A BASELINE OF ADOPTION OF CONSERVATION CROPPING - WIMMERA REGION

August 2001

AGRICULTURE VICTORIA - BENDIGO
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SUMMARY

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

- Cultivation: Average number of cultivations per crop now stands at 2.9. Minimum tillage is well established, but direct drilling is still an activity undertaken by a minority of farmers. There has been no change in the usage of minimum tillage and direct drilling through the mid 1990s.

- Fallow: Findings support anecdotal evidence that the extent of fallow has reduced from 90 percent of cropped land to 30 percent of cropped land currently (Wimmera Regional Landcare Plan 1993). This is associated with a trend towards increasing intensity of crop rotations. There is also a clear trend away from cultivated fallow towards more use of chemical fallow.

- Stubble retention: Stubble burning practices on a quarter of stubble area through the mid 1990s. Full stubble retention is still limited in adoption to a small minority.

- Herbicide Use: Use of chemical fallow is rising, to the point where the area of chemical fallow was similar to the area of cultivation fallow in 1996/97. However, chemical use is often associated with cultivation. There was no significant relationship between the number of cultivation passes and the number of boom spray passes.

The overall state of adoption of conservation cropping can be studied in more detail by undertaking a simple market segmentation based upon the comprehensive data available for the Warracknabeal Shire (Table 1).This shows how farmers are following different paths towards more sustainable cropping.

Conventional: Twenty-nine percent of croppers belong to the conventional cropping group. These farmers rely on a conventional mix of fallow, cultivation and burning of stubbles. Interestingly, these farmers run a similar intensity of cropping to members of other groups.

Fallow incorporators: These farmers (approximately 10 percent of the population) have eliminated much of their burning of stubble. They favour incorporation of stubble ahead of burning, but rely upon cultivation and fallow.

Continuous incorporators: At 44 percent of the population, this is the largest segment. These farmers have reduced their use of fallow and manage stubble predominantly by incorporation and to a lesser extent by burning.

Minimum tillers: The smallest segment at 6 percent of the population. These farmers have a low use of fallow, a mean number of cultivations of less than two per crop. Their stubble management is shared between retention and incorporation, suggesting half of their paddocks are cultivated about four times as part of incorporation, and half are not cultivated but sown into standing stubble (on average).

Trash farmers: The remaining group, comprising 13 percent of the population, have the lowest rates of fallow use and cultivation. They manage stubbles predominantly by retention. It is interesting these farmers have a similar cropping intensity to other segments. However, they differ in having a much higher use of non-cereal crops in their rotations.

Table 1 A market segmentation of conservation cropping in the Warracknabeal Shire (1992/93.)

Segment	Farms (%)	Cropping intensity (% of area)	Crop sown on fallow (%)	Mean cultivations to sow crop	Stubbles burnt (%)	Stubbles incorporated (%)	Stubble retained (%)	Non cereals as % of total crop
Conventional	29	55	33	3.2	87	8	4	12
Fallow incorporators	8	41	74	4.3	23	75	1	5
Continuous incorporators	44	51	23	3.1	36	62	60	24
Minimum tillers	6	43	18	1.8	10	41	48	10
Trash farmers	13	51	5	.7	16	23	60	52

Source: Wilkinson & Cary (1993)

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1 THE WIMMERA REGION

1.1 Cropping sustainability in the Wimmera

The Wimmera has a semi-arid climate with a high rainfall variation and a small temperature variation across the catchment. Rainfall varies from 700-1000 mm/yr in the south of the catchment to a low of 300 mm/yr on the northern plains. The Wimmera River catchment covers about 20 000 square kilometres. About 80 percent of the catchment land has been cleared of native vegetation and the remaining is in the form of national parks, state forests and public reserves.

Soil erosion, soil structure decline and dryland salinity are the major land degradation problems in the Wimmera catchment. The estimated production losses from crop land in the catchment due to soil losses and structure decline in 1988/89 were $8 million dollars (10-40 percent). About 17 000 ha of the catchment area is currently salt affected and loss of production due to this is estimated to be around $230 000 per year. About 60 000 ha of land on sandier soils in the northern part of the catchment is at risk of wind erosion (Wimmera Regional Landcare Plan 1993; Wimmera Regional Catchment Strategy 1997).

There are two major types of Wimmera cropping soils: the friable brown or grey clays and the red duplex soils. The two soil forms require different management. The friable clays are naturally well structured and less prone to soil erosion than the cropping soils of the Mallee or North Central regions of Victoria. They are moderately prone to soil structural damage (Commissioner for the Environment 1991; Kent 1987). The stability of these soils has encouraged little attention, until recently, to the impact of cropping on these soils. Recently the focus has been on the impact of the loss of organic matter. This can be addressed by the increased use of stubble retention, a reduction in the use of fallow and the appropriate use of legume crops or pastures in rotations. The friable clay soils are judged to be at only moderate risk of rising watertables caused by fallow practices (Wimmera Catchment Salinity Management Plan 1992; Wimmera Regional Catchment Strategy 1997).

The red duplex soils are hard setting and have historically proved difficult to manage (Barr & Cary 1992; Commissioner for the Environment 1991). These soils are generally rated as at high risk of soil structural decline and water erosion (Wimmera Regional Landcare Plan 1993). They are also more prone to watertable recharge due to the use of long fallow. The Wimmera Salinity Management Plan has recommended the adoption of reduced tillage, longer phases of improved legume pastures, improved crop rotations, integration of lucerne, maximising water use and reduction in the use of long fallow (Wimmera Catchment Salinity Management Plan 1992; Rendell, O'Callaghan & Clark 1996; Wimmera Regional Catchment Strategy 1997).

1.2 Indicator practices

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

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

The first three indicator practices are generally accepted as being most likely to minimise the adverse impacts of cropping activities on the soil resource (Wimmera Catchment Salinity Management Plan 1992; Wimmera Landcare Plan 1993). 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 fourth 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 soil degradation. This is an indicator of awareness rather than resource condition. Awareness of degradation is not generally a sufficient condition to initiate changed agricultural practice. The link between awareness and environmental action is seldom so simple (Barr & Cary 1992). Rather, awareness is a pre-condition for the inclusion of resource conservation considerations within farm management decision making. This indicator is reported in the accompanying report on Community attitudes to environmental issues: statewide and regional overview (Karunaratne, Barr & Brown 2001).

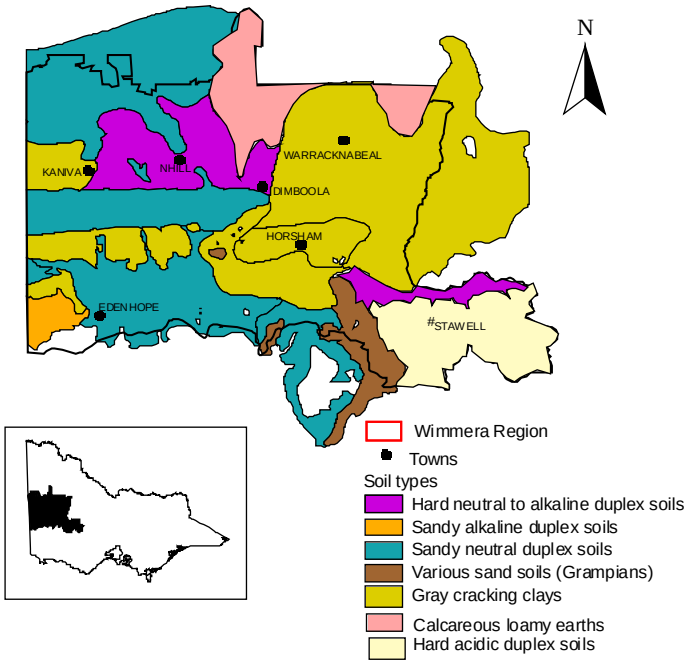
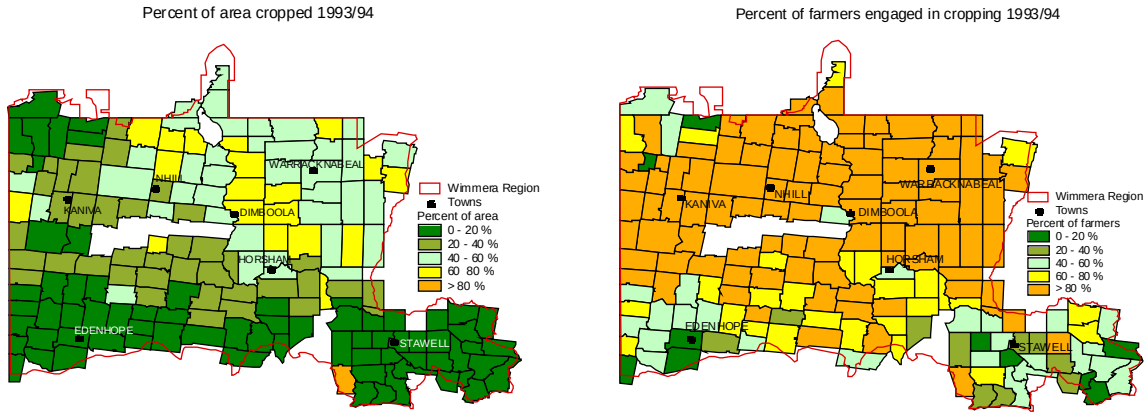
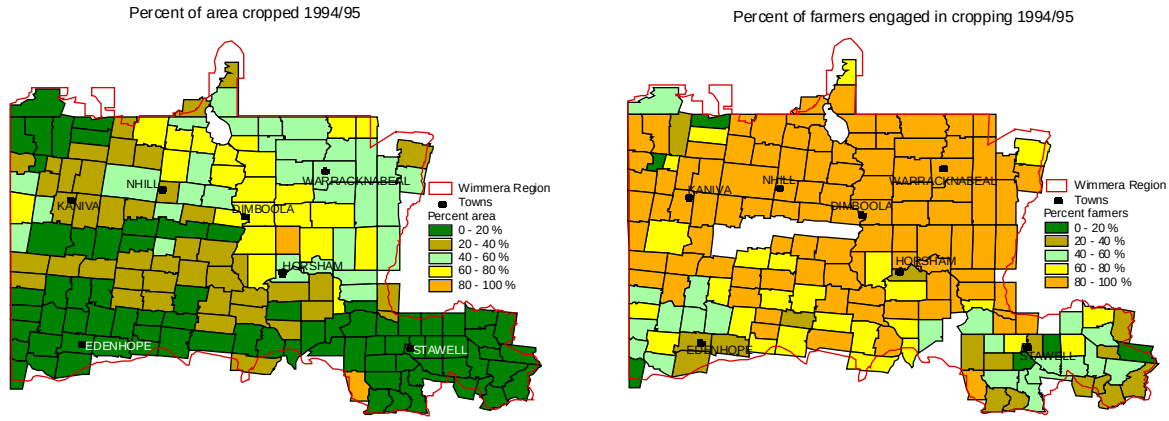


Figure 1 Soil types in the Wimmera Region



Source: Australian Bureau of Statistics (1993/94)

Figure 2 Intensity of cropping in the Wimmera Region (1993/94)



Source: Australian Bureau of Statistics (1994/95)

Figure 3 Intensity of cropping in the Wimmera Region (1994/95)

2 DATA SOURCES AVAILABLE

2.1 Australian Bureau of Statistics

The Australian Bureau of Statistics (ABS) farm census is distributed annually to all Australian farming businesses 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 and pastures. In recent years, questions have covered perception of land degradation hazard, cultivation practice and use of stubble retention. Data from the ABS farm census is normally available only in aggregated form at state or local government area. As part of this project, data was purchased disaggregated at parish levels. As parishes are significantly smaller than local government areas, ABS data was reaggregated according to catchment and soil type boundaries.

2.2 University of Melbourne Wimmera Conservation Cropping Study

In 1993 John Cary and Roger Wilkinson of the University of Melbourne conducted a personal interview survey of a random sample of 120 cropping farmers in the then Shire of Warracknabeal. As part of a broader study of chemical use and understanding of chemical labels, comprehensive measures were taken of tillage and stubble management on a paddock by paddock basis. The format of the questions was based upon lessons learnt from previous studies of conservation cropping adoption in north-east Victoria undertaken by this team. The format is likely to be the most accurate tool available for the measurement of the adoption of conservation cropping practices (Table 2). The conservation cropping component of this study has not been previously published. The authors have given permission for the reanalysis and publishing of the results of their study. The data will provide an extremely accurate standard against which to judge the accuracy of ABS farm census data.

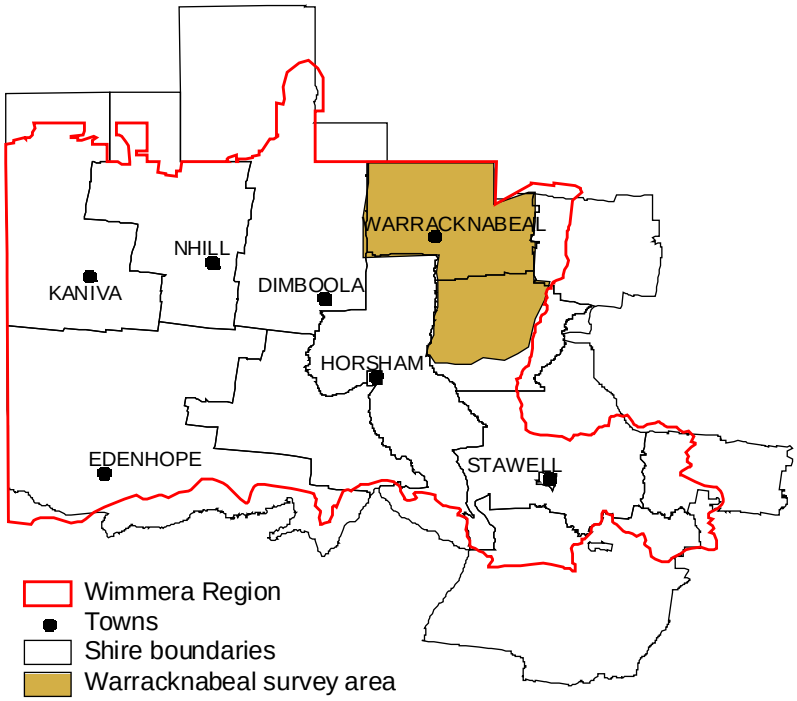


Figure 4 Location of Wimmera cropping adoption studies

Table 2 Sample portion of University of Melbourne conservation cropping interview schedule

I'd like to go through each of your paddocks sown to crop this season. For each paddock I would like to find out a few details. Let's go through the paddocks one at a time.

