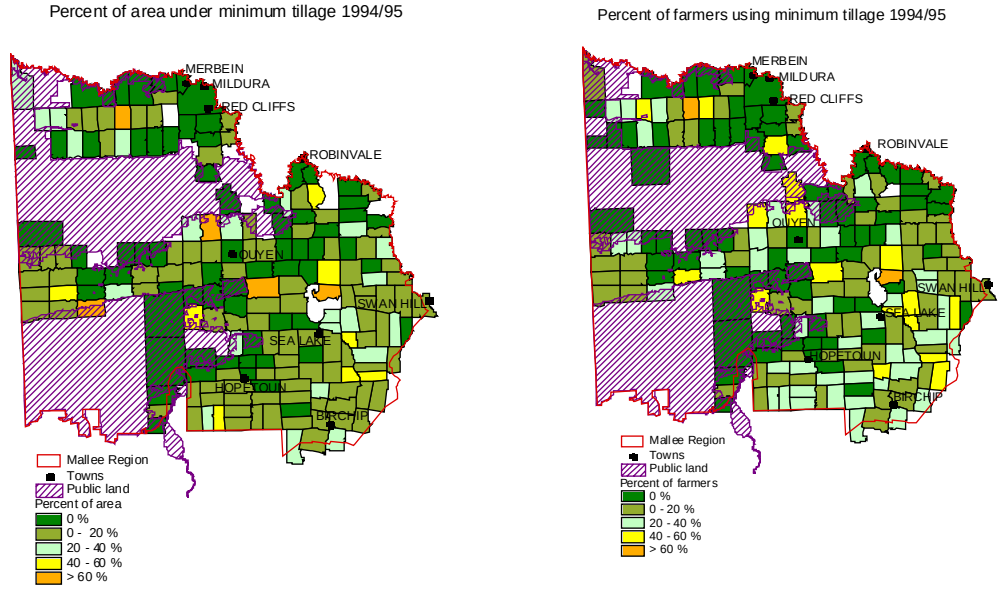
	Direct drilling	Minimum tillage	Conventional tillage
% area	6%	12%	82%
% farms	4%	9%	36%

Source: Australian Bureau of Statistics (1994/95)



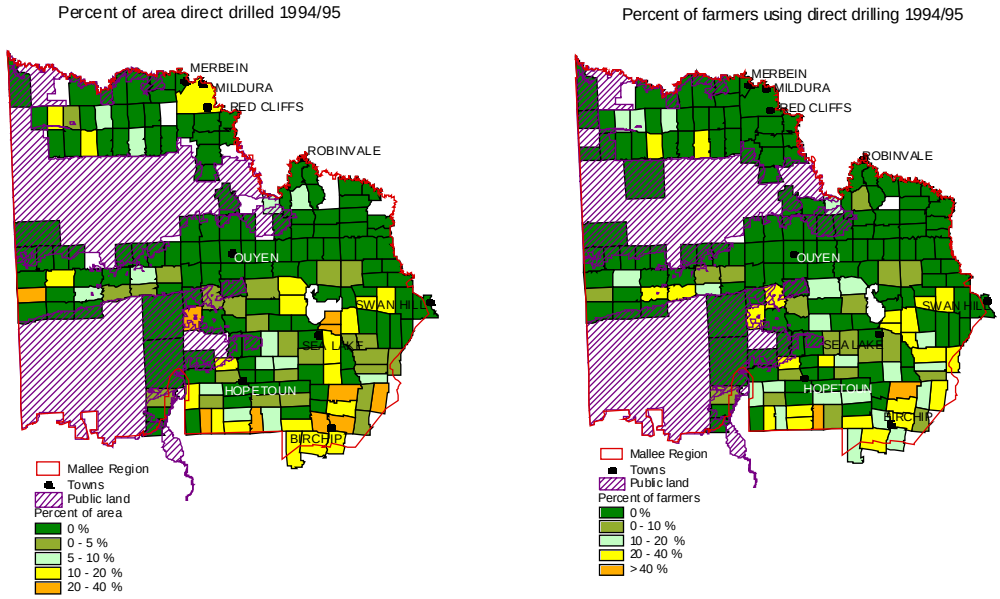
Source: Australian Bureau of Statistics (1994/95)

Figure 10 Adoption of conventional tillage in the Mallee Region (1994/95)



Source: Australian Bureau of Statistics (1994/95)

Figure 11 Adoption of minimum tillage in the Mallee Region (1994/95)

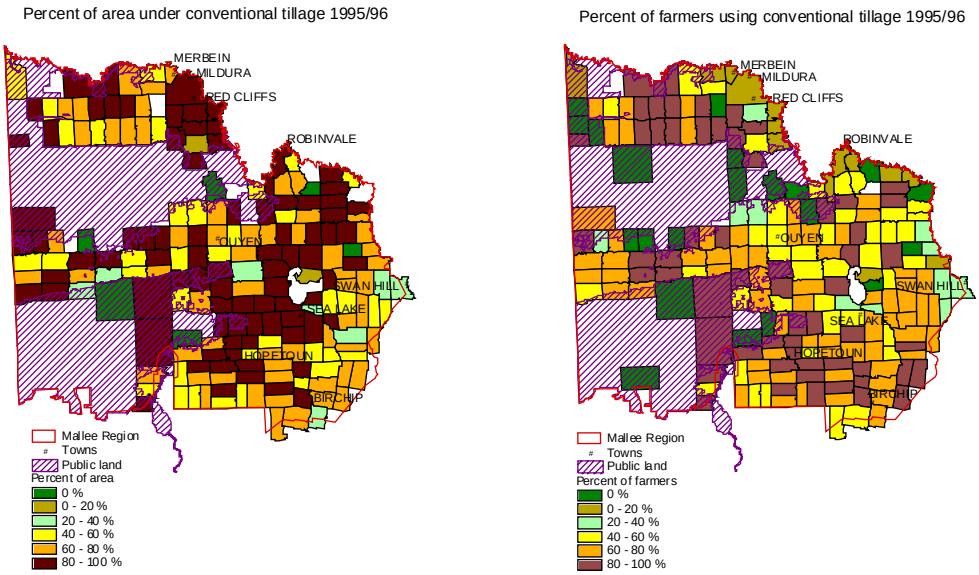


Source: Australian Bureau of Statistics (1994/95)

Figure 12 Adoption of direct drilling in the Mallee Region (1994/95)

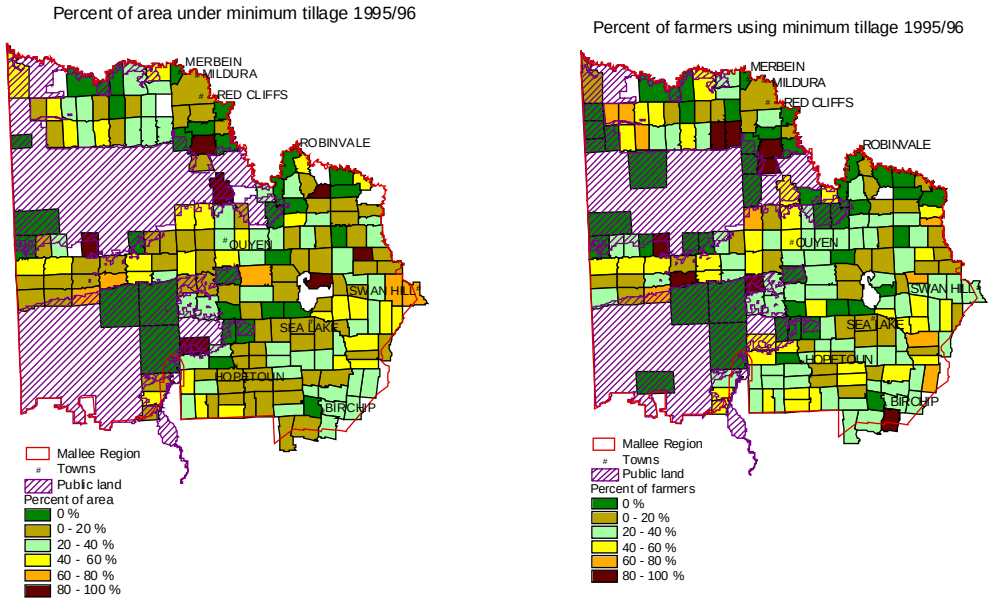
3.1.6 1995/96 Australian Bureau of Statistics

The 1994/95 format of the tillage question was used again in 1995/96 with a small 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 (Appendix 1). This restricts the possibility of direct comparisons for conservation cropping and minimum tillage measure between the two years. Both the percentage of crop land sown with direct drilling and the percentage of farmers direct drilling their crops have not changed during this year. However, the number of farmers direct drilling slightly increased while the area direct drilled decreased, suggesting more farmers direct drilling smaller areas. Spatial distribution of adoption levels in each parish for 1995/96 season is shown in Figures 13, 14 and 15.



