Trends in Pulse and Oilseed Crops in Winter Cereal Rotations in NSW

John P. Brennan
Principal Research Scientist (Economics),
NSW Department of Primary Industries, Wagga Wagga, NSW

John D. Sykes
Research Leader (Pulse and Oilseed Genetics and Improvement),
NSW Department of Primary Industries, Dubbo, NSW

J. Fiona Scott
Economist,
NSW Department of Primary Industries, Tamworth, NSW

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Abstract
The key aims in this study are to assess the current level of importance of pulse and oilseed (broadleaf) crops in winter cereal rotations in NSW, and to identify recent trends. The production of broadleaf crops has increased in each region of NSW, but different crops have been favoured. Canola has played a key role in southern regions, and chickpea in the northern regions. In many areas, pulse crops have been grown more because of rotational benefits than their direct gross margins. If recent trends continue, the role of broadleaf crops will increase to 25% of the area sown to field crops in NSW by 2020. However, that will only be achieved with a focussed effort in both research and extension activities.

Keywords: broadleaf crop; oilseed; pulse; production; rotation; NSW

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Authors' Contact:
John Brennan, NSW Department of Primary Industries, Wagga Wagga Agricultural Institute, Private Mail Bag, Wagga Wagga, NSW 2650
Telephone (02) 6938 1999; Facsimile (02) 6938 1809
E-mail: john.brennan@dpi.nsw.gov.au

John Sykes, NSW Department of Primary Industries, P.O. Box 865, Dubbo, NSW 2830
Telephone (02) 6881 1282; Facsimile (02) 6881 1295
E-mail: john.sykes@dpi.nsw.gov.au

Fiona Scott, NSW Department of Primary Industries, Tamworth Centre for Crop Improvement, RMB 944, Tamworth, NSW 2340
Telephone (02) 6763 1156; Facsimile (02) 6763 1222
E-mail: fiona.scott@dpi.nsw.gov.au

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Acknowledgments

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Trends in Pulse and Oilseed Crops in Winter Cereal Rotations in NSW

Executive Summary

Farmers in the broadacre cropping areas of NSW have developed farming systems that generally involve rotations between crops, fallow and/or pasture, depending on the region and its soils and climate. However, despite the fact that some benefits of rotations are well known, cereals have dominated many of these regions. The dominance of cereals has a number of disadvantages for the farming systems, and if cereals are too dominant it is an indicator that the system may not be sustainable in the long term.

The key aims in this study are to assess the current level of importance of pulse and oilseed (broadleaf) crops in winter cereal rotations in NSW, and to identify recent trends. A further aim is to establish a basis on which NSW Department of Primary Industries can monitor its future performance in relation to a target figure for the importance of broadleaf crops. Thus, not only is it important to establish recent trends and levels of the importance of broadleaf crops, but also to enable continuing and on-going assessment of those levels.

An examination of the recent trends in the importance of broadleaf crops indicates production increases have occurred in each region of NSW, but different crops have been favoured. Canola has played a key role in southern regions, but in the northern regions chickpea has been the dominant crop. The prices obtained for pulses, particularly those used only for stockfeed purposes, have tended to increase more slowly than those for wheat and other food grains. In many areas, pulse crops been grown because of rotational benefits that enhance their direct gross margins sufficiently to make them worthy of inclusion in crop rotations.

If recent trends continue, the role of broadleaf crops will reach 25% of the area sown to field crops in NSW before 2020. However, achieving a level of 25% of alternative crops in winter cereal rotations will require:

(a) robust varieties with improved disease resistance, drought tolerance and harvestability;
(b) development of human consumption markets and a focus on selling high quality grain; and
(c) specific extension programs to promote broadleaf crops, particularly in districts where adoption is low (5-10%).

These requirements will only be achieved with a focussed effort in both research and extension activities.

1. Introduction

Farmers in the broadacre cropping areas of NSW have developed farming systems that generally involve rotations between crops, fallow and/or pasture, depending on the region and its soils and climate. However, despite the fact that some benefits of rotations are well known (for example, see Felton *et al.* 1995; Heenan and Chan 1992; Patton and Mullen 2001), cereals have dominated in many of these regions.