What is the area of the paddock? *(KEEP UNITS CONSISTENT)* UNIT: (ACRES 1) (HECTARES 2)	What crop did you sow? WHEAT 1 BARLEY 2 OATS 3 CANOLA 4 SAFFLOWER 5 FIELD PEAS 6 OTHER 8 (SPECIFY)	What was the paddock used for last season? PASTURE 0 WHEAT 1 BARLEY 2 OATS 3 CANOLA 4 SAFFLOWER 5 FIELD PEAS 6 NOT SOWN 7 FALLOW 8 OTHER (SPECIFY) 9	*IF IN CROP LAST SEASON:* How did you handle the stubble? *(CIRCLE ONE OR MORE)* 1 Hot Early Burn 2 Late Cool Burn 3 Incorporate 4 Graze 5 Mulch 6 Leave standing 7 Cut for Hay 8 Other *specify 9 Don't Know	How many times did you cultivate before sowing the crop? *(AFTER HARVESTED PREVIOUS CROP)*	How many times did you spray the crop? *(HOW MANY PASSES WITH THE BOOMSPRAY?)* *(INCLUDE CHEMICAL FALLOW, PRE AND POST-EMERGENT SPRAYS)*
___ ___ ___			1 2 3 4 5 6 7 8 9	___ ___	___
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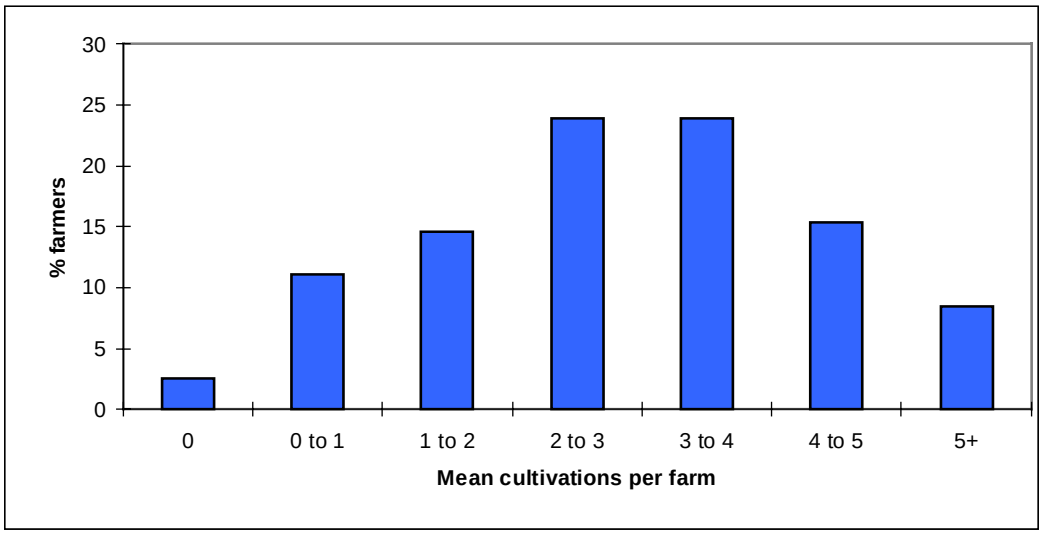
3 MEASURING CONSERVATION CROPPING PRACTICES

3.1 Cultivation

3.1.1 1993 University of Melbourne Warracknabeal study

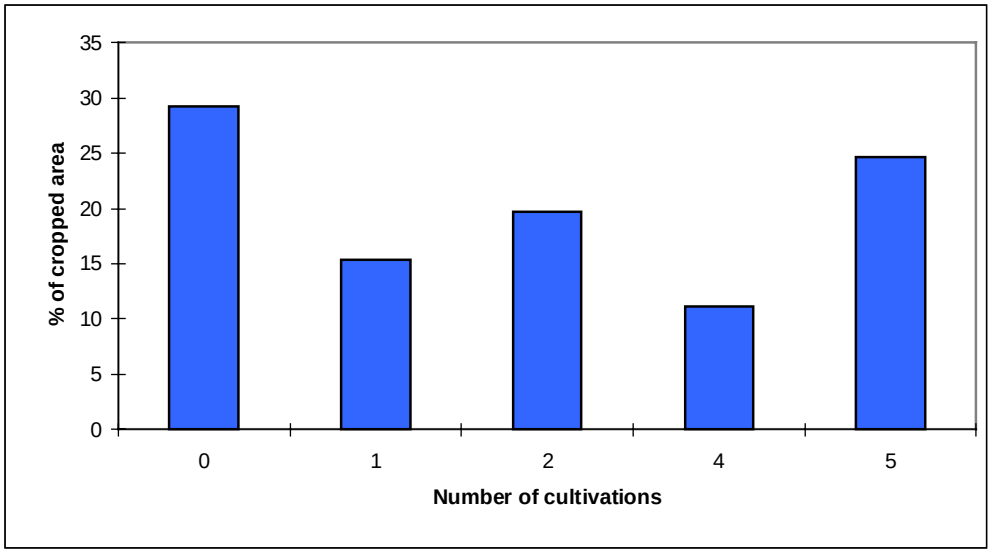
There is less data on conservation cropping and cultivation practice in the Wimmera than in other cropping regions of the state. This reflects the greater historic priority placed upon the more fragile soils of the Mallee, North Central and North East regions. However, available data is of a high quality. The 1993 University of Melbourne study provides an extremely accurate estimate of the extent of cultivation of crop land in the Warracknabeal Shire during sowing for the 1993 season.

Experience with direct drilling is well established. According to this survey 46 (±4.7) percent of the respondents direct drilled some crops during the 1993 season. There is no evidence of disadoption in the previous three years. Forty percent of farmers believed they had adequate equipment to enable them to direct drill. However, many of the 46 percent of direct drilling adopters chose to direct drill only a small part of their crop. The mean number of cultivations for crop land was 2.9 (±0.15). Most cropping farmers cultivated an average of between two and four cultivations per paddock (Figure 5). While only 15 percent of farmers averaged less than one cultivation, almost 30 percent of the cropped area was direct drilled (Figures 5 & 6). This suggests that direct drilling is applied more intensely on the larger properties. The reasons for this may lie in the need to minimise labour input. The FAST (FM500 and Sustainable Technology) project identified economies of scale as the major benefit of direct drilling (Rendell McGuckian 1996).



Source: Wilkinson & Cary (1993)

Figure 5 Mean number of cultivations in the Warracknabeal Shire (1992/93)



Source: Wilkinson & Cary (1993)

Figure 6 Percentage of land under different cultivation intensities in the Warracknabeal Shire (1992/93)

3.1.2 1993/94: ABS tillage data

The next available data on the extent of tillage in the Wimmera is that reported in the 1993/94 farm census data provided by the Australian Bureau of Statistics. A question on the census asked farmers to report the area of crop land sowed with conventional tillage, minimum tillage and direct drilling. The format of the question is shown in Appendix 1.

The results of the ABS census are shown in Table 3. Minimum tillage and conventional tillage were the predominant tillage methods applied to cropped paddocks in the Wimmera. Direct drilling is used on 19 percent of farms and applied to 18 percent of the total cropped area.

Table 3 Tillage practices in the Wimmera Region (1993/94)

	Direct drilling	Minimum tillage	Conventional tillage
Area (%)	18%	43%	39%
Farms (%)	19%	46%	53%

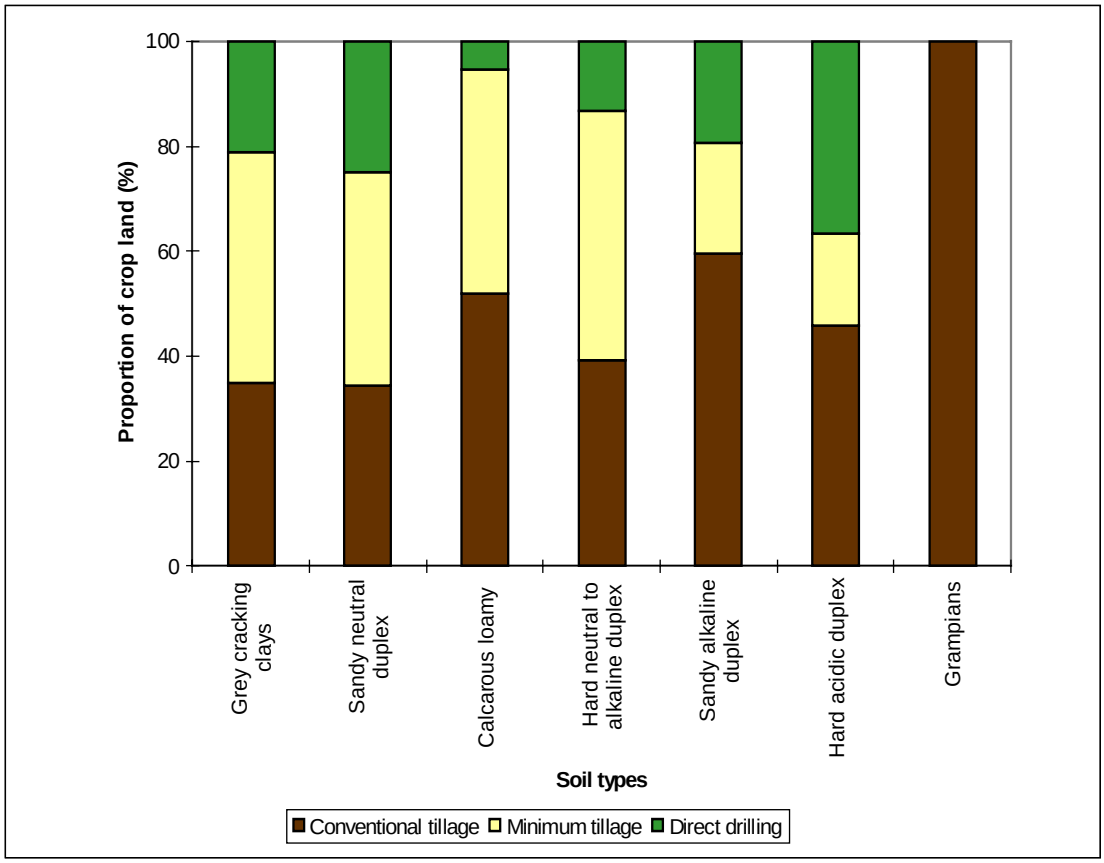
Source: Australian Bureau of Statistics (1993/94)

Mapping of the ABS parish data reveals few obvious patterns (Figures 8, 9 and 10). Aggregating parishes according to soil type helps interpret the patterns which do exist. This information must be treated with caution as the framing of the ABS question in 1993/94 did not differentiate between tillage for establishing crops and pastures. In those areas that are less intensively cropped, there is a strong possibility that tillage for pasture establishment is included in the ABS data.

Direct drilling is rare in the sandier soils (the calcareous loams and the Grampians sands). There appears to be a noticeably higher use and adoption of direct drilling in the grey soil areas to north of Horsham (where cropping is by far the most predominant agricultural activity) and in the various duplex soils (Figure 7).

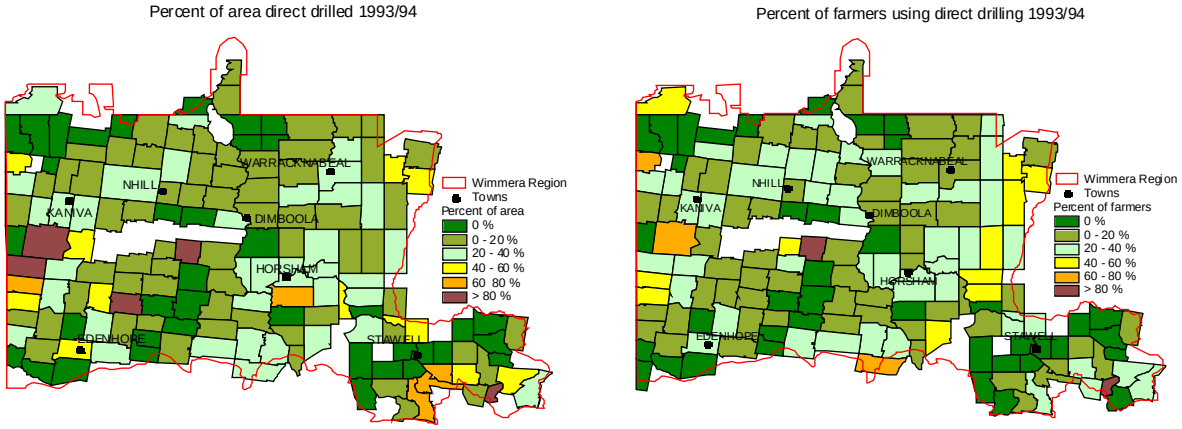
Minimum tillage is more prevalent in the plains to the south and west of Horsham. Minimum tillage seems less established in the south-east of the region (Figure 9).

Conventional tillage is the preferred means of sowing in the south-east of the region (Figure 10). This is consistent with findings elsewhere in Victoria (Wilkinson & Cary 1993) that investment in the techniques of conservation cropping is more likely to be undertaken by specialised cropping farmers rather than what might be called opportunistic croppers. The south-east is an area where grazing tends to predominate over cropping activities.