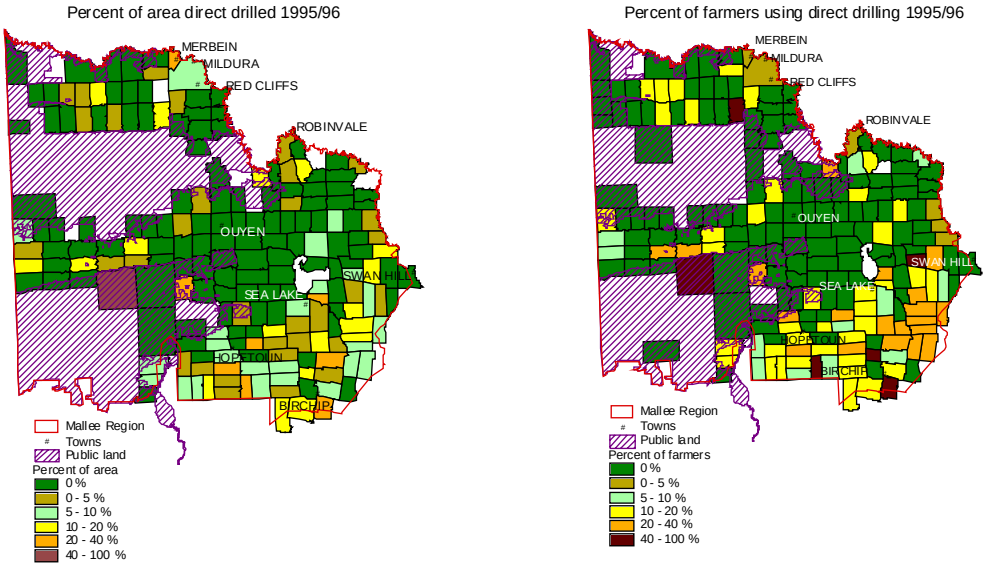
Source: Australian Bureau of Statistics (1995/96)

Figure 13 Adoption of conventional tillage in the Mallee Region (1995/96)



Source: Australian Bureau of Statistics (1995/96)

Figure 14 Adoption of minimum tillage in the Mallee Region (1995/96)



Source: Australian Bureau of Statistics (1995/96)

Figure 15 Adoption of direct drilling the Mallee Region (1995/96)

3.1.7 1996/97 Australian Bureau of Statistics

In 1996/97 the ABS repeated the 1995/96 format of the tillage question to overcome the definitional problems of the previous questions. This allows a direct comparison of these two sets of data. In contrast to the previous year, the same number of farmers have direct drilled more area, with a 1 percent increase in the area direct drilled (Table 5). A trend towards the increased adoption of minimum tillage was evident while the use of conventional tillage had declined (Table 5 and Figures 16, 17).

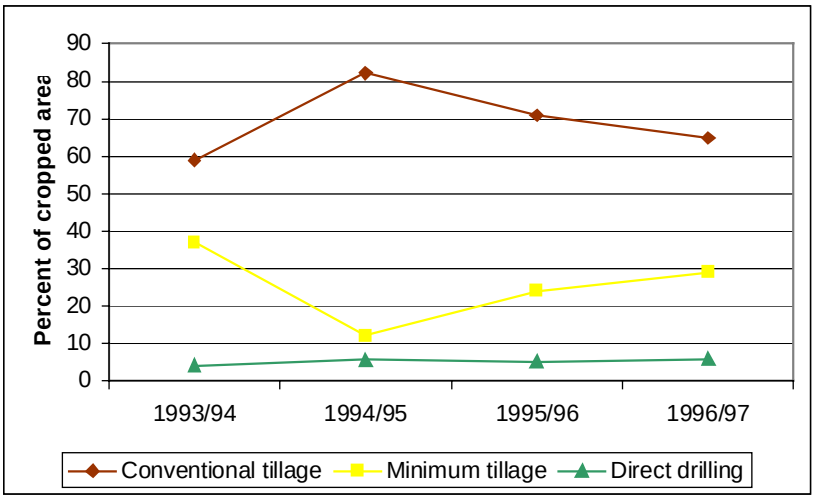
Figures 16 and 17 show the trends in adoption of different tillage methods on crop land in the Mallee Catchment Management Region from 1993/94 to 1996/97. There has not been

a significant change in the area direct drilled during this time. The impact of wording changes in the definition of 'limited cultivation' on the results obtained should be taken into consideration when interpreting these trends in conventional and limited cultivation. The large variation in these two measures in the 1994/95 season can be explained as a result of this change in the definition. However, a trend towards the increased use of minimum cultivation is suggested in the data.

Table 5 Cultivation techniques used by Mallee cropping farmers (1993/94-1996/97)

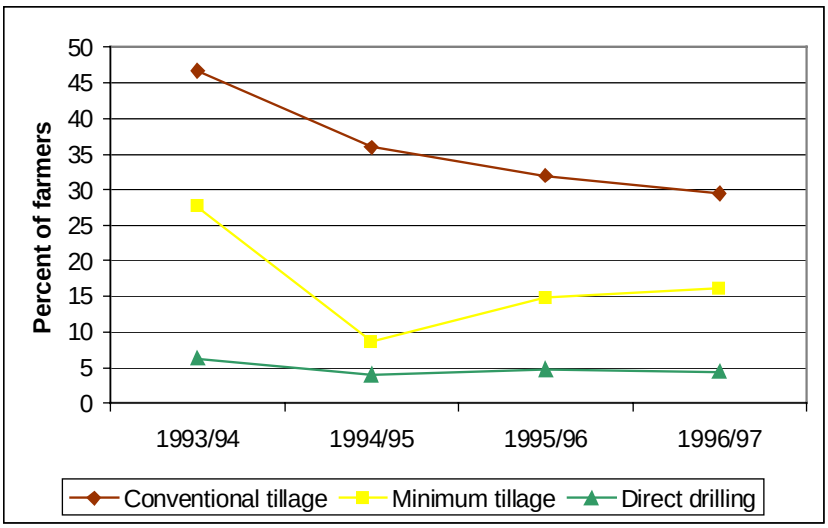
Year	Conventional tillage		Minimum tillage		Direct drilling	
	% farmers	% area	% farmers	% area	% farmers	% area
1993/94	46.7	59	27.7	36.9	6.3	4.1
1994/95	36.0	82.2	8.6	12.1	4.0	5.7
1995/96	32.0	70.9	14.8	24.0	4.7	5.2
1996/97	29.5	64.9	16.1	29.1	4.4	6.0

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



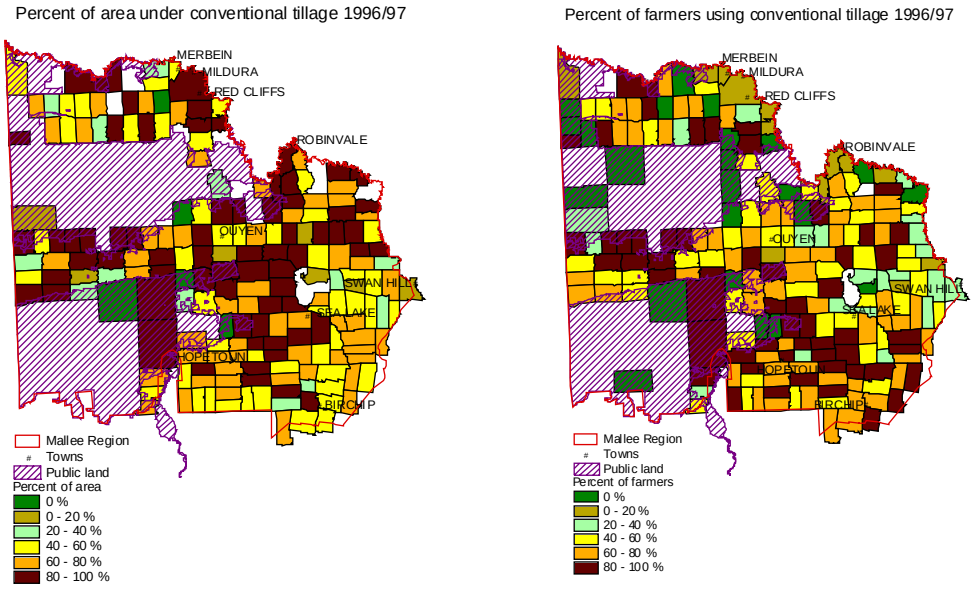
Source: Australian Bureau of Statistics (1993/94-1996/97)