The dominance of cereals tends to occur in both the summer and winter cropping system in NSW, as it does in the other grain-producing states. In this study, the focus is on the winter cropping systems in NSW. The main winter cereal crops in NSW are wheat, barley and oats, although lesser areas are also sown to triticale and rye.

The dominance of cereals has a number of disadvantages for the farming systems:

(a) the run-down of soil nutrients over time, needing to be replenished by artificial sources of nitrogen and other nutrients;
(b) the development of weed populations that are difficult to control in cereals;
(c) the carryover of diseases between cereals, such as the root-borne diseases crown rot (*fusarium pseudograminearum)* and take all (*gaeumannomyces graminis* var. *tritici*); and
(d) the over-dependence of farmers for income on a limited number of cereal crops, whose prices all tend to move together.

It is a widely held viewpoint among scientists that if cereals are dominant (say, more than 80% of the cropping area), it is an indicator that the system may not be sustainable in the long term[1]. As part of its strategic planning ("2020 Vision"), NSW Department of Primary Industries has set a target of 25% of the NSW cropping area being sown to pulses and oilseeds (broadleaf crops) in each region by 2020.

Research, development and extension efforts are being made to increase both the pasture content in rotations and the extent to which broadleaf crops are included in the rotations. These broadleaf crops include both pulse (grain legume) and oilseed crops. The winter crops included in each category are shown in Table 1.

Table 1: Winter Crop Groups in NSW

Cereal crop	Pulse crops	Oilseed crops
Wheat	Chickpea	Canola
Barley	Faba bean	
Oats	Field pea	
Triticale	Lupin Albus	
Rye	Lupin Angustifolia	

[1]Our definition of "sustainability" draws on that of the Brundtland Report: "… development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). For a broad discussion of the issues relating to sustainability as it applies to agriculture, see Mullen (2001). For our purposes, sustainability in this context means the capacity to continue to produce cereal crops into the future without depleting the soil's resources.

The broadleaf crops grown vary in the different regions of NSW. In the south, the main winter pulse crops are lupins, field peas, and to a lesser extent chickpeas and faba beans. In the northern areas, the main pulse crops are chickpeas and faba beans. The only significant winter oilseed crop grown in rotation with cereals in both the north and the south is canola.

The key aims in this study are to assess the current level of importance of broadleaf crops in winter cereal rotations in NSW, and to identify recent trends. In addition, a further aim is to establish a basis on which the NSW Department of Primary Industries can monitor its future performance in relation to a target figure for the importance of broadleaf crops. Thus, not only is it important to establish recent trends and levels of the importance of broadleaf crops, but also to enable continuing and on-going assessment of those levels. That requires the use of data for the area and production of each crop that are readily available in a timely fashion each year. For that reason, figures from the NSW Grains Report, based on estimates from local District Agronomists, are used for the regional analysis in this study.

While NSW has a combination of winter and summer cropping, the focus in this study is on the winter cropping systems. The area sown to winter crops is far greater than the total area sown to summer crops in all regions, particularly in the southern regions of NSW. A separate study of summer cropping systems is planned.

2. Changes in Area of Winter Crops in NSW

2.1 Importance of Broadleaf Crops in NSW

While research in improvements in wheat and the other main cereals (barley and oats) began in the late Nineteenth Century, research into adapting or breeding pulse and oilseed crops in NSW only began in the late 1960s for some crops, and even more recently for others. The impetus for the research at that time was the advent of (short-lived) wheat production quotas until the early 1970s. Since the 1980s, production of these crops has increased, and the areas sown have become significant enough to be estimated regularly by the Australian Bureau of Statistics (ABS) and the Australian Bureau of Agricultural and Resource Economics (ABARE)[2].