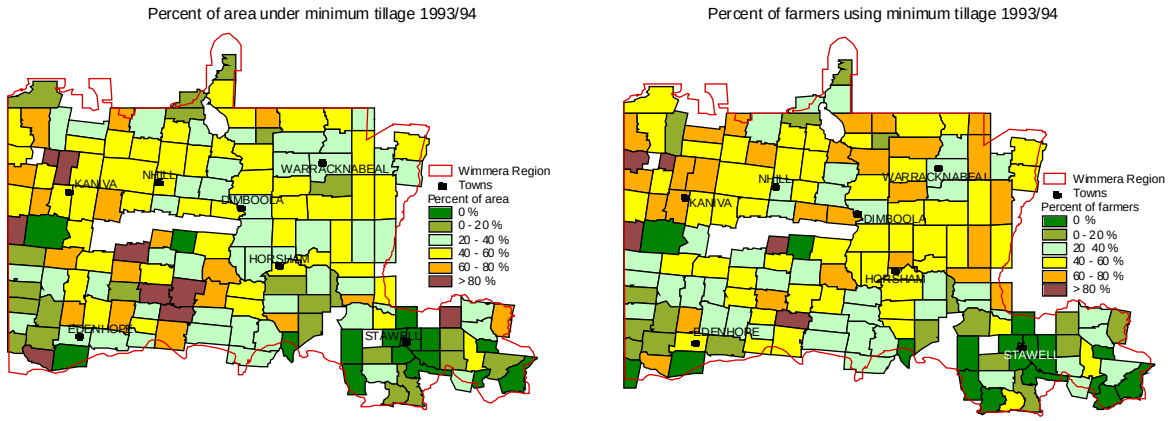
Source: Australian Bureau of Statistics (1993/94)

Figure 7 Proportion of tillage methods used in different soil types in the Wimmera Region (1993/94)



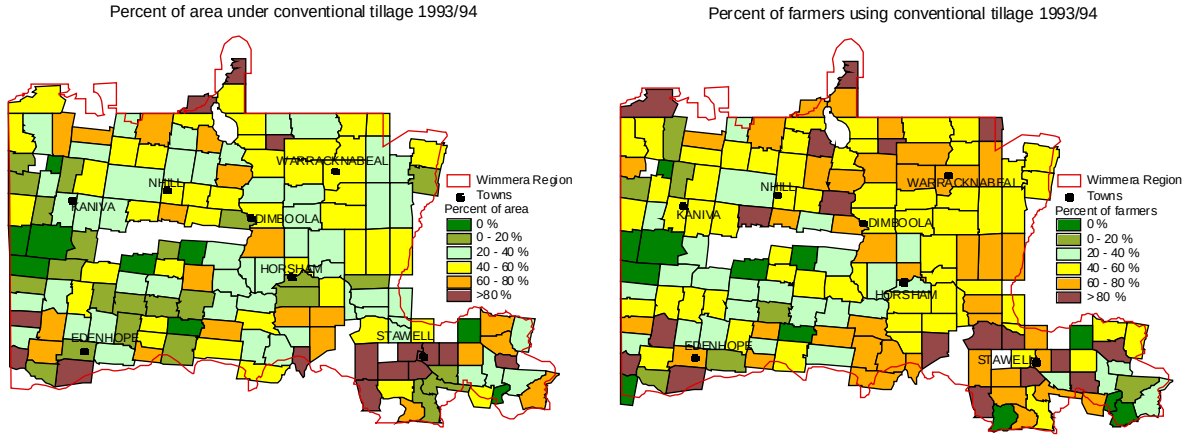
Source: Australian Bureau of Statistics (1993/94)

Figure 8 Distribution of direct drilling in the Wimmera Region (1993/94)



Source: Australian Bureau of Statistics (1993/94)

Figure 9 Distribution of minimum tillage across the Wimmera Region (1993/94)



Source: Australian Bureau of Statistics (1993/94)

Figure 10 Distribution of conventional tillage in the Wimmera Region (1993/94)

Using the Warracknabeal study to calibrate ABS tillage data

The ABS farm census question on cultivation in the 1993/94 farm census is not tightly defined, leaving farmers to categorise whether their practices fit within the descriptions of conventional tillage, minimum tillage or direct drilling.

In seeking to make a comparison between the ABS and University of Melbourne data, it has been assumed that direct drilling is interpreted as meaning sowing with no cultivation, minimum tillage is sowing with one or two cultivations and conventional tillage is sowing with three or more cultivations.

Significant discrepancies exist between the two data sets. The area of direct drilling recorded by University of Melbourne is significantly greater than recorded in the ABS farm census (Table 4). Despite the lower area of direct drilling recorded by the ABS, the ABS adoption rate figure is much higher than the University of Melbourne study at 61 percent. It can only be concluded that this is a coding error and it has been omitted from the table.

The limitations discussed above must be borne in mind when considering the full set of ABS tillage data for the Wimmera for the season 1993/94. This data may underestimate the area of direct drilling and overestimate the area of conventional tillage. The overall aggregated Wimmera data shown in Table 3 is very similar to the ABS data for Warracknabeal Shire.

Farmers reported a greater area of conventional tillage to the farm census than was reported to interviewers in the University of Melbourne study. Despite this, the percentage of farmers reporting conventional tillage to the census was lower than discovered by the University of Melbourne study.

There are a number of possible explanations for these differences. Firstly, it appears farmers have a tendency to not report the full variation of their crop management practices to the ABS farm census. Many farmers with relatively small areas of conventional tillage are not reporting this to the ABS. Other differences may lie in the lack of definition in the 1993/94 format of the farm census tillage question and the linking of chemical weed control practice to tillage practice. The question is framed with the assumption that tillage and chemical weed control are practices which substitute for each other. Results of the University of Melbourne Warracknabeal study show there is in fact no correlation between tillage practice and use of chemicals.

Table 4 Comparison of ABS 1993/94 data and University of Melbourne cultivation data for the Warracknabeal Shire

Definitions		Percentage of crop area		Adoption rate	
ABS	University of Melbourne	ABS	University of Melbourne	ABS	University of Melbourne
Direct drilling	Direct drilling	19.0	29.2 (±2.7)	n.a.	46 (±4.6)
Minimum tillage	1 or 2 cultivations	37.0	35.1(±2.1)	46.7	80 (±3.7)
Conventional tillage	3 or more cultivations	44.0	35.7(±3.0)	57.0	90 (±2.8)

Sources: Australian Bureau of Statistics (1993/94); Wilkinson & Cary (1993).

3.1.3 1994/95 Australian Bureau of Statistics

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

There was a 3 percent increase in the area direct drilled and a 6 percent increase in its adoption rates during 1994/95 compared to the previous year. The reported reduction in crop land sowed 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 5). Spatial distribution of adoption levels in each parish for 1994/95 season is shown in Figures 11, 12 and 13. The use of direct drilling is most common in the north-east of Horsham and in the south-west of the region. There is a greater tendency to minimise cultivation in the south-west of the Wimmera Region.

Table 5 Tillage practices in the Wimmera Region (1994/95)

	Direct drilling	Minimum tillage	Conventional tillage
Area (%)	21	24	55
Farms (%)	25	36	65

Source: Australian Bureau of Statistics (1994/95)

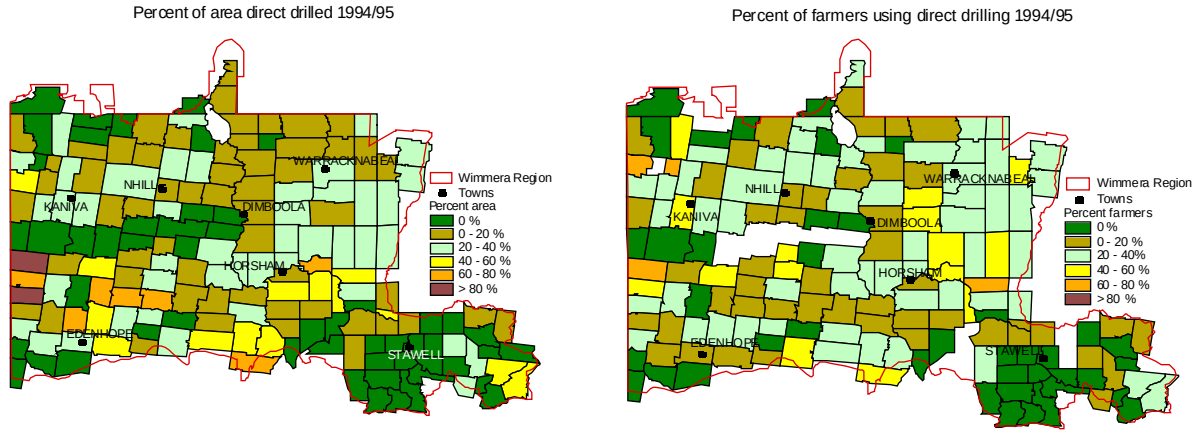
The apparent underestimation of the area of direct drilling and the overestimation of conventional tillage area by ABS farm census data is once again evident in the 1994/95 data set. The area of direct drilling recorded by 1994/95 ABS census in Warracknabeal was half the area recorded in University of Melbourne survey, while the reported area of conventional tillage was almost twice as the area recorded by the University survey (Table 6).

However, the ABS measure of minimum tillage sowing with one cultivation for the Warracknabeal Shire area corresponds closely with the University of Melbourne measure of the area sown under one cultivation. The ABS measured 17.3 percent of crop land sowed with one cultivation, while University of Melbourne survey measured 15.4 percent of crop land as being cultivated with one cultivation. The previous year's comparison between the ABS measure of minimum tillage and University of Melbourne measure for one or two cultivations also corresponds closely. It may be that most farmers have interpreted minimum tillage as one or two cultivations when responding to the ABS tillage question. However, a similar comparison between ABS measure of minimum tillage and data from a sample survey of cropping practices in the North Central Region has shown that some farmers may have interpreted minimum tillage as being one cultivation and others may have interpreted it as two cultivations (see report on Adoption of Best Management Practices in North Central Victoria).

Table 6 Comparison of ABS 1994/95 data and University of Melbourne cultivation data for the Warracknabeal Shire.

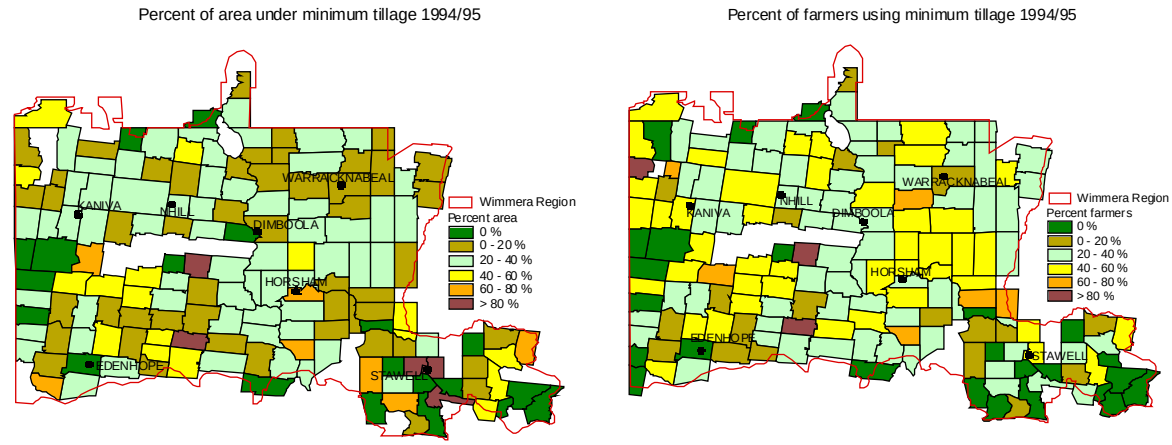
Definitions		Percentage of crop area		Adoption rate	
ABS	University of Melbourne	ABS	University of Melbourne	ABS	University of Melbourne
Direct drilling	Direct drilling	15.5	29.2 (±2.7)	25	46 (±4.6)
1 cultivation	1 or 2 cultivations	17.3	35.1(±2.1)	33	80 (±3.7)
More than one cultivation	3 or more cultivations	67.0	35.7(±3.0)	75	90 (±2.8)

Sources: Australian Bureau of Statistics (1994/95); Wilkinson & Cary (1993).



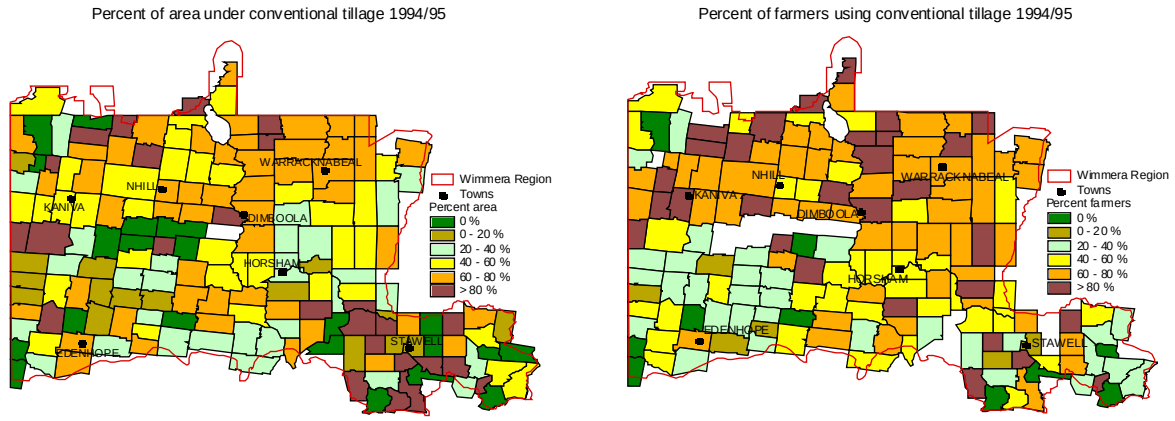
Source: Australian Bureau of Statistics (1994/95)

Figure 11 Distribution of direct drilling in the Wimmera Region (1994/95)



Source: Australian Bureau of Statistics (1994/95)

Figure 12 Distribution of minimum tillage in the Wimmera Region (1994/95)