Figure 16 Cultivation techniques used by cropping farmers (percent area) in the Mallee Region (1993/94-1996/97)



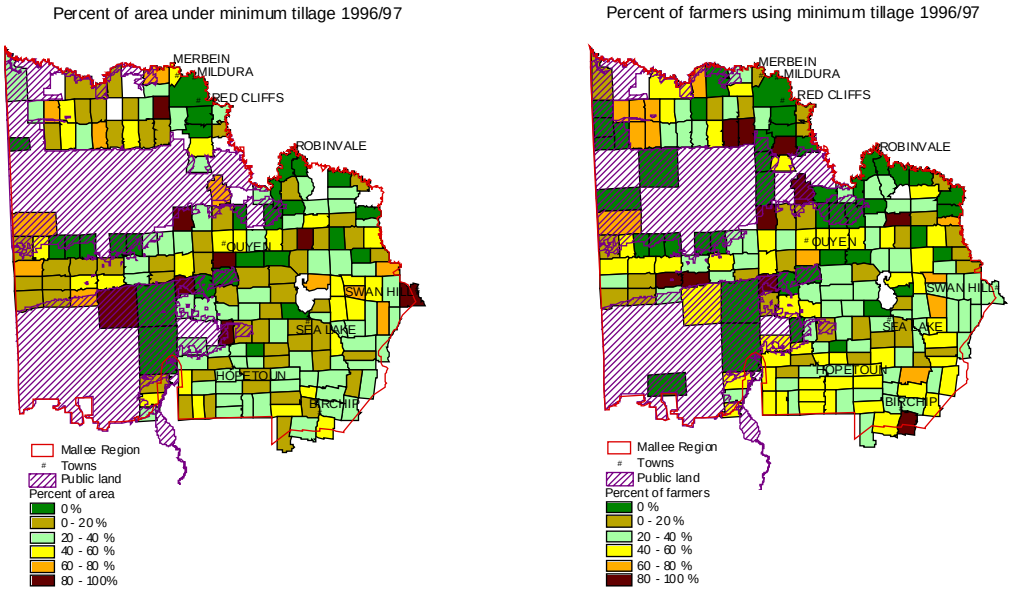
Source: Australian Bureau of Statistics (1993/94-1996/97)

Figure 17 Cultivation techniques used by cropping farmers (percent of farmers) in the Mallee Region (1993/94-1996/97)



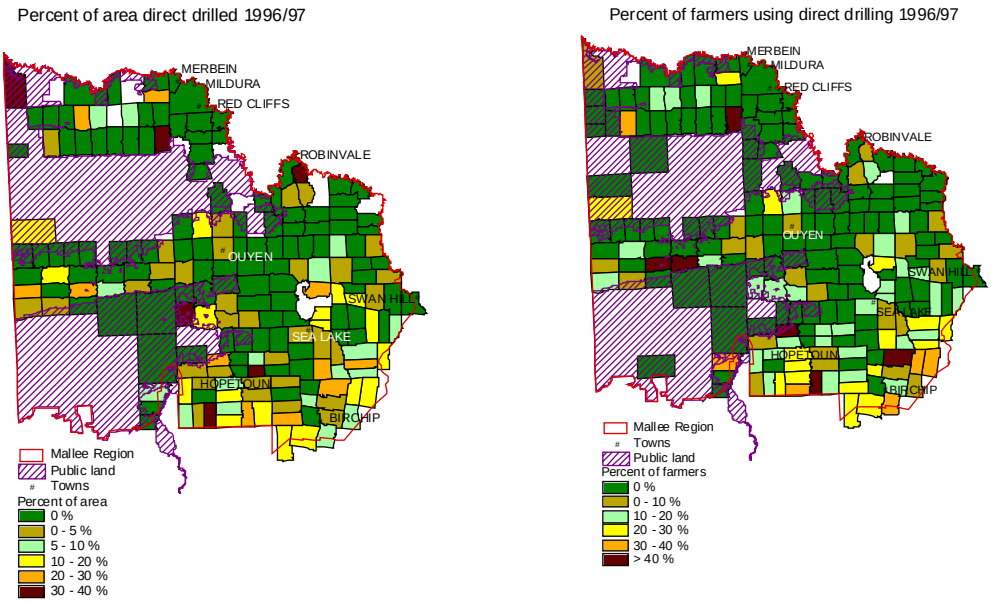
Source: Australian Bureau of Statistics (1996/97)

Figure 18 Adoption of conventional tillage in the Mallee Region (1996/97)



Source: Australian Bureau of Statistics (1996/97)

Figure 19 Adoption of minimum tillage in the Mallee Region (1996/97)



Source: Australian Bureau of Statistics (1996/97)

Figure 20 Adoption of direct drilling in the Mallee Region (1996/97)

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 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 upon 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 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 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 such a paddock was used 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 1984-1989 Ballarat College study

The Harvey *et al*. survey in 1984 found 40 percent of farmers reporting cultivation as soon as possible after harvest. Sixty-seven 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. The Ballarat College repeat survey in 1989 reveals a gradual reduction in the use of long fallow in the Mallee between 1984 and 1989 (Tables 1 and 2). The results suggest 8 percent of farmers shifted the time of their first cultivation from soon after harvest to after the autumn break.

3.2.2 1986-89 Mallee transect study

The results from the Ballarat College studies do not correspond with the most reliable measure of the use of fallow in the Mallee. In the transect survey, a sample of paddocks from Mildura, Ouyen and Swan Hill was monitored to determine the level of adoption of long fallow and trash retention on these fallows, and to report the soil drift in these fallow areas due to wind erosion. The amount of long fallow consistently increased from 18 percent to 21 percent and to 23 percent respectively over the period of available data (Table 6). In the period to 1991 there was little change in the observed use of fallow (Anderson *et al*. 1991).

Table 6 Percent of land under long fallow (1986-89)

Year	% of area under long fallow
1986	18
1987	21
1988	23

Source: Mallee Transect Survey (Sonogan 1988; Anderson *et al*. 1991)