At the state level, the area sown to winter pulses and oilseeds has grown substantially from very low levels since the 1980s (Table 2), reaching a peak of 820,000 ha in 2001. However, cereals still accounted for 85% of the area sown to all broadacre winter crops in NSW in 2002, down from 99% in the mid-1980s (see Appendix A for more detailed data). In the drought-affected crops of the past two years, the level has risen to over 90%.

Table 2: Area Sown to Winter Crops, NSW, 1984 to 2004

	Area sown (000 ha)					*% of total area*			
	Total	**Cereals**	**Pulses**	**Oilseeds**	**Total Broadleaf**	***Cereals***	***Pulses***	***Oilseeds***	***Total Broadleaf***
1984	4,651	4,592	44	16	59	*99%*	*1%*	*0%*	***1%***
1985	4,813	4,716	57	40	97	*98%*	*1%*	*1%*	***2%***
1986	4,202	4,097	67	38	105	*98%*	*2%*	*1%*	***2%***
1987	3,710	3,557	123	30	153	*96%*	*3%*	*1%*	***4%***
1988	3,485	3,342	119	24	143	*96%*	*3%*	*1%*	***4%***
1989	3,067	2,939	98	30	128	*96%*	*3%*	*1%*	***4%***
1990	3,224	3,045	126	53	179	*94%*	*4%*	*2%*	***6%***
1991	2,781	2,476	204	101	305	*89%*	*7%*	*4%*	***11%***
1992	3,102	2,857	174	71	245	*92%*	*6%*	*2%*	***8%***
1993	3,325	3,059	166	101	266	*92%*	*5%*	*3%*	***8%***
1994	2,611	2,284	175	153	327	*87%*	*7%*	*6%*	***13%***
1995	3,952	3,628	154	170	324	*92%*	*4%*	*4%*	***8%***
1996	4,801	4,502	120	179	299	*94%*	*3%*	*4%*	***6%***
1997	4,566	4,146	171	250	421	*91%*	*4%*	*5%*	***9%***
1998	4,750	4,176	231	343	574	*88%*	*5%*	*7%*	***12%***
1999	4,954	4,194	236	523	759	*85%*	*5%*	*11%*	***15%***
2000	5,376	4,592	230	554	784	*85%*	*4%*	*10%*	***15%***
2001	5,418	4,598	284	536	820	*85%*	*5%*	*10%*	***15%***
2002	4,680	3,994	210	476	686	*85%*	*4%*	*10%*	***15%***
2003	4,630	4,288	147	195	342	*93%*	*3%*	*4%*	***7%***
2004	4,897	4,435	162	300	462	91%	3%	6%	***9%***

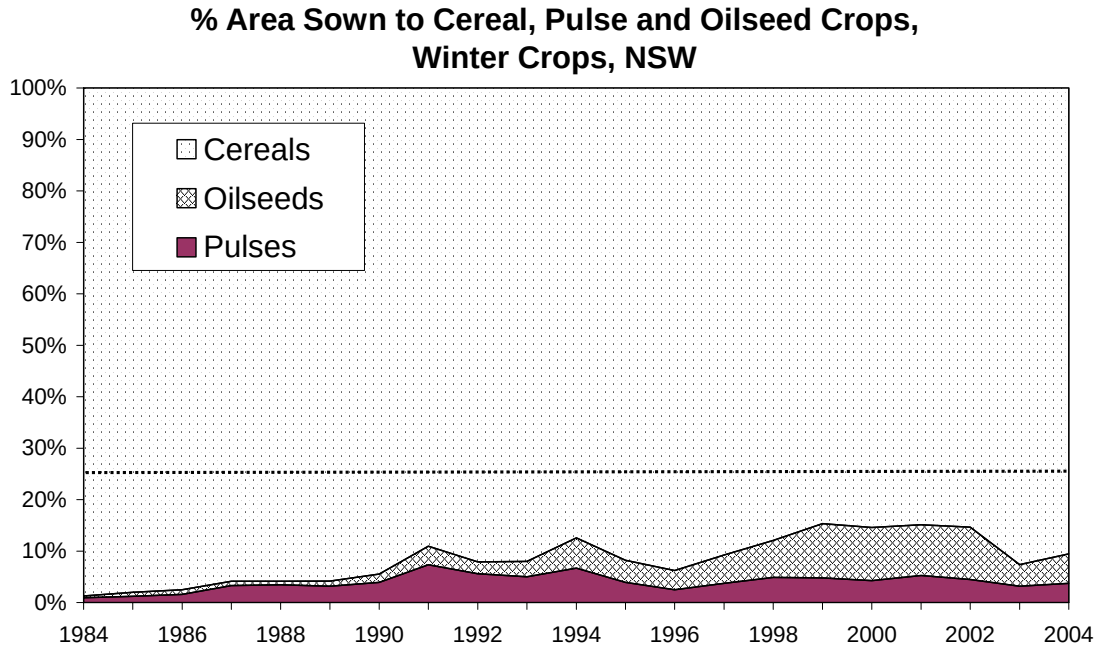
Source: ABARE (2003) and ABARE (2005).