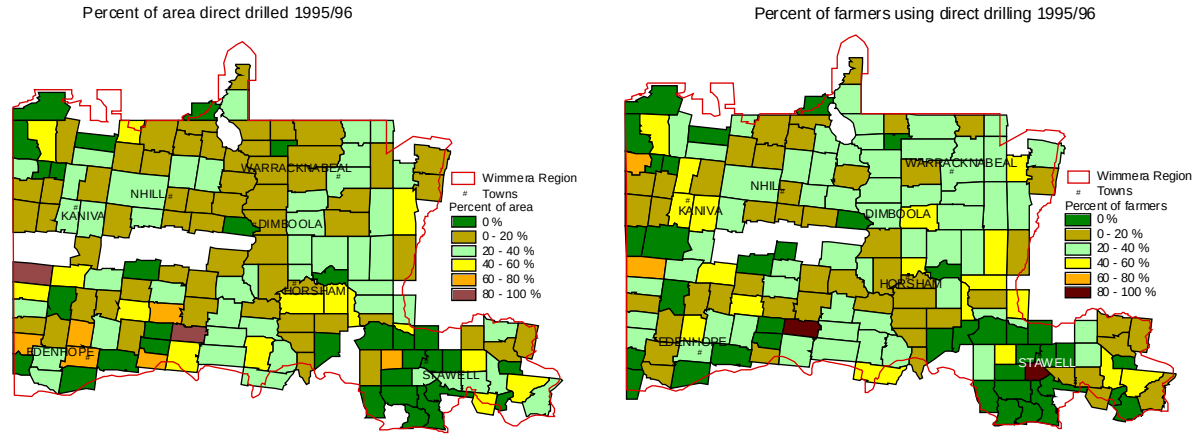


Source: Australian Bureau of Statistics (1994/95)

Figure 13 Distribution of conventional tillage in the Wimmera Region (1994/95)

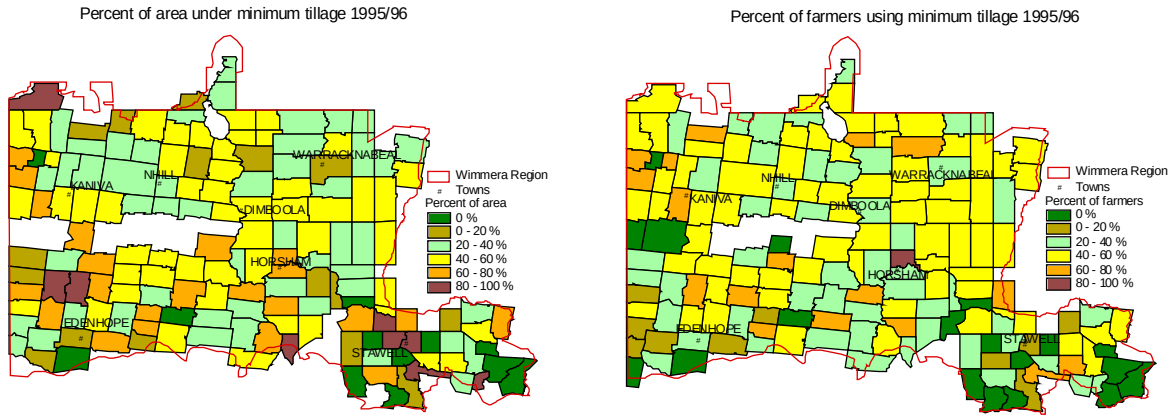
3.1.4 1995/96 Australian Bureau of Statistics

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 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 measures between the two years. The percentage of crop land sown with direct drilling has increased by 1 percent during this year while the number of farmers direct drilling their crops has decreased by the same percentage. However, both the number of farmers direct drilling and the area direct drilled have slightly decreased. Spatial distribution of adoption levels in each parish for 1995/96 season is shown in Figures 14, 15 and 16.



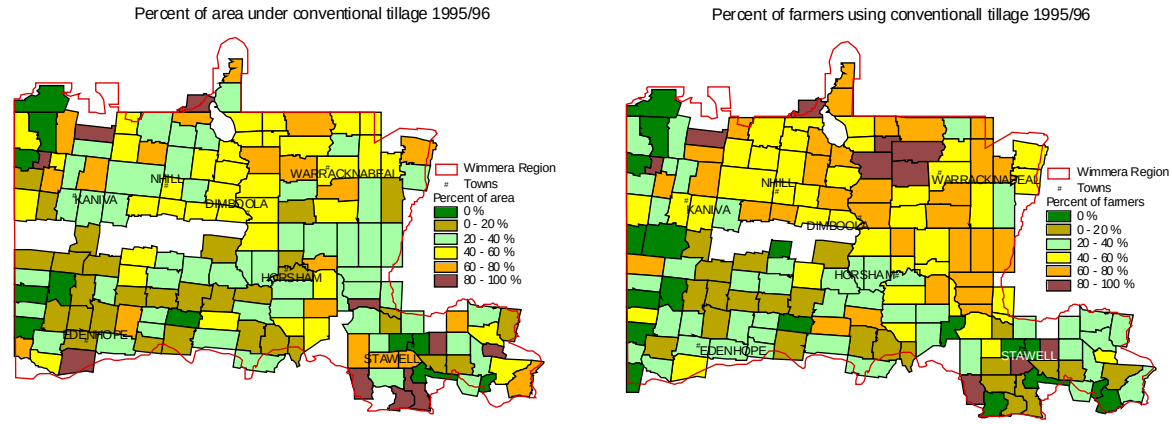
Source: Australian Bureau of Statistics (1995/96)

Figure 14 Distribution of direct drilling in the Wimmera Region (1995/96)



Source: Australian Bureau of Statistics (1995/96)

Figure 15 Distribution of minimum tillage in the Wimmera Region (1995/96)



Source: Australian Bureau of Statistics (1995/96)

Figure 16 Distribution of conventional tillage in the Wimmera Region (1995/96)

3.1.5 1996/97 Australian Bureau of Statistics

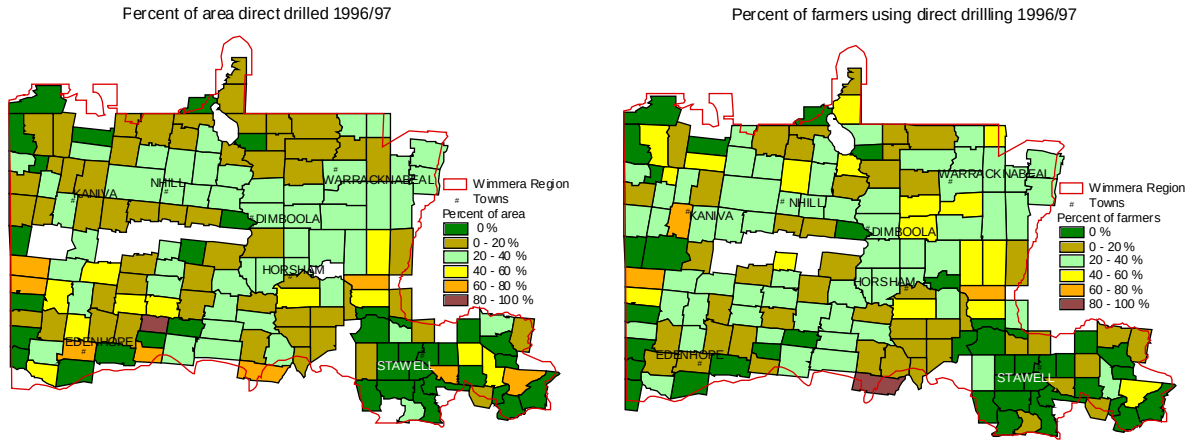
In 1996/97 ABS repeated the 1995/96 form of the tillage question to overcome the definitional problems of the previous questions. This allows a direct comparison of these two sets of data. In contrast to the previous year, more farmers (2 percent) have reported direct drilling on an increased area of crop land (1 percent). There is a significant increase in the adoption of minimum tillage, while the use of conventional tillage has declined (Table 7). The increase in direct drilling is mainly to the north of Horsham while minimum tillage is dominant in the west of the region (Figures 17, 18 and 19).

Figures 20 and 21 show the trends in adoption of different tillage methods on crop land in the Wimmera Catchment Management Region from 1993/94 to 1996/97. The area of direct drilling had a minimal increase over the period of four years with an average of 1 percent per year. The impact of wording changes in defining 'limited cultivation' on the results obtained should be taken in to consideration when interpreting these trends for conventional and limited cultivation. The large variation in these two measures in 1994/95 can be explained as a result of this change in the definition.

Table 7 Cultivation techniques used by Wimmera farmers (1994/95-1996/97)

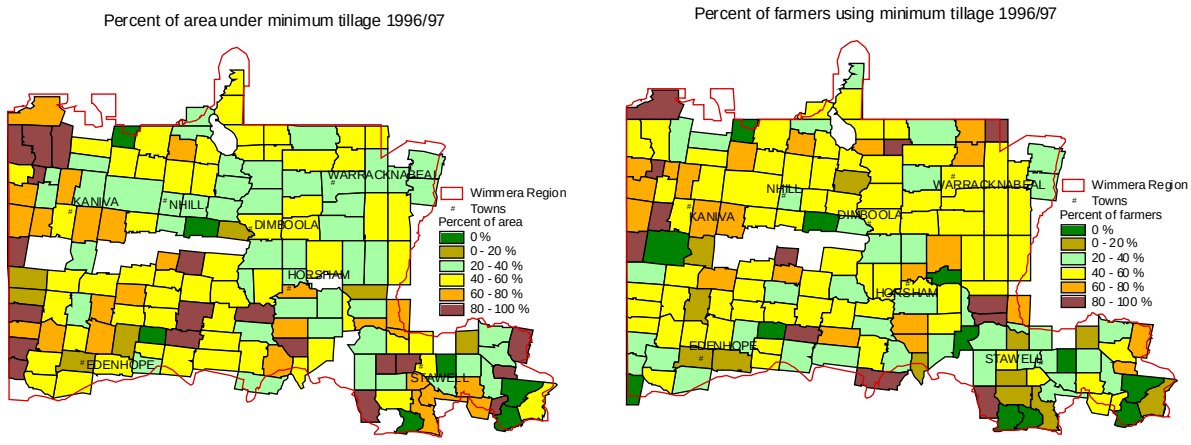
Year	Conventional tillage		Minimum tillage		Direct drilling	
	% Farmers	% Area	% Farmers	% Area	% Farmers	% Area
1993/94	53	39	46	43	19	18
1994/95	65	55	36	24	25	21
1995/96	48	39	45	39	24	22
1996/97	44	34	48	43	26	23

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



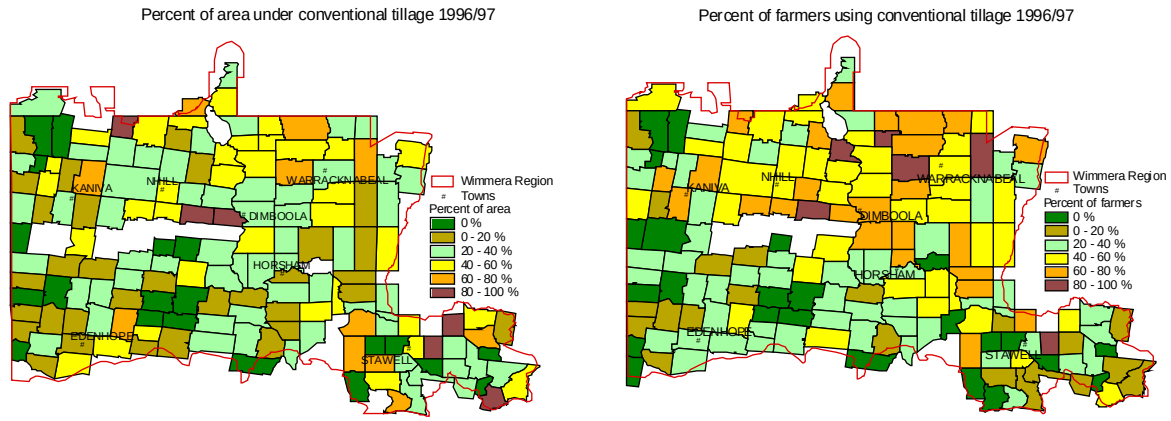
Source: Australian Bureau of Statistics (1996/97)

Figure 17 Distribution of direct drilling in the Wimmera Region (1996/97)



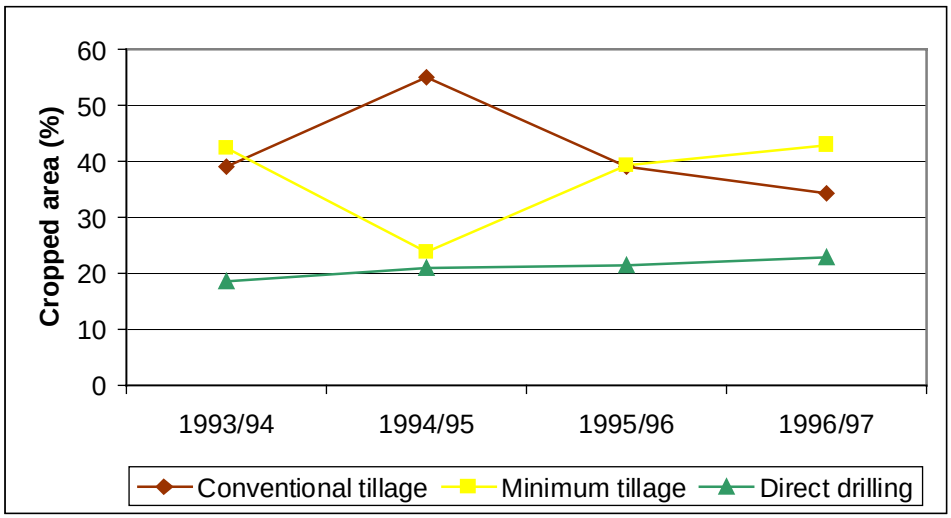
Source: Australian Bureau of Statistics (1996/97)

Figure 18 Distribution of minimum tillage in the Wimmera Region (1996/97)