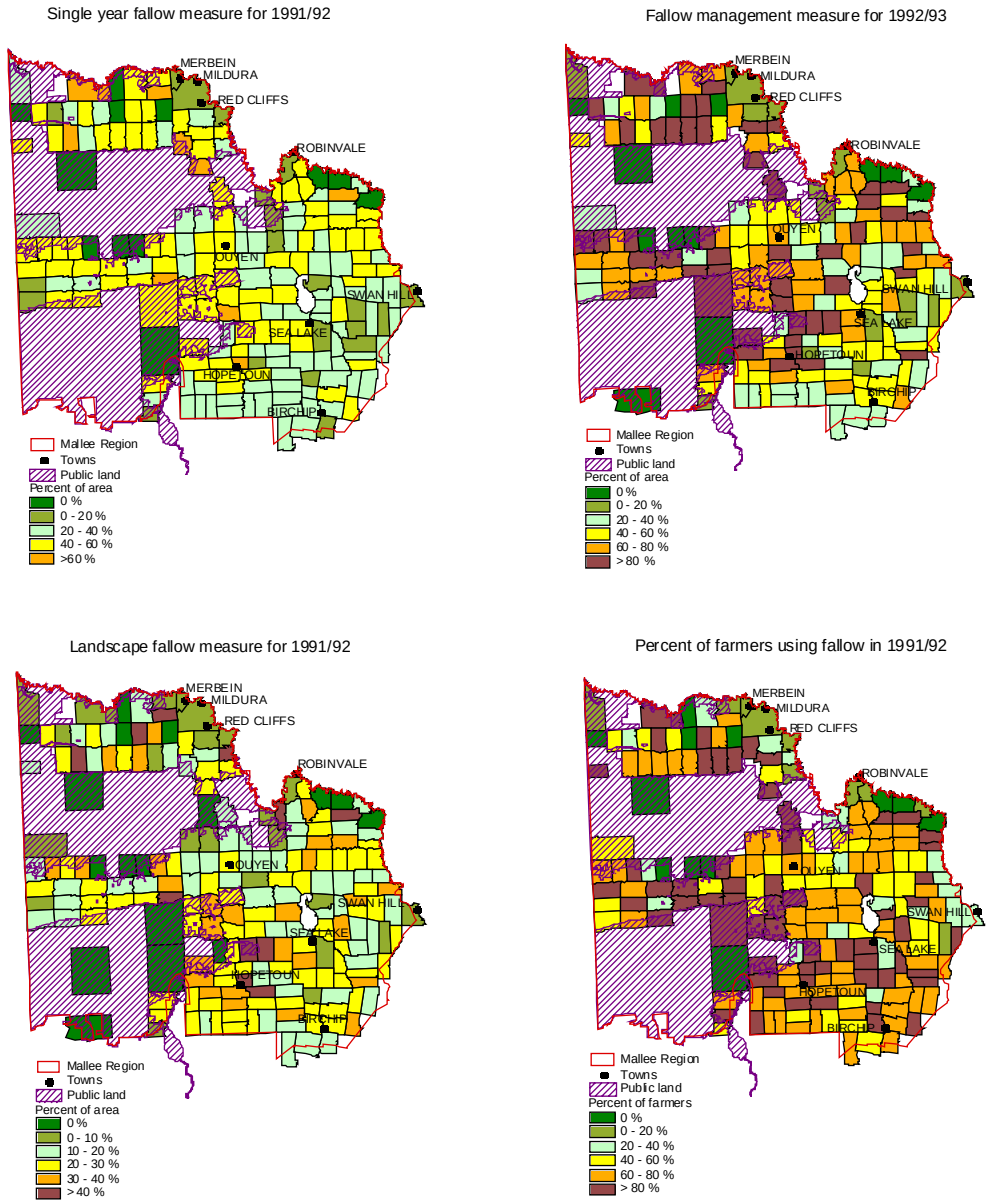
This study also determined the degree of erosiveness of the northern and southern sands of the Mallee, which is an outcome of both land management and weather conditions. A period of low erosiveness was reported from 1987-1992 as a result of the use of herbicides and reduced cultivation as an alternative to traditional bare fallowing by frequent cultivation. A shift toward the use of bare fallowing by frequent cultivation was shown in the 1990s due to the lack of appreciation of the effects of cultivation reduction on root diseases and mouse plagues, and also the low returns for the cropping industries during the early 1990s (Mallee Regional Catchment Strategy 1997). This resulted in higher levels of erosion in 1990s (Figure 5).

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 during the season 91/92’. This question is possibly ambiguous. It is likely that farmers will have interpreted the question as including long fallow because of the use of the word ‘spelled’. However, it is also possible that some farmers included short fallow.

Utilisation of fallow was reported by 35 percent of cropping farmers. The single year fallow/crop percentage constructed using single year data for 1991/92 was 37.8 percent. The more reliable 'fallow management' measure for 1991/92, constructed using the cropping area for 1992/93 was very much higher at 56 percent. This difference is a result of a trend away from cropping enterprises during the 1992/93 season. Both these figures are significantly higher than the measure of fallow observed in the Mallee transect study.

Explanations for this difference may lie in the wording of the question or in differences in practice between the Mallee as a whole, and the area of the Mallee transect study. Geographic differences do not seem to be a reasonable explanation. Mapping of parish level data reveals that reported fallow utilisation was most common in the central Mallee region where the Mallee transect study is undertaken (Figure 21). It must be concluded that the differences lie in the wording of the ABS question



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

Figure 21 Fallow management measures for the Mallee Region (1991/92)

3.2.4 1994/95 Australian Bureau of Statistics

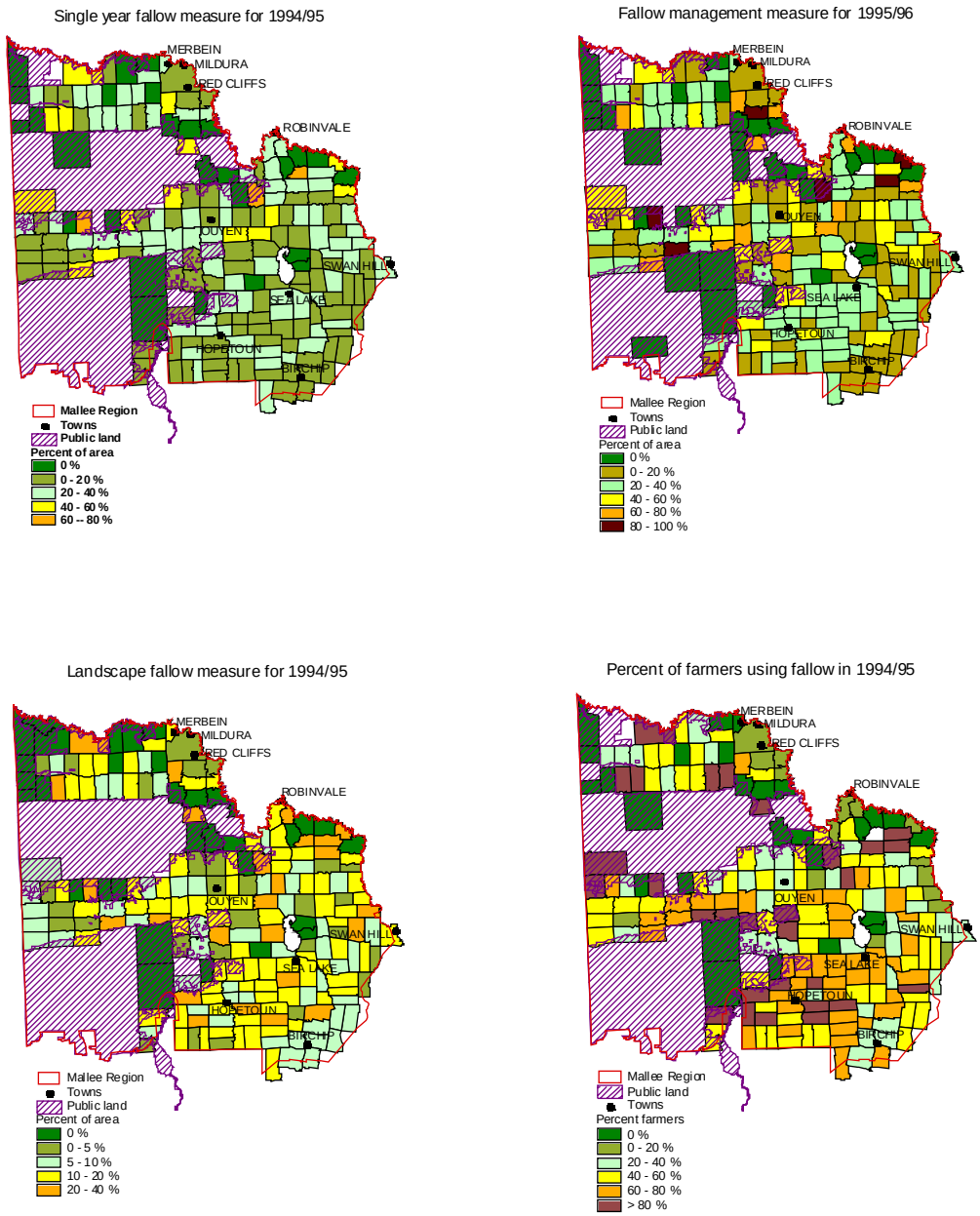
In 1994/95 a much improved format for the fallow question was asked in the ABS farm census. This question specified the time of commencement of fallow as 'before Christmas' and classified fallow according to mechanical, chemical or pasture topping methods. Explicit time specification will allow a comparison with the results of the Mallee transect study. This question format was used in the years after the transect study found a significant increase in paddock erosion due to seasonal conditions and an increase in the use of conventional cultivation.