[2] While ABARE produces estimates of the area sown and production during the season, the final estimate of the area sown each year is determined by ABS and is accepted by ABARE. As a result, ABS and ABARE data are the same for historical data, but ABARE is able to produce more up-to-date estimates during the season.

With winter crops, the proportion of the area sown to pulses and oilseeds increased relatively steadily from around 2% to 15% in the period from the mid-1980s to 2002 (Figure 1). Until the early 1990s, pulses were more important than oilseeds as alternatives to cereals, but since that time oilseeds (in this case, canola) have become more important than pulse crops. Pulses reached a peak of 7% of the total area sown to winter crops in the early 1990s, while canola reached a peak of 11% in 1999. Both have declined in relative importance since those peaks.

The decline in the area sown to pulses and oilseeds since 2002 is evident, although it is difficult to determine at this stage whether this is a change in trend or merely one of the consequences of the severe drought in NSW in 2002 to 2004. Winter crop production in NSW in 2002 was only 32% of the average of the previous three years, and in 2003 production was still only 77% of the recent average. These severe reductions in both area and yield mean that trends are difficult to discern until further data are obtained in future years. The area and yield of winter crops in 2004 was closer to the recent averages, but the relative importance of broadleaf crops remained at a lower level (approximately 9%), reinforcing concerns that the impact may be a more permanent one.

Figure 1: Relative Importance of Broadleaf Winter Crops, NSW, 1984 to 2004



The area sown to broadleaf crops in 2002 and particularly 2003 are influenced by the severe drought in those years. In particular, the decline in the relative importance of broadleaf crops in 2003 reflects the perception (and perhaps the reality) among farmers that those crops are less robust in difficult production conditions than the more reliable cereal crops. It can also reflect the time horizon of farmers in times of financial difficulties, where the focus is on immediate cash returns rather than crops that provide a lower immediate financial return but can lead to improved crops later in the rotation. Both of these factors help to explain the sharp decline in the relative importance of broadleaf crops, particularly oilseeds, in 2003.

While the longer-term trend has been towards a reduction in the dominance of cereals in winter crop rotations, the role of pulses and oilseeds remains relatively minor. For the winter crops, the role of canola and pulses has increased significantly over the past two decades, but the overall ratio of broadleaf crops to cereals has still averaged less than 1:8 at the state level in the ten years to 2003.

Given the role that legume *pastures* play in farming systems over much of the state, the role of broadleaf crops in the entire rotation is certainly even lower. To the extent that most pastures in the cropping zone are broadleaf pastures, the proportion of broadleaf species to cereals in the rotation is likely to be considerably greater than the recent 15% of crops that are sown to broadleaf crops. However, data on pasture area are notoriously unreliable, and it has not been possible to obtain comparable data for pastures in rotation with crops.