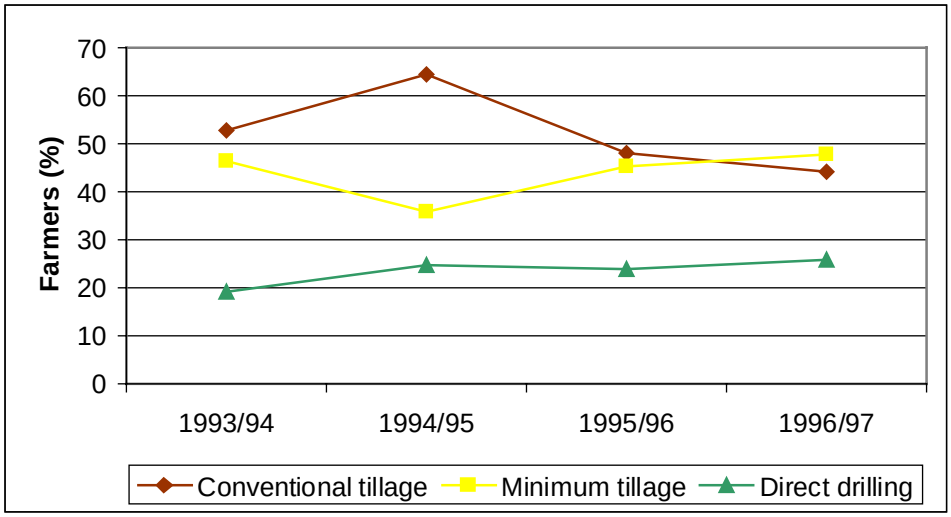
Source: Australian Bureau of Statistics (1996/97)

Figure 19 Distribution of conventional tillage in the Wimmera Region (1996/97)



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

Figure 20 Cultivation techniques used by Wimmera cropping farmers (percent area) (1993/94-1996/97)



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

Figure 21 Cultivation techniques used by Wimmera cropping farmers (percent farmers) (1993/94-1996/97)

3.1.6 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 Warracknabeal Shire. The perceived advantages of direct drilling, in order of importance were:

- Saves money-68 percent (±4.5)
- Improves soil-62 percent (±4.5)
- Saves time-52 percent (±4.6)
- Conserves moisture-34 percent (±4.4)
- Improves trafficability-21 percent (±3.7)
- Increases yield-6 percent (±2.2)

Beliefs about savings in time, moisture retention and trafficability are the most influential in the decision of farmers as to whether to use minimal cultivation or direct drilling. More detailed analysis of the University of Melbourne survey data shows 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 major disadvantages of direct drilling were:

- Increased risk of mice plagues-50 percent (±4.6)
- Increased chemical use-42 percent (±4.5)
- Need proper machinery-41percent (±4.5)
- Poor seed bed-19 percent (±3.6)
- Lower yields-16 percent (3.4)

With the exception of concern about the poor seed bed formed by direct drilling, there is no significant difference in the adopters and non-adopters' perceptions of the disadvantages of direct drilling. Both are equally concerned about the risk of mice plagues, the use of chemicals and the need for proper machinery.

3.2 Stubble management

3.2.1 1993 University of Melbourne Warracknabeal study

Measurement of stubble management methods is quite complex. This complexity is obvious in the University of Melbourne survey schedule. Burning of stubble is common, practiced by 83 percent (±3.4) of cropping farmers in 1993. Thirty-six percent (±1.5) of stubbles were burnt in this season. Cool autumn burning was the most common practice, closely followed by hot burning. A small area of stubble was burnt in combination with grazing or mulching.

Incorporation of stubble was the most common stubble management practice, being used on 41 percent (±1.5) of stubble areas by 74 percent (±4.0) of farmers. The two most common incorporation practices were straight incorporation, or grazing prior to incorporation. Incorporation was also combined with mulching, grazing and hay cutting in a number of other combinations, accounting for 8 percent of all stubbles.

Stubble retention is the least favoured method of stubble management, practised by 33 (±4.3) percent of farmers on 23 (±1.3) percent of stubbles. The most common method of stubble retention is in combination with grazing. Almost as common is simple stubble retention with no other method of stubble mass reduction. Other minor retention methods are combined with mulching, grazing and mulching, and cutting hay (Table 8).

Table 8 Stubble management methods used in the Warracknabeal Shire (1992/93)

Stubble management method	Area (ha)	Area within stubble management type (%)	Area of all stubble (%)	Farmers (%)
BURNING				
Cool burn	7582	43	16 (±1.1)	
Hot burn	6651	38	14 (±1.1)	
Graze and burn	3191	18	7 (±0.8)	
Burn and mulch	280	2	1 (±0.3)	
Total	17 704		36 (±1.5)	83 (3.4)
INCORPORATION				
Graze and incorporate	8437	42	17 (±1.2)	
Incorporate	7711	39	16 (±1.1)	
Mulch and incorporate	1499	7	3 (±0.5)	
Cut hay and incorporate	1341	7	3 (±0.5)	
Graze, mulch and incorporate	911	5	2 (±0.4)	
Cut, graze and incorporate	88			
Total	19 987		41 (±1.5)	74 (±4.0)
RETENTION				
Graze and retain	4624	42	9 (±0.9)	
Retain	3742	34	8 (±0.8)	
Mulch and retain	901	8	2 (±0.4)	
Cut hay and retain	54			
Graze, mulch and retain	1738	16	4 (±0.6)	
Total	11 059		23 (±1.3)	33 (±4.3)

Source: Wilkinson & Cary (1993)

A simple market segmentation may be developed from the trash management behaviour reported to the University of Melbourne interviewers (Table 9). There are four groups. The conventional farmers comprise 31 percent of the population. These farmers burn the overwhelming majority of their stubbles. The largest group is the incorporators. These farmers comprise 37 percent of the population. They incorporate 71 percent of their stubble, The remainder of their stubble is mostly burnt. In between these two segments is a small transition group who tends to equally burn and incorporate stubble. The remaining group of 13 percent of the population are focussed predominantly on trash retention as the major method of stubble management. Clearly stubble retention is an activity adopted by a minority of farmers.

Table 9 A simple segmentation of the adoption of stubble retention in the Warracknabeal Shire (1992/93)

Market segment	Population (%)	Stubble burnt-mean (%)	Stubble incorporated-mean (%)	Stubble retained-mean (%)
Conventional	31 (±4.2)	84 (±2.7)	11 (±2.2)	4 (±1.6)
Intermediate	13 (±3.1)	54 (±1.3)	44 (±1.0)	1 (±1.7)
Incorporators	37 (±4.4)	24 (±2.5)	71 (±2.4)	4 (±4.4)
Trash farmers	13 (±3.1)	14 (±3.9)	18 (±4.6)	67 (±4.7)

Source: Wilkinson & Cary (1993)

3.2.2 1994/95 Australian Bureau of Statistics

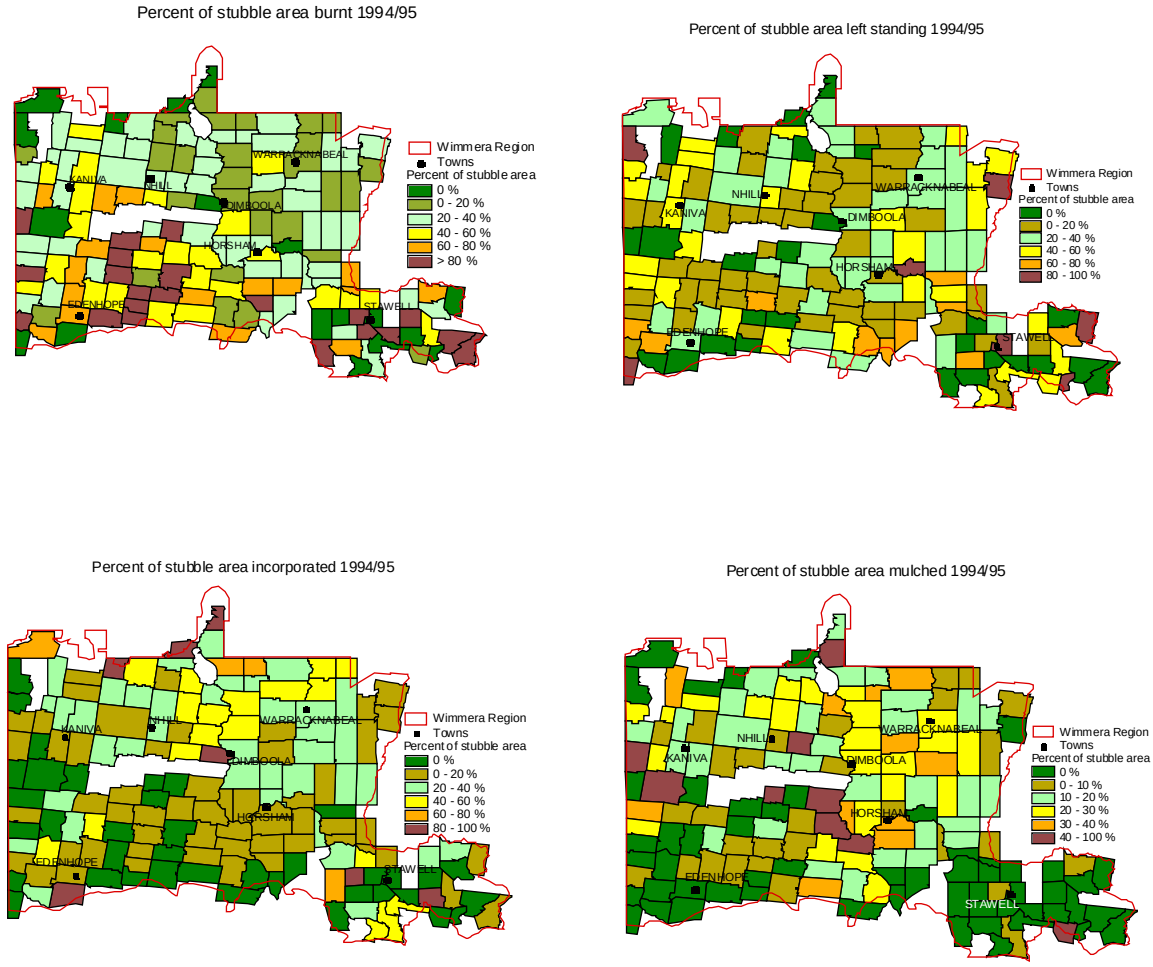
In 1994/95 the Australian Bureau of Statistics included a stubble retention question. Farmers were asked to report the area of crop land on which the different crop stubble techniques were used. The format of this question is given in Appendix 2.

Stubble burning was still the most common method practiced by 44 percent of cropping farmers. These farmers burned 29 percent of stubbles (Table 10). Burning was a common practice in the southern cropping zone of the region. More than 60 percent of stubble was burnt in most parishes in this part of the region, while less than 40 percent of stubble were burnt in the northern part of the region (Figure 22). High rates of stubble burning in the southern areas with low cropping intensities may reflect a lack of commitment to investments in conservation cropping technology by farmers on predominantly grazing based properties. Most of these farmers appear to practice a conventional cropping management system by burning their stubble and cultivating soil before sowing their crops. Twenty-eight percent of the stubble in the region was left standing by 26 percent of farmers. Incorporation and mulching of stubble was equally favoured, both being adopted by approximately 25 percent of the cropping farmers in the region. However, a lesser area of stubble was mulched than incorporated.

Table 10 Adoption of stubble management in the Wimmera Region (1994/95)

	Burn		Incorporated		Mulched		Left standing	
	% Area	% Farmers	% Area	% Farmers	% Area	% Farmers	% Area	% Farmers
Wimmera	29	44	24	24	19	25	28	26

Source: Australian Bureau of Statistics (1994/95)



Source: Australian Bureau of Statistics (1994/95)

Figure 22 Stubble management method used by Wimmera cropping farmers (1994/95)

3.2.3 1995/96 Australian Bureau of Statistics

In the following year the Australian Bureau of Statistics asked a modified stubble retention question (see Appendix 2). 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 responses to the previous year's question. It is quite possible that different techniques were used on the one area of stubble (e.g. mulching and incorporating). Finally, the question was to be applied to crop and pasture stubble prior to sowing, rather than to crop stubble as in the previous year. There may be some difficulties in making comparisons with data from the previous year. This is explored in a later section of this report.

Measures for all methods of stubble management have reduced significantly during this year. This may partly be due to the inclusion of grazing and baling as a separate category in the question. At least some farmers from all four categories in 1994/95 have managed their stubble in combination with grazing or baling. This is consistent with the findings from the Warracknabeal survey which shows that grazing stubble was a popular practice among most farmers before it was either burnt, incorporated or left standing. Burning was still the most commonly used practice by 34 percent of the farmers. Sixteen percent of stubble was either heavily grazed or

baled by another 21 percent of farmers, while mulching was practised by 19 percent on 22 percent of their stubble. Grazing was more popular in the southern part of the region where grazing industry predominates while less than 20 percent of the stubble was grazed in the area north of Horsham (Figure 23). Incorporation and stubble retention were equally favoured, both being adopted by 17 percent of farmers (Table 11).

Table 11 Adoption of stubble management in the Wimmera Region (1994/95-1996/97)

	Burn		Incorporated		Mulched		Left standing		Grazing/baling	
	% Area	% Farmers	% Area	% Farmers	% Area	% Farmers	% Area	% Farmers	% Area	% Farmers
1994/95	29	44	24	24	19	25	28	26		
1995/96	23	34	19	17	22	19	20	17	16	21
1996/97	27	40	13	15	26	23	20	19	14	19

Source: Australian Bureau of Statistics (1994/95, 1995/96 and 1996/97)

3.2.4 1996/97 Australian Bureau of Statistics

In the following year the Australian Bureau of Statistics asked the same stubble retention question. The survey results indicated an increase in the use of stubble burning being used on 27 percent of the stubble area by 40 percent of the farmers. Stubble mulching has considerably increased while both grazing and incorporating stubble have slightly decreased. The area of stubble retained had not changed over the year. The spatial distribution of adoption of these practices is shown in Figure 24.