The ABS survey reports that 21 percent of crop area was under fallow, which corresponds with the results from the Mallee transect survey. Figures for the 1994/95 season show that the fallow area has reduced by half during the three years from 1992 to 1995 (Table 7). Given these results are completely at odds with those of the Mallee transect study, it must be reiterated that the 1992 ABS question is a poor measure of the utilisation of cropping fallow. It seems responses to this earlier question included additional spelled land that was not in fallow for cropping purposes. The results also show that the area under cultivated fallow is over four times larger than the area fallowed using a herbicide in the 1994/95 season. 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 22. The pattern of distribution of fallow was similar to the 1991/92 season, with fallow usage more common in the central Mallee.

Table 7 Measures of fallow usage in the Mallee Region

Census year	Fallow adoption rate %	% Single year fallow	% Fallow management	% Landscape fallow
1991/92	35.0	37.8	56.0	20.4
1994/95	26.0	21.4	27.4	10.9

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



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

Figure 22 Fallow management measures for the Mallee Region (1994/95)

3.2.5 1995/96 Australian Bureau of Statistics

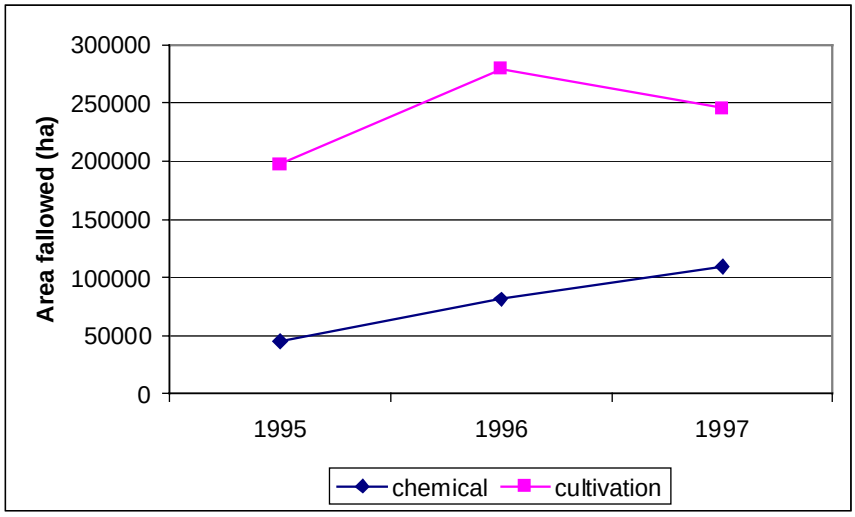
The 1994/95 format of the fallow question was repeated in the 1995/96 farm census. The only modification was to specify the commencement of fallow cut off date as 31 December rather than as Christmas. This should make little difference to the data. Reasonable comparison should still be possible between this and the preceding year's data. There was an increase in the use of fallow in 1995/96 season compared to the reduction shown in the previous year. Thirty-three percent of farmers fallowed a quarter of their crop area in 1995/96 season while 40 percent of the crops grown in 1996/97 was sown in to land fallowed in the 1995/96 season (Table 8). There is also a clear trend away from cultivated

fallow towards more use of chemical fallow. Both the area under chemical fallow and the number of farmers adopting chemical fallow increased at a higher rate compared to the use of cultivated fallow (Figures 23 and 24). The increase in fallow is seen mainly in the west and the centre of the region (Figure 25).

Table 8 Measures of fallow usage in the Mallee Region (1995/96-1996/97)

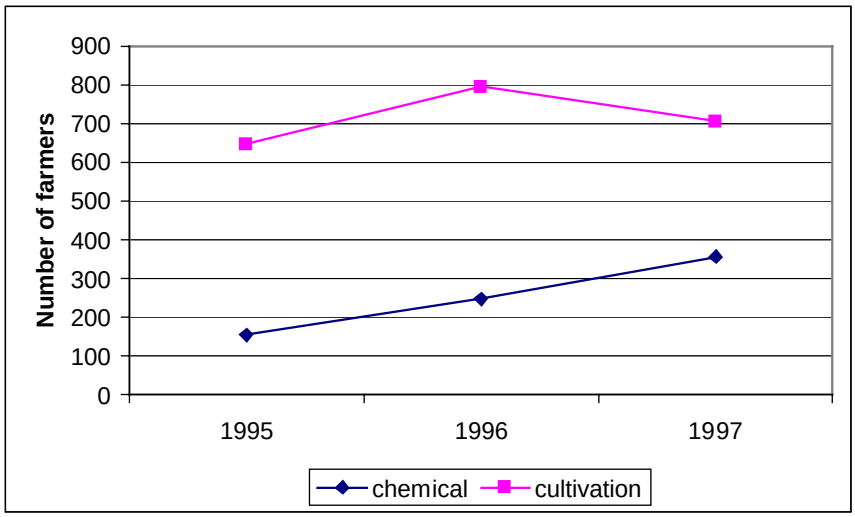
Census year	Fallow adoption rate %	% Single year fallow	% Fallow management	% Landscape fallow
1995/96	33.2	26.8	39.2	16.0
1996/97	32.0	25.7		16.1

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



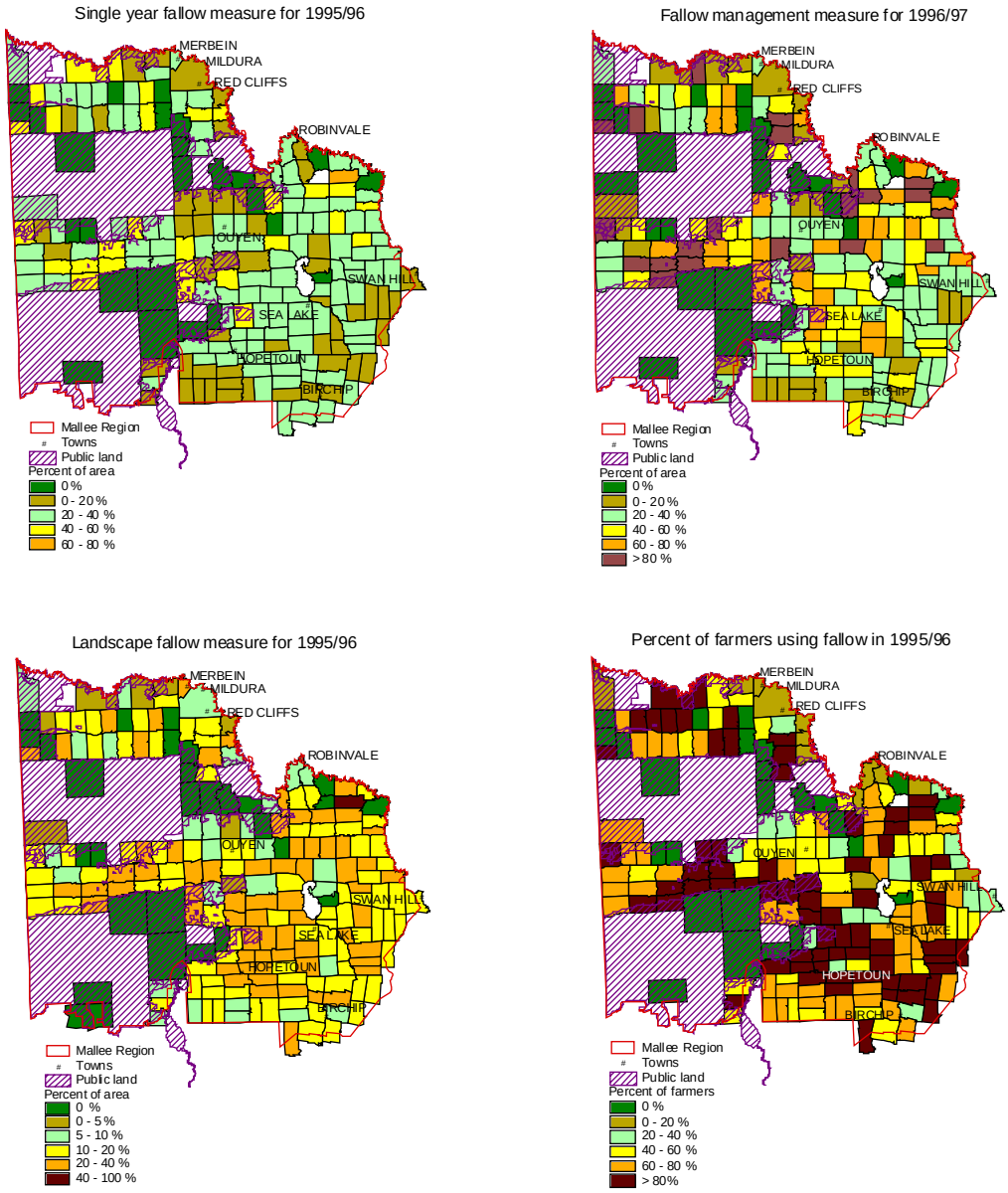
Source: Australian Bureau of Statistics (1994/95-1996/97)