An important issue is what level of cereals in a cropping rotation is “sustainable”. While there is no precise rule, a ratio of cereals to broadleaf crops and pastures closer to 1:1 is likely to be closer to a biologically sustainable rotation for much of NSW. Long-term research (Heenan and Chan 1992) has shown that cropping rotations based on approximate equal components of cereals and broadleaf species (including crops and pastures) are the most sustainable in a biological sense in southern NSW. Within that overall 1:1 ratio, a ratio of broadleaf crops to cereal crops of around 1:4 is considered appropriate for sustainable cropping systems, given that 2-3 years of consecutive cereals can create disease problems and that broadleaf crops can create disease problems if the same crop is grown within four years in the same paddock.

Because of the lack of direct information on rotations, it is difficult to take these generalities too far towards precision. For example, a rotation that has only cereals and pastures may well be sustainable, without any broadleaf crops. Similarly, in continuous cropping where there is no pasture phase, one broadleaf for every four cereal crops will not be sustainable (Heenan and Chan 1992). Therefore, these ratios are merely broad-based targets that provide a basis for measuring improvements in overall sustainability of the production of winter crops in NSW.

Economic factors also have an impact on the role of pastures and non-cereal crops in profitable rotations. For example, Patton and Mullen (2001) found that in the Central West of NSW, a pasture component of around four years was profitable for a wide range of wool and wheat prices and a cereal cropping phase of 3-4 years. In the lower-rainfall areas, profitable rotations tended to have higher components of pasture or non-cereal crops and lower proportion of cereals. These proportions have been found to be relatively stable over a wide range of relative prices for crops and livestock.

2.2 Comparison of NSW with Other States

NSW shows a broadly similar pattern to other states in the use of broadleaf crops (Table 3), with slightly higher than average dominance of cereals among its winter crops. Over the five years to 2002-03, NSW has averaged lower levels of winter pulse crops but higher levels of winter oilseeds crops than the other main grain-producing states. The reasons for these differences are complex, and involve soil types, the impact of summer cropping in some northern areas, and a possible stronger reliance on pasture legumes in southern NSW than in some other states.

Table 3: Average Area Sown to Winter Crops, by State, 1999-00 to 2003-04

	Area sown (000 ha)					***% of total area***			
	Total crops	**Cereals**	**Pulses**	**Oilseeds**	**Total Broadleaf**	***Cereals***	***Pulses***	***Oilseeds***	***Total Broadleaf***
N.S.W.	5,011	4,333	221	457	678	*86%*	*4%*	*9%*	*14%*
Victoria	2,765	2,220	288	258	546	*80%*	*10%*	*9%*	*20%*
Queensland	1,022	947	74	1	75	*93%*	*7%*	*0%*	*7%*
W.A.	7,407	5,919	965	523	1,488	*80%*	*13%*	*7%*	*20%*
S.A.	3,663	3,166	314	182	496	*86%*	*9%*	*5%*	*14%*
Tasmania	26	25	0	0	1	*97%*	*2%*	*2%*	*3%*
Australia	**19,894**	**16,610**	**1,862**	**1,422**	**3,284**	***83%***	***9%***	***7%***	***17%***

3. Changes in Area of Winter Crops in Regions of NSW

Data are not available on a regional level for the same time period. ABARE and ABS no longer publish annual regional data at the shire or district level. However, regional data based on estimates of District Agronomists of NSW Department of Primary Industries are available since 1993. While these data are not as reliable as those at the state level, they provide a valuable source of information for comparisons within NSW.

Within NSW, four main regions for District Agronomist estimates are defined, based on the silo groups and recommendation zones for wheat:

- North east
- North west
- South east
- South west

The Agronomy Districts comprising each of the regions are listed in Table 4. These regions include some Districts where there is no significant winter cropping, but they are included for completeness. Some of the Agronomy Districts have significant levels of irrigated production of winter crops, and some contain irrigation systems aimed at summer crops such as cotton and rice. However, most remain essentially dryland production systems. Because of the difficulty of obtaining accurate data on crops under irrigation, it is not possible to separate irrigated and dryland production in the analysis. It is clear, however, that the major winter crop production Districts in the south-west region predominantly have non-irrigated dryland cropping.

Table 4: Definition of Regions in NSW: Agronomy Districts by Region