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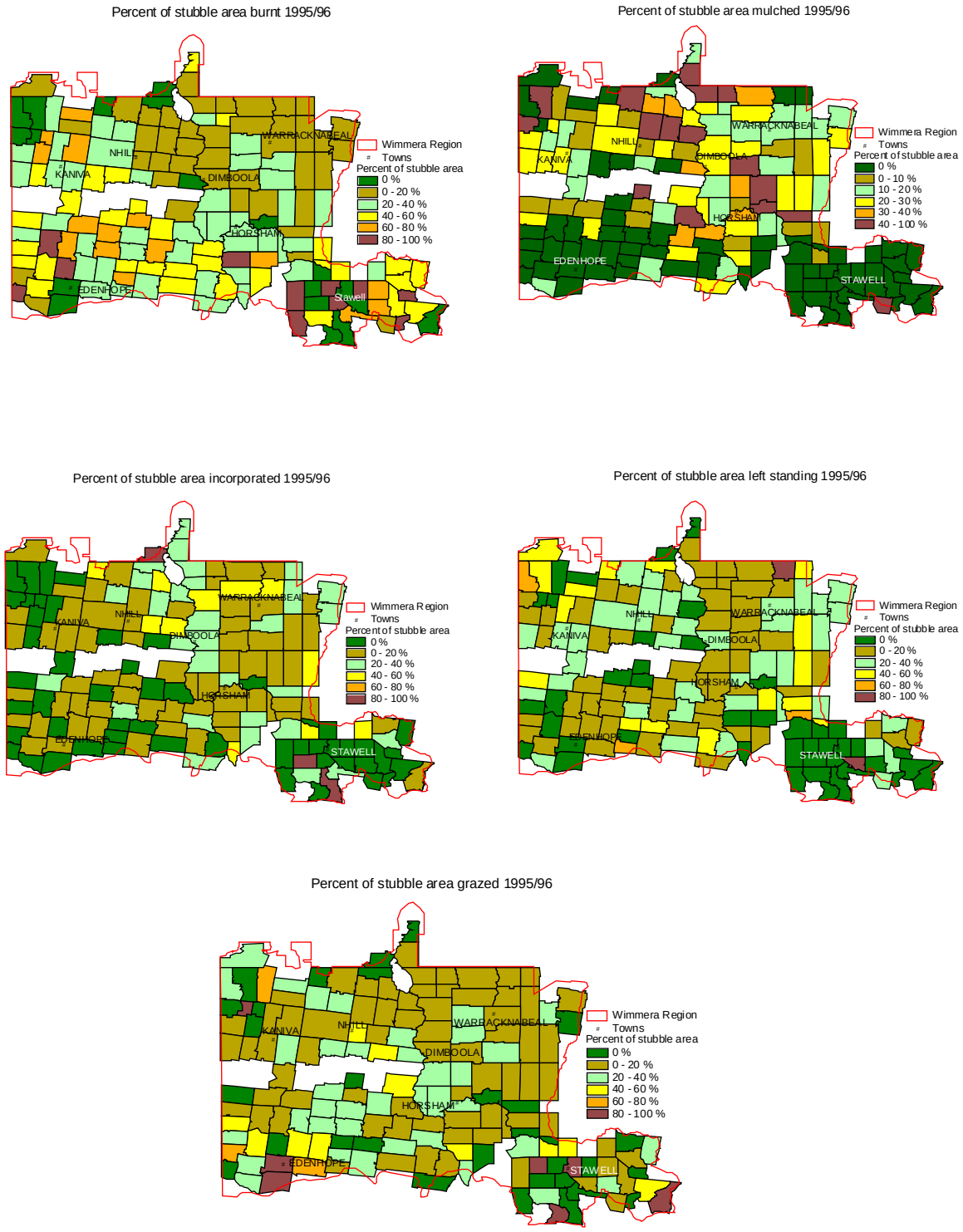
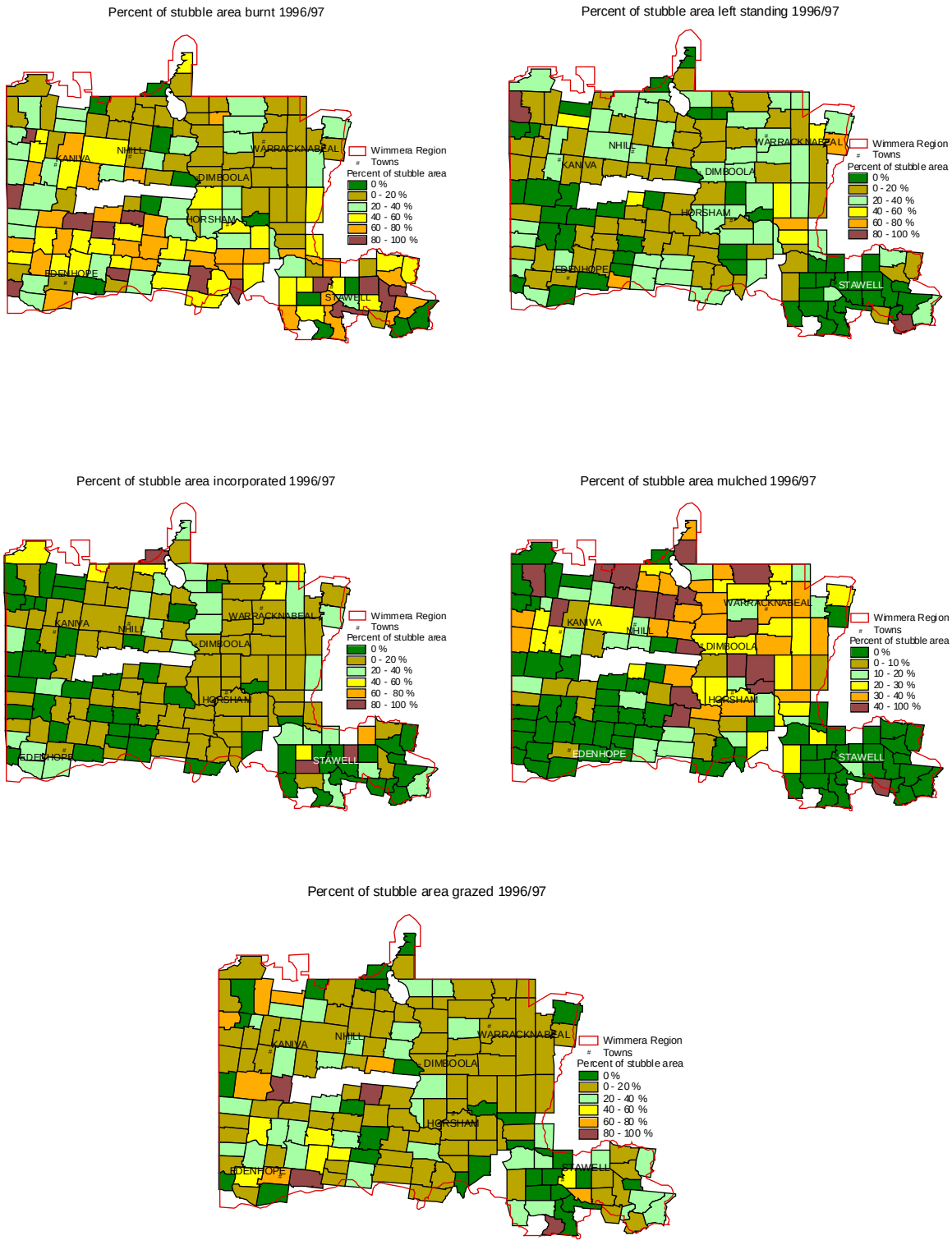


Source: Australian Bureau of Statistics (1995/96)

Figure 23 Stubble management methods used by Wimmera farmers (1995/96)



Source: Australian Bureau of Statistics (1996/97)

Figure 24 Stubble management methods used by Wimmera farmers (1996/97)

Using the Warracknabeal study to calibrate ABS stubble data

There are differing interpretations of the word 'incorporation' amongst cropping farmers and these differences may affect the measurement of stubble management practice in other studies. A farmer who practices direct drilling and describes his/her stubble management method as 'leaving stubble standing' may be considered to be employing a classic conservation cropping trash farming system, where the crop is sown into the stubble of the preceding year's crop. However, a farmer who does not practice direct drilling may also describe his/her stubble management practice as 'leaving stubble standing'. Stubble in this case would only be left standing until the sowing of the next crop when the remains of the crop are incorporated. In the Warracknabeal survey, 22 percent of the stubble described by farmers as 'left standing' was incorporated in preparation for the sowing of the next crop. To this farmer the stubble management phase of the crop cycle clearly finishes with the commencement of the sowing phase. This problem is overcome in the ABS farm census stubble question by specifically linking stubble retention with direct drilling.

The difficulty, however, of describing a complex farm management behaviour such as stubble retention, within the simple format of a single question, will lead to interpretative difficulties with the ABS question. This is particularly so where stubble is managed by a combination of practices which are separated into more than one category in the ABS question (e.g. grazing and mulching or graze, mulch and leave standing). The possibility for social desirability influencing answers and the already recounted tendency to discount cultivation dictates the need for caution in interpreting results. This is demonstrated in the attempt to reclassify the data from the Warracknabeal study into a form comparable with recent stubble management questions in ABS farm censuses. Small but significant changes in categories have produced large differences in results, many of which would not be detected in a naive scan of the data (Table 12).

Table 12 Reclassification of answers to Warracknabeal 1993 data according to ABS farm census questions in 1994/95 and 1995/96.

Census Year	Data source	Question categories				
1994-95		Burnt (%)	Incorporated (%)	Mulched (%)	Standing (%)	
	Warracknabeal survey	36	36	11	16	
	ABS data (Warracknabeal Shire)	24	33	17	26	
	ABS(Wimmera Region)	29	24	19	28	
1995-96	Data source	Hot burn (%)	Baling, grazing, fire harrow (%)	Incorporated (%)	Mulched (%)	Standing (%)
	Warracknabeal survey	14	51	16	11	8
	ABS data (Warracknabeal Shire)	13	16	27	17	16
	ABS(Wimmera Region)	23	16	19	22	20

Sources: Wilkinson & Cary (1993); Australian Bureau of Statistics (1994/95, 1995/96).

3.2.5 Barriers to the adoption of stubble retention

The University of Melbourne study of the Warracknabeal district reveals the main perceived advantages and disadvantages of stubble retention. The advantages are clearly seen in terms of soil conservation:

- Improved moisture storage capacity-65 percent (±4.4)
- Improving soil structure-62 percent (±4.5)
- Preventing erosion-59 percent (±4.5)

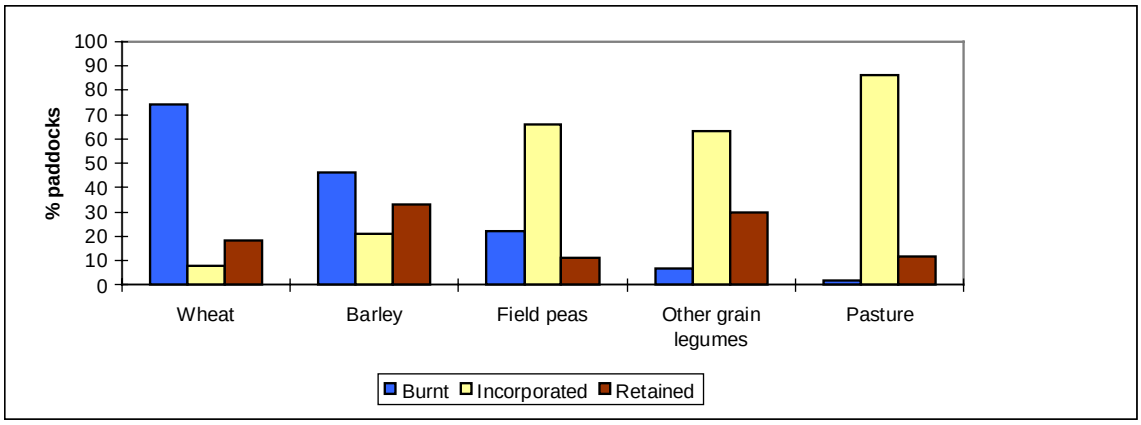
In contrast to the limited number of perceived advantages, there is a long list of perceived disadvantages of stubble retention.

- Disease carryover-53 percent (±4.6)
- Lack of machinery-42 percent (±4.6)
- Mice plague risk-38 percent (±4.5)
- Trash blockages-38 percent (±4.5)
- Nitrogen tie-up-27 percent (±4.1)
- Less effective weed control-15 percent (±3.3)

According to the University of Melbourne study of the Warracknabeal district the adopters of stubble retention recognise the same disadvantages as non-adopters. The only clear difference in the attitudes of adopters and non-adopters of stubble retention is the belief in the soil conservation advantages of stubble retention.

The greatest determinant of stubble handling technique is the 'type' of crop stubble. In the Warracknabeal study, 75 percent of wheat stubble paddocks were burnt, but only 20 percent of field peas and 6 percent of grain legume stubble were burnt (Figure 25).

The croppers most likely to have high levels of stubble retention are those who have adopted continuous cropping systems with grain legume crops as a major component of the rotation. Farmers following a pasture/fallow/wheat or pasture/fallow/oats rotation will score more highly on the measure of stubble burning. However, if these farmers run a looser rotation with longer periods of pasture ley, the impact of stubble burning will be small compared to the improvement to soil structure from the pasture phase.



Source: Wilkinson & Cary (1993)

Figure 25 Stubble management strategies on different crop stubbles (1993)

3.3 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 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 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 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.