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



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

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

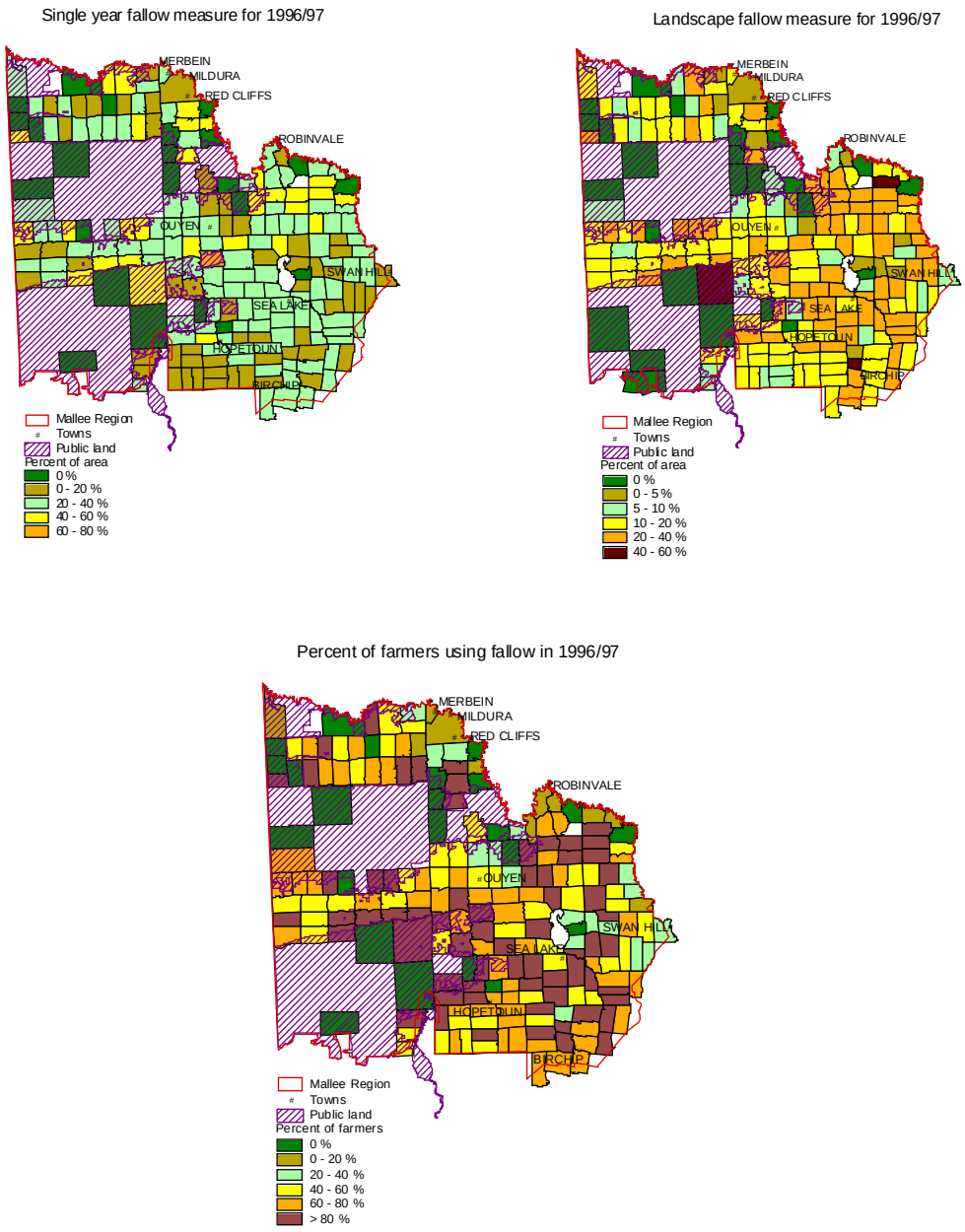


Source: Australian Bureau of Statistics (1995/96-1996/97)

Figure 25 Fallow management measures for the Mallee Region (1995/96)

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 use of fallow remained unchanged during this season, with 25 percent of the crop land being fallowed by 32 percent of cropping farmers. However, the trend towards chemical fallow was even stronger, with an increase in both the area and the number of farmers using chemicals on fallow, and a decrease in the use of cultivated fallow compared to the previous year (Figures 23 and 24). The spatial variation in fallow adoption is again similar to the pattern shown in the previous year, with high adoption rates in the centre of the region (Figure 26)



Source: Australian Bureau of Statistics (1996/97)

Figure 26 Fallow management measures for the Mallee 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 stubble management behaviour within the simple format of a single question in mail surveys such as used by Harvey *et al*. (1985, 1990).

3.3.1 1986-1989 Mallee transect survey

The Mallee transect survey provides the best available information on the adoption of stubble retention on fallows in the Mallee. This study was designed to measure the extent of stubble retention on paddocks in long fallow. For the years 1986 to 1988 the extent of retained trash on fallow paddocks was 25 percent, 39 percent and 34 percent

respectively. There is a high degree of variability in the adoption of stubble retention according to seasonal conditions. The same variability has been observed in the data from subsequent transect surveys (Anderson *et al*. 1991).

3.3.2 1984-89 Ballarat College survey

The Ballarat College survey clearly indicates a decrease in the use of stubble burning between 1984 and 1989, which seems to contradict the findings of the transect study (Table 9). It has already been reported that the Ballarat College survey data must be treated with caution because of low response rates. The Harvey *et al*. (1985, 1990) results may reflect a response bias in favour of those farmers inclined to particular practices. It may also indicate much of the increase in stubble retention occurred in the years soon after the 1982 drought. The Harvey *et al*. (1990) study indicates that stubble burning has, to an extent, been replaced by stubble grazing. The most common combinations of different stubble management practices identified are shown in Table 8.

The Ballarat College study shows a change in attitude to stubble retention over this period (Table 11). Over the five years of this study there were increasing concern about the desirability of stubble retention on Mallee farms.

Table 9 Treatment of Mallee crop stubble (percent of respondents).

Treatment	1989	Change from 1984
Grazed	76	+13
Burned	25	-20
Baled	4	+3
Fallowed	16	+5
Left or ploughed in	16	+6
Prickle chained	10	*
Other	19	

* Data for 1984 was not available

Source: Harvey *et al*. (1990)

Table 10 Most common combinations of stubble management in the Mallee (percent of respondents).

Treatment	1989	Change from 1984
At least some left or ploughed in	17	+7
Grazed and burned	13	-5
Grazed not burned	58	+20
Burned not grazed	9	-14
Other	2	

Source: Harvey *et al*. (1990)

Table 11 Mallee farmers' perceptions of trends in their use of stubble retention (percent of respondents).

Conservation practice	Trends	1989	Change from 1984
Stubble Retention	Increasing	33	- 10
	Not changing	63	+ 9

	Decreasing	4	+ 1

Source: Harvey *et al*. (1990)

3.3.3 1994/95 Australian Bureau of Statistics

In 1994/95 the Australian Bureau of Statistics included a stubble retention question. This asked the farmers to report the area of crop land on which the different crop stubble techniques were used (Appendix 3).

The lower rainfall and subsequent lower burden of stubble means that stubble management is comparatively easier in the Mallee Region. This was evident in the low adoption of stubble burning in the region. Only 10 percent of stubble was burnt by 7 percent of the cropping farmers, while stubble retention was widely adopted in the region (Table 10). The high risk of wind erosion in poor seasons, and the difficulties of eliminating cultivation from the cropping system, provide a significant incentive to retain stubble in the Mallee. This locally perceived need to cultivate means that most stubble is retained through incorporation. Half of the region's stubble area was incorporated with most of the parishes having incorporated over 60 percent of their stubble (Figure 27). Another 30 percent of stubble was left standing. This was mostly seen in the northern and central Mallee.

Table 12 Adoption of stubble management in Mallee in 1994/95

	Burn		Incorporated		Mulched		Left standing	
	% area	% farmers	% area	% farmers	% area	% farmers	% area	% farmers
Mallee	10	7	50	18	10	5	29	10

Source: Australian Bureau of Statistics (1994/95)

3.3.4 1995/96 Australian Bureau of Statistics

In the following year the Australian Bureau of Statistics asked a modified stubble retention question. There were three major differences between this and the question used the previous year (see Appendix 3). This new question included grazing and baling as a separate category of stubble handling. The question also instructed respondents to include each area only once. This was to overcome the possibility that areas had been double counted in the previous year's question. It is likely 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 had been done in the previous year). Because of these changes there may be some difficulties in making comparisons with data from the previous year.

The percentage of stubble burnt or incorporated has not changed during this year. Incorporation was still the most popular method of stubble handling. Mulching increased by 6 percent while both the percentage of stubble area left standing and the number of farmers adopting this practice significantly dropped during this year. Grazing or baling stubble was not a popular technique in the area, with only 5 percent of cropping farmers using grazing/baling as the main stubble management technique on 11 percent of their stubble area (Table 13). It may be that these farmers have used grazing in combination with stubble retention rather than together with any other technique in the previous year. This is also consistent with the change in spatial distribution of adoption of these techniques. Grazing was commonly used in northern Mallee where there was high adoption of stubble retention the previous year (Figure 28).

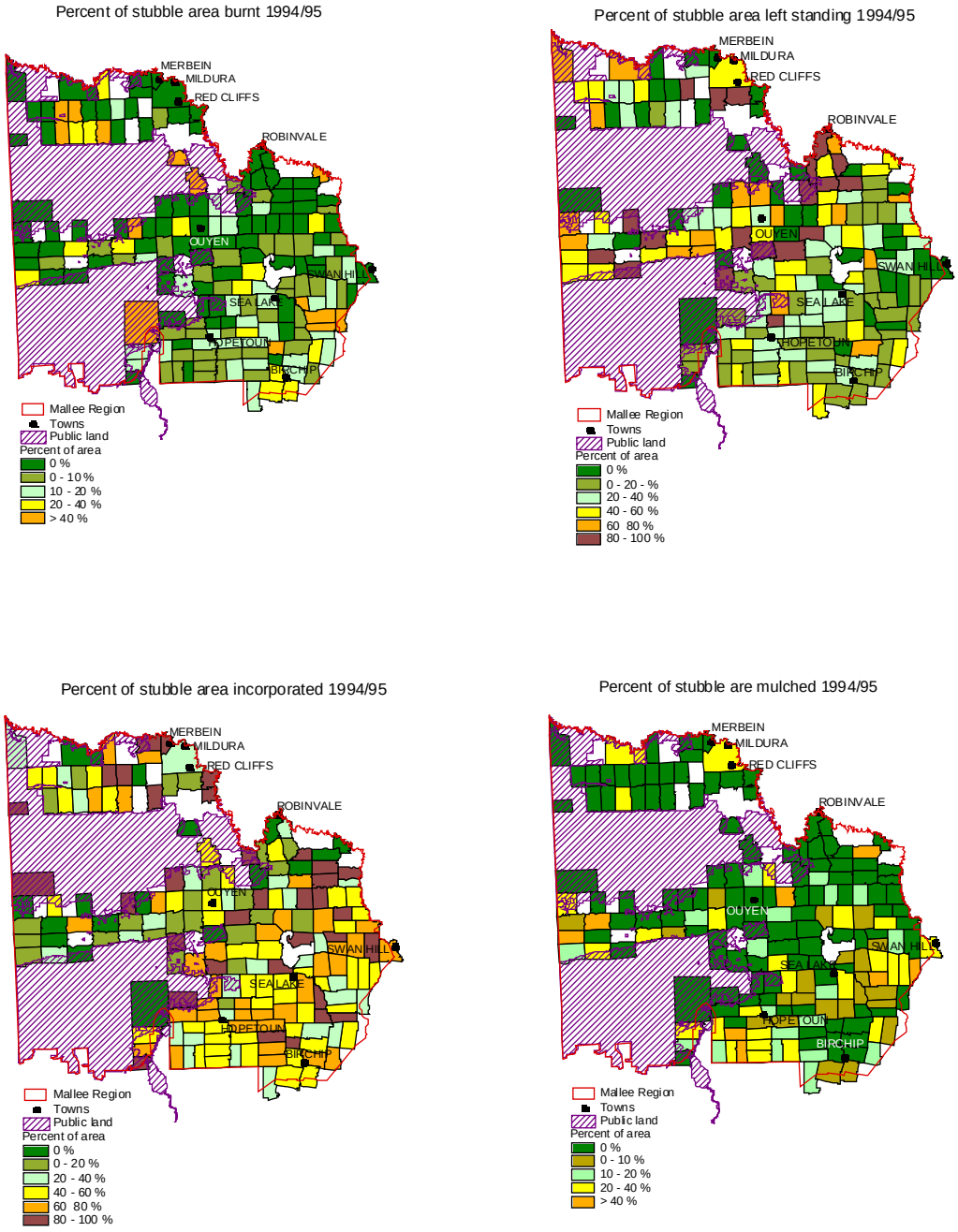
Table 13 Adoption of stubble management in the Mallee Region (1995-1997)

	Burn		Incorporated		Mulched		Left standing		Grazing/Baling	
	% area	% farmers	% area	% farmers	% area	% farmers	% area	% farmers	% area	% farmers
1994/95	10.0	7.3	50.3	18.1	10.2	5.3	29.5	10.4		
1995/96	9.8	6.5	49.4	15.0	16.8	5.7	12.6	4.9	11.5	5.4
1996/97	10.9	7.2	40.2	12.1	18.3	6.0	16.1	5.5	14.5	5.1

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

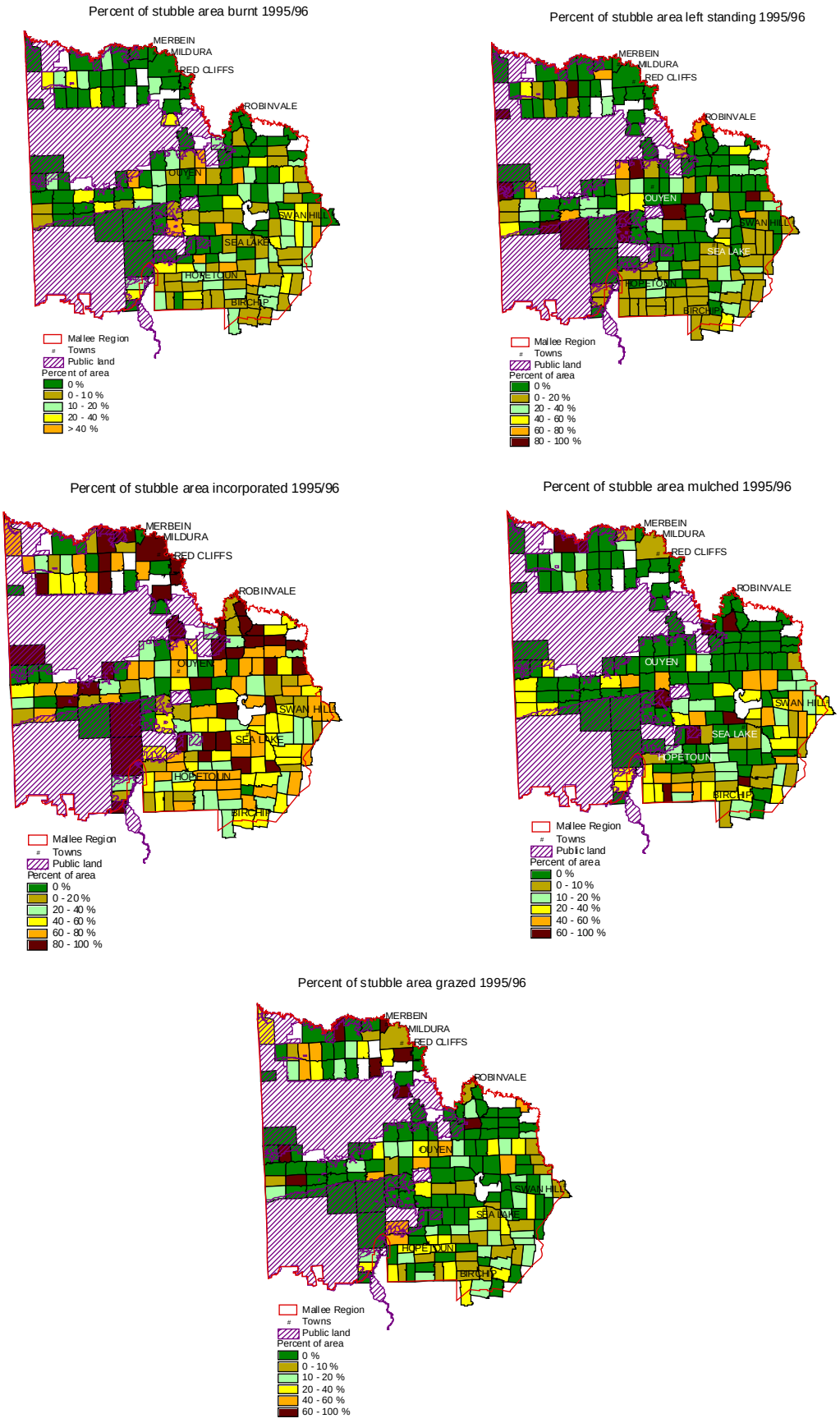
3.3.5 1996/97 Australian Bureau of Statistics