3.3.1 1991/92 Australian Bureau of Statistics

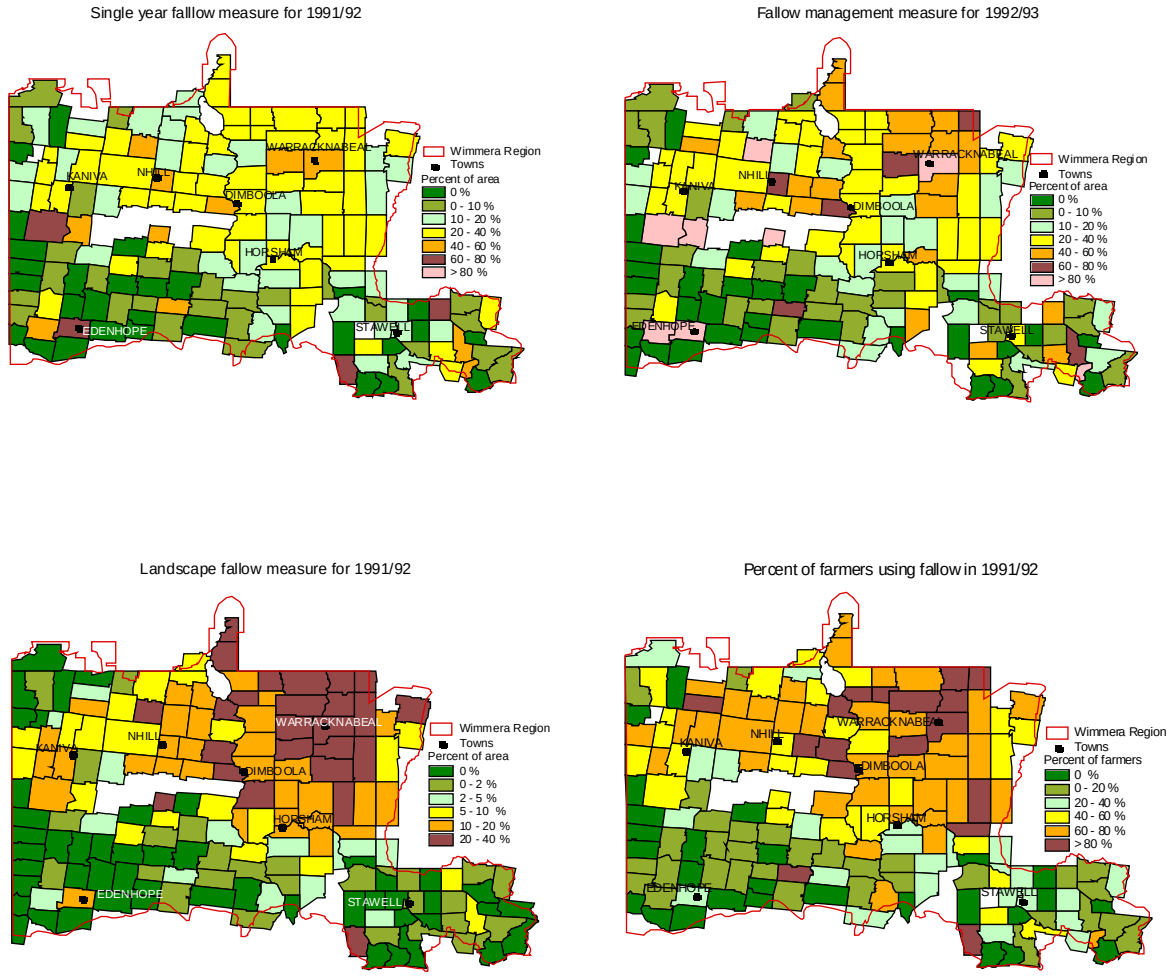
In 1991/92 farmers were asked the area of land which was 'fallowed and or spelled'. It is likely farmers will have interpreted the question as including long fallow, because of the use of the word 'spelled'. However, there is also a possibility that not all farmers included short fallow. Data in other regions has highlighted this as a methodological weakness in the question.

Table 13 shows calculations of the various fallow measures of usage, based upon 1991/92 fallow data and 1992/93 cropping data. Fallow was used by 51.7 percent of cropping farmers. Twenty-seven percent of 1992/93 crops were sown on land fallowed in the previous year. The mapping of parish data shows a clear pattern in the location of fallow utilisation (Figure 26). Fallow is more prevalent in the north of the region. This seems unrelated to soil types.

Table 13 The comparison of ABS and University of Melbourne measures of fallow management for Warracknabeal Shire and Wimmera Region.

Fallow management measures	University of Melbourne	ABS (1991/92)	ABS (1991/92)
	Warracknabeal Shire	Warracknabeal Shire	Wimmera Region
Fallow adoption rate (% farmers)	75	73	51.7
Single year fallow (% area)	31	35.7	23.6
Management fallow (% area)	-	50.8	27.6
Landscape fallow (% area)	15	27.5	9.8

Sources: Wilkinson & Cary (1993); Australian Bureau of Statistics (1991/92).

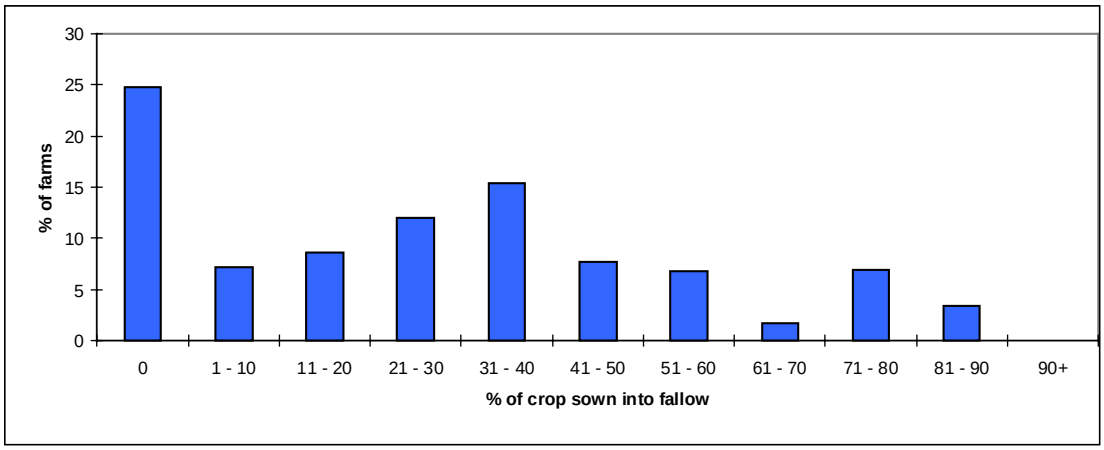


Source: Australian Bureau of Statistics (1991/92 and 1992/93)

Figure 26 Fallow management measures for the Wimmera Region (1991/92)

3.3.2 1993 University of Melbourne Warracknabeal study

The University of Melbourne data for Warracknabeal Shire confirms the usage of fallow measured by the ABS. The mean area of fallow on Warracknabeal farms in the 1992/93 season was 143 (±12) hectares. This was 31 percent (±1.0) of total crop area and 15 percent of total farm area. Fallow was used by 75 percent (±4.0) of farmers (Figure 27).



Source: Wilkinson & Cary (1993)

Figure 27 Fallow use in the Warracknabeal area (1992/93)

Table 13 shows the comparison between University of Melbourne and ABS data for the Warracknabeal Shire. Although these two data sets are from different years, they are the best means available of validating the ABS data. The ABS data shows that 73 percent of farmers utilised fallow in 1991/92, while the University of Melbourne data shows that 75 percent of farmers utilised fallow in 1993. According to ABS data, fallow was utilised in 35 percent of the Warracknabeal crop area. This was 27.5 percent of the total farm area which is defined as landscape fallow elsewhere in this report. The fallow management measure for 1991/92, constructed using 1992/93 crop area, shows 51 percent of the area in 1992/93 was cropped on fallow land. These figures are within an acceptably close range of the University of Melbourne data, suggesting a degree of confidence in the ABS data can be placed.

3.3.3 1994/95 Australian Bureau of Statistics

In 1994/95 a much improved format of the fallow question was asked In the ABS farm census. The format of this question is shown in Appendix 3. This specified time of fallow as 'before Christmas' and classified the fallow according to mechanical, chemical or pasture topping methods.

This shows that the fallow area had reduced by more than half during the three years from 1992 to 1995 (Table 14). Due to changes in question format, this result needs to be treated cautiously. The results also show that the area under cultivated fallow is three times larger than the area fallowed using a herbicide in 1994/95 season. This can be compared with future data to measure the expected trend away from cultivated fallow towards chemical fallow. The spatial distribution of adoption levels in each parish for 1994/95 season is shown in Figure 28. Fallow usage is clearly highest in the grey soil district of Warracknabeal and the north-east Wimmera.

Table 14 Measures of fallow usage in the Wimmera Region (1994/95)

Census year	Fallow adoption rate (%)	Single year fallow (%)	Fallow management (%)	Landscape fallow (%)
1991/92	51.7	23.6	27.6	9.8
1994/95	37	11.2	13	4.7

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

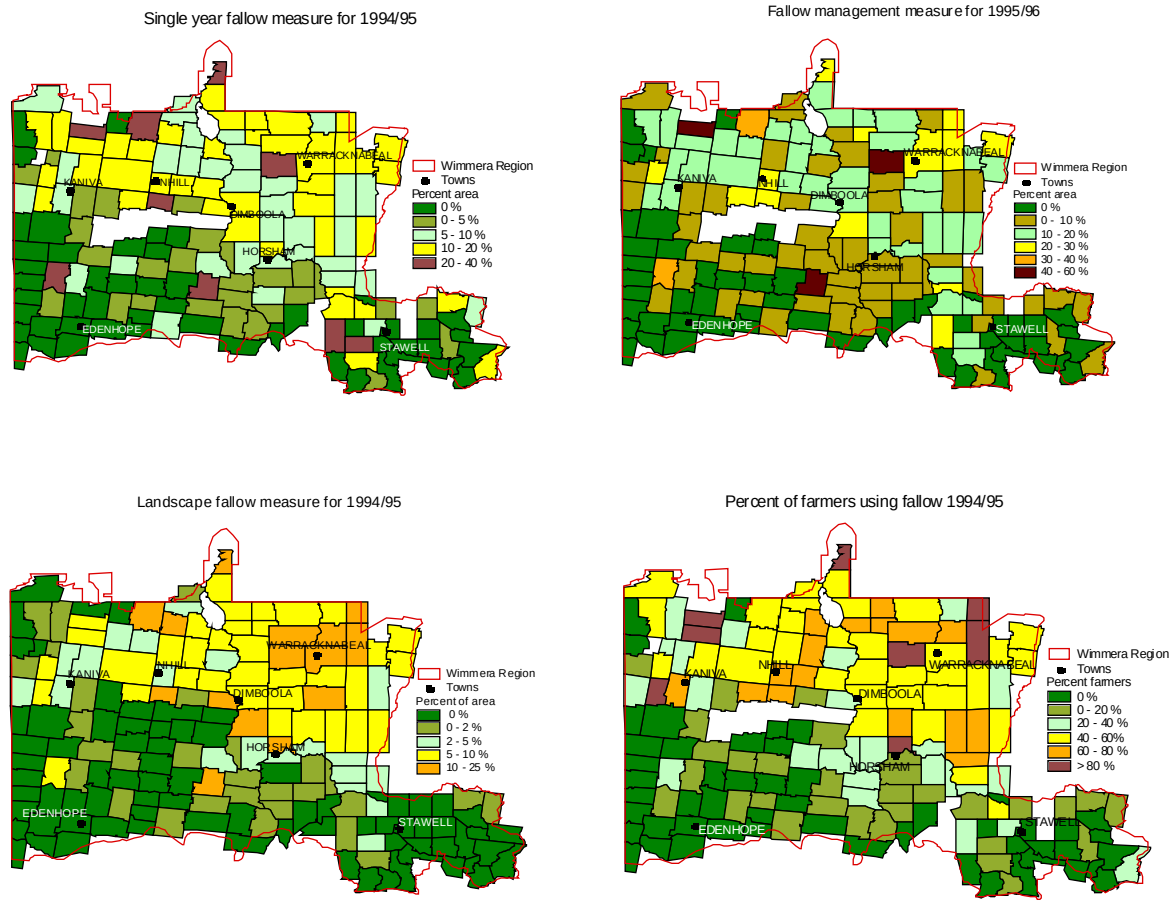
3.3.4 1995/96 Australian Bureau of Statistics

The 1994/95 format of the fallow question was repeated in the 1995/96 farm census. The only modification was to specify the cut off date as 31 December rather than as Christmas. This set of data shows a slight increase in the use of fallow compared to the huge reduction in 1994/95. Forty-three percent of farmers fallowed 14 percent of their crop area in 1995/96 season while 16 percent of the crops grown in 1996/97 was sown into land fallowed in 1995/96 season (Table 15). There is also a clear trend away from cultivated fallow towards the 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 29 and 30). The spatial variation in fallow adoption was again similar to the pattern shown in the previous year with higher fallow adoption rates in the Warracknabeal region (Figure 31).