In the following year the Australian Bureau of Statistics asked the same stubble retention question. The use of stubble burning did not change between 1995/96 and 1996/97, while incorporation of stubble was considerably reduced. The use of grazing, mulching and stubble retention increased during this year. However, incorporation was still the most favoured method of stubble management in the region, practised by 12 percent of cropping farmers on 40 percent of stubble area. The spatial distribution of adoption of these practices is shown in Figure 29.



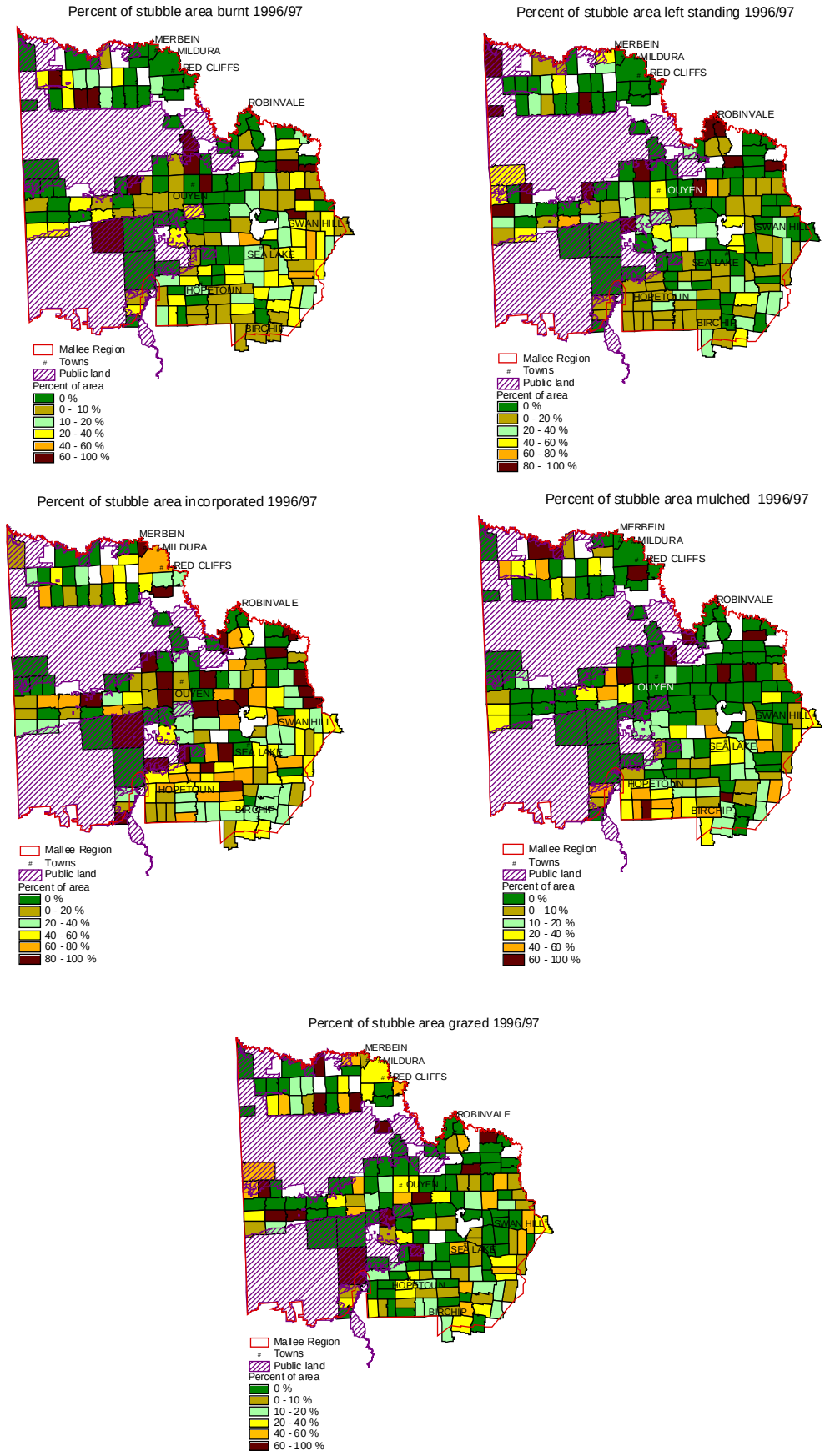
Source: Australian Bureau of Statistics (1994/95)

Figure 27 Stubble management methods used by Mallee cropping farmers (1994/95)



Source: Australian Bureau of Statistics (1995/96)

Figure 28 Stubble management methods used by Mallee cropping farmers (1995/96)



Source: Australian Bureau of Statistics (1996/97)

Figure 29 Stubble management methods used by Mallee cropping farmers (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 the Mallee Region (Karunaratne & Barr 2001).

4 RECOMMENDATIONS

The aim of this report is to provide baseline information and establish trends in adoption of conservation cropping practices in the Mallee Region. 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 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 improved 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 the information to calculate the 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 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

Include
- Each area once

- **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**

Hectares

Total area prepared for crop

Method of crop preparation:

If different tillage methods were applied to the same area, report under that method involving most cultivation.

Hectares

More than one cultivation using discs, tines, ploughs, etc.....

One cultivation immediately prior to sowing.....

No cultivation .....

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 between1 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

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. Hence, the same format can be used in future to estimate the measure of fallow management used in this report.

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6 APPENDICES: AUSTRALIAN BUREAU OF STATISTICS FARM CENSUS QUESTIONS

Appendix 1: ABS tillage questions

Tillage methods - season 1993/94

Include
- Each area once

- **Area of holding to which the following tillage practices were applied:**

Hectares

If different tillage methods were applied to the same area, report under that method involving most cultivation.

Conventional tillage (using only discs, tines or ploughs for fallow weed control or seedbed preparation) .....

Minimum/reduced tillage (limited cultivation with some use of herbicides for fallow weed control) .....

No tillage (No cultivation, fallow weed control by herbicide and direct drill or no tillage seeding) .....

ABS Tillage question: cultivation for broadacre crops - season 1994/95

Include
- Each area once

- **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**

Hectares

More than one cultivation using discs, tines, ploughs, etc.....

One cultivation immediately prior to sowing.....

No cultivation .....

ABS tillage question: cultivation for broadacre crops - season 1995/96

Include
- Each area once

- **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**

Hectares

More than two passes using discs, tines, ploughs, etc.....

One or two passes only prior to sowing.....

No cultivation (apart from the actual sowing operation).....

Appendix 2: ABS fallow questions

ABS fallow question - season 1994/95

2e. Fallow land

- **In preparation for this years' crop, how much land was in fallow before Christmas 1994 through the following preparations:**

Hectares

Pasture topping (preventing seed development by spraying herbicide at milky dough stage).....

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

2c. Disposal of crop stubble during season 1994/95

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

Hectares

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

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).....

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

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

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.....