Table 15 Measures of fallow usage in the Wimmera Region (1995/96)

Census Year	Fallow adoption rate (%)	Single year fallow (%)	Fallow management (%)	Landscape fallow (%)
1995/96	43.1	13.6	15.8	6.0
1996/97	43.3	12.5	-	5.7

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

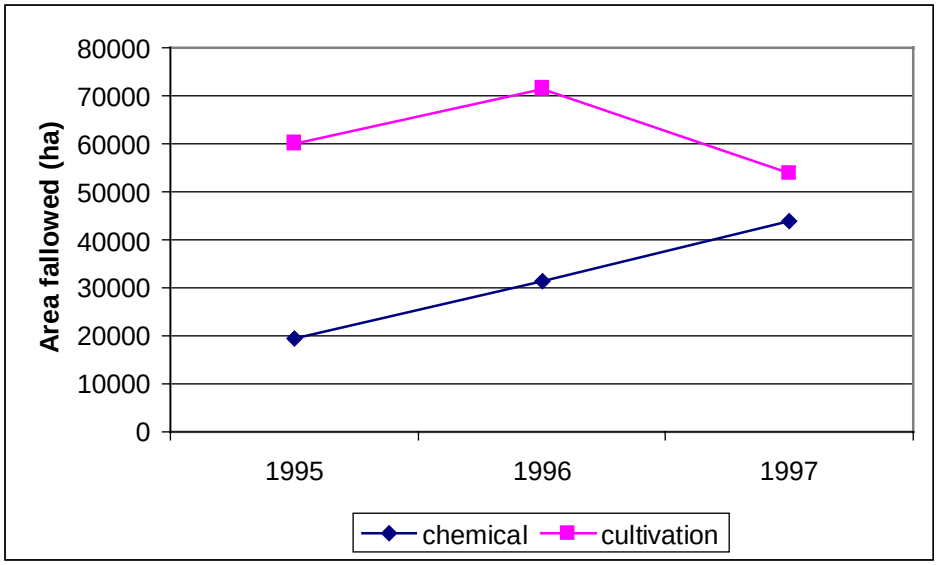


Source: Australian Bureau of Statistics (1994/95)

Figure 28 Single year fallow measure for the Wimmera Region (1994/95)

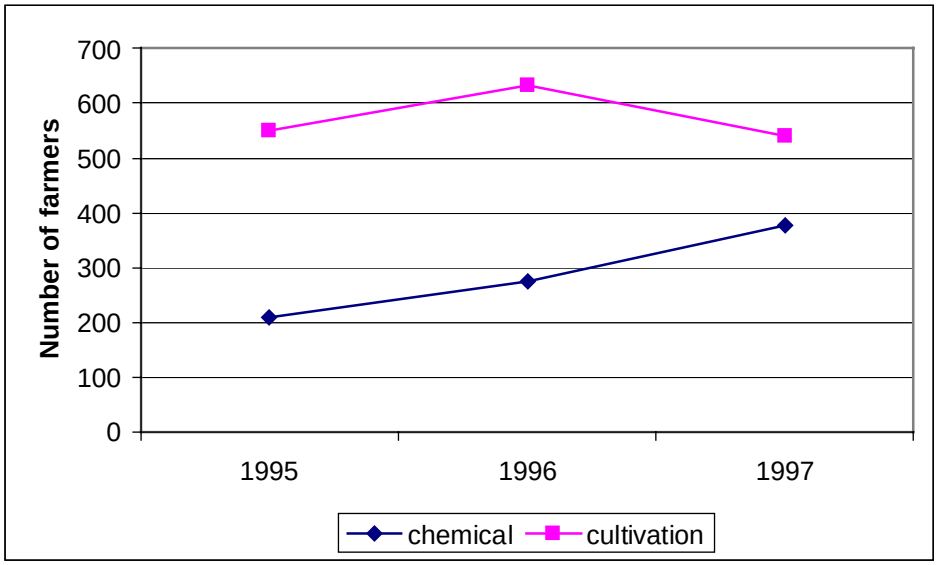
3.3.5 1996/97 Australian Bureau of Statistics

The 1995/96 format of the fallow question was repeated again in the 1996/97 farm census. The overall use of fallow remained unchanged during this season. Fallow was used by 43 percent of the cropping farmers on 13 percent of their crop land. However, the difference between the area under cultivation fallow and chemical fallow has further reduced with an increase in both the area and the number of farmers using chemicals on fallow and a decrease in the use of cultivation fallow compared to the previous year (Figures 29 and 30).



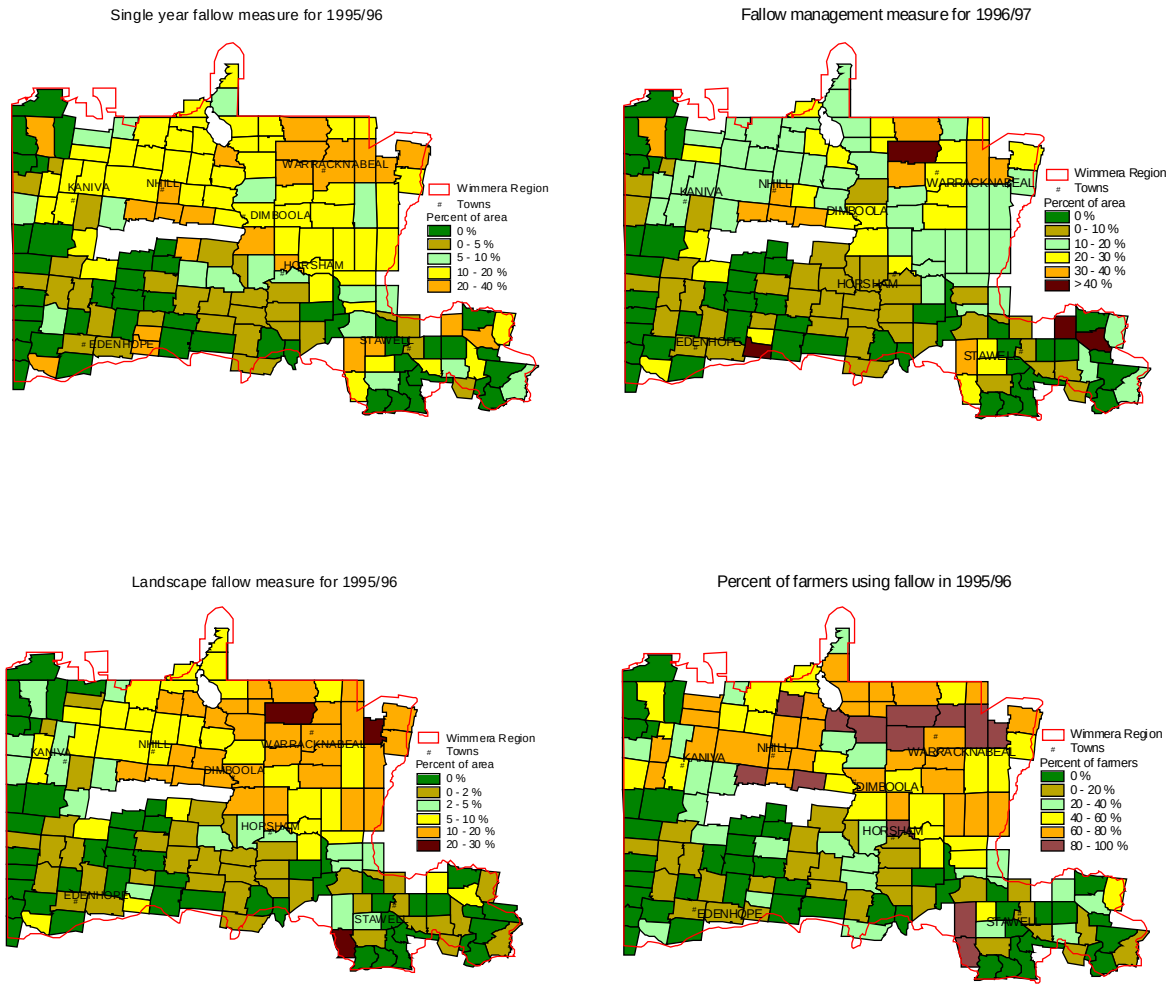
Source: Australian Bureau of Statistics (1994/95-1996/97)

Figure 29 Area under cultivation and chemical fallow (1995-97)



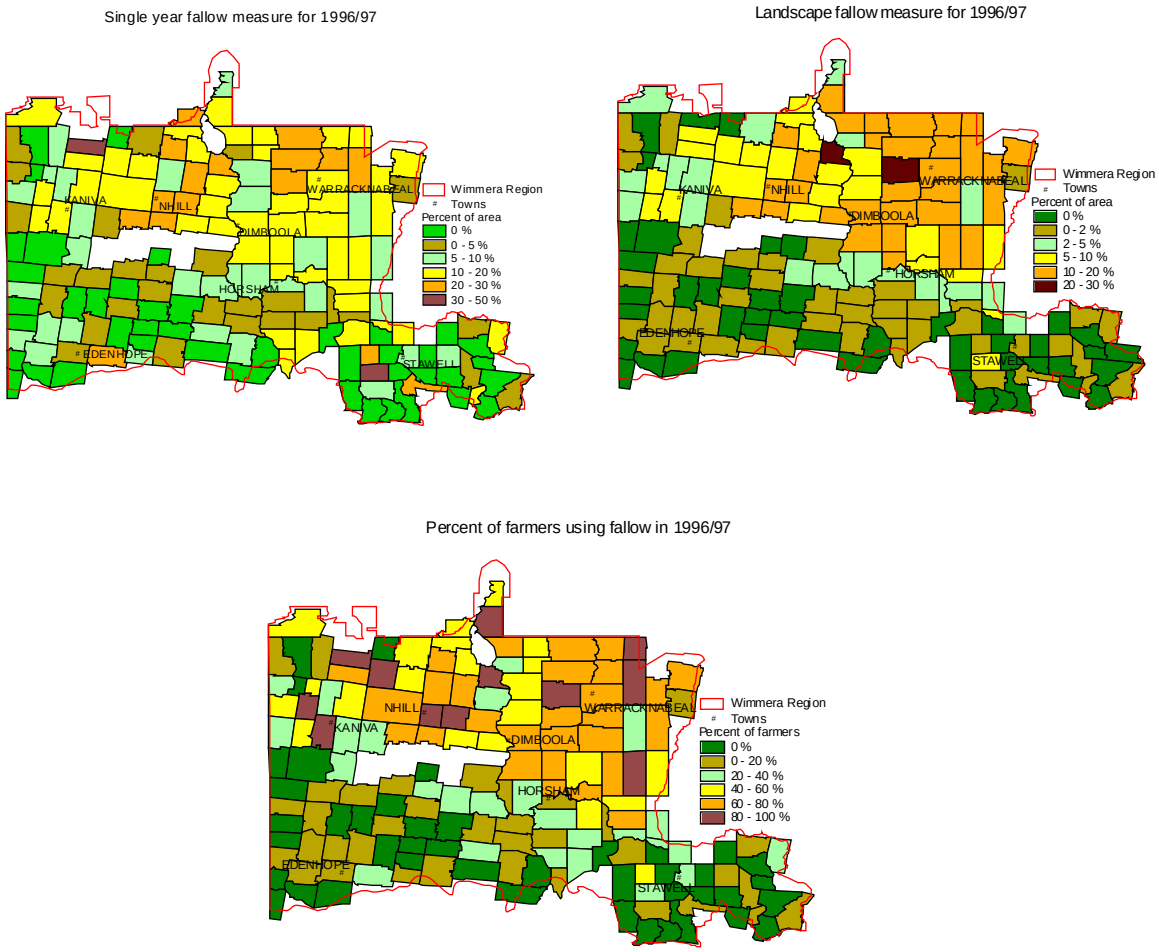
Source: Australian Bureau of Statistics (1994/95-1996/97)

Figure 30 Number of farmers using cultivation and chemical fallow (1995-97)



Source: Australian Bureau of Statistics (1995/96)

Figure 31 Fallow management measures for the Wimmera Region (1995/96)



Source: Australian Bureau of Statistics (1996/97)

Figure 32 Adoption of fallow for the Wimmera 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, 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.

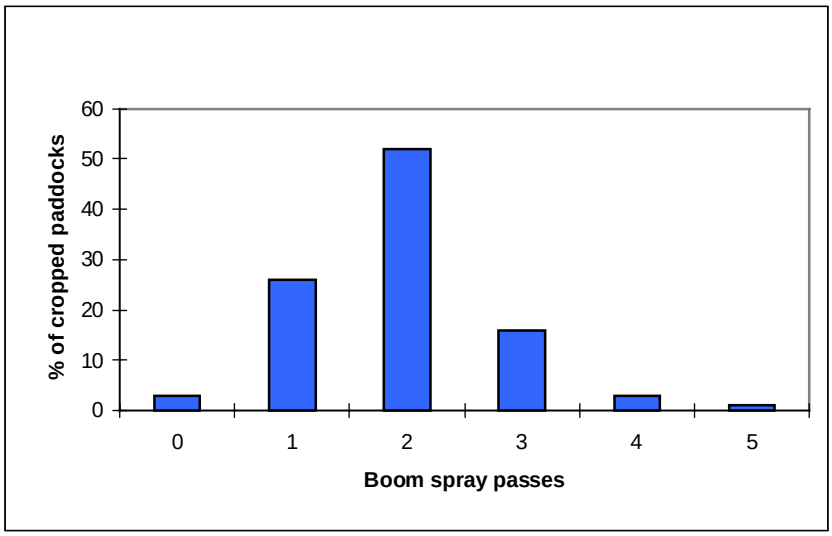
Analysis of this data is reported in the accompanying report on Adoption of Pasture Management Practices in the Wimmera Region (Karunaratne & Barr 2001)

3.5 Use of herbicides

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 Warracknabeal study shows the widespread use of herbicides. Less than 2 percent of paddocks are sown and harvested without one pass of the boom spray. Forty-nine percent (±1.5) of paddocks receive two boom spray passes (Figure 33).

Chemical use if often considered to be a *substitute* for weed control by cultivation. This is not the case in the Wimmera Shire, with no statistical relationship existing between the number of cultivations in a paddock and the number of passes of the boom spray.



Source: Wilkinson & Cary (1993)

Figure 33 Chemical application to crops in the Warracknabeal area (1992/93)

4 RECOMMENDATIONS

The aim of this report is to provide baseline information and establish trends in adoption of conservation cropping practices in the Wimmera Region. There is less data available on conservation cropping practices in this region than in other cropping regions of the state. The information in this report developed from the University of Melbourne survey provides accurate estimates of adoption of conservation cropping practices in the Warracknabeal Shire during the 1993 season. The adoption rates estimated from 1994/95 ABS data provides reliable information and can be used as a baseline to monitor future adoption of these practices. A few amendments to the set of questions on conservation cropping practices asked in 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 data, 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 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

Include

- Each area once

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

- **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: 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 utilise 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 Season 1995-96

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

Hectares

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

Note

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

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

Hectares

Stubble removed by burning.....

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

Stubble ploughed into the soil.....

Stubble was mulched.....

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

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

5 REFERENCES AND DATA SOURCES

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6 APPENDICES AUSTRALIAN BUREAU OF STATISTICS FARM CENSUS QUESTIONS

APPENDIX 1 ABS tillage question

ABS tillage question: tillage methods - season 1993/94

Include

- Each area once

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

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

Hectares

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

APPENDIX 2 ABS stubble management questions

Stubble management question - season 1994/95

2c. Disposal of crop stubble during Season 1994-95

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

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

Hectares

Stubble was burnt.....

Stubble was incorporated (farm machinery used to plough stubble iinto 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).....

Stubble management question - season 1995/96

2c. Disposal of crop and pasture stubbles (Trash) prior to sowing Season 1995-96

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

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

Hectares

Stubble removed by burning.....

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

Stubble ploughed into the soil .....

Stubble was mulched .....

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

APPENDIX 3 ABS fallow question

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).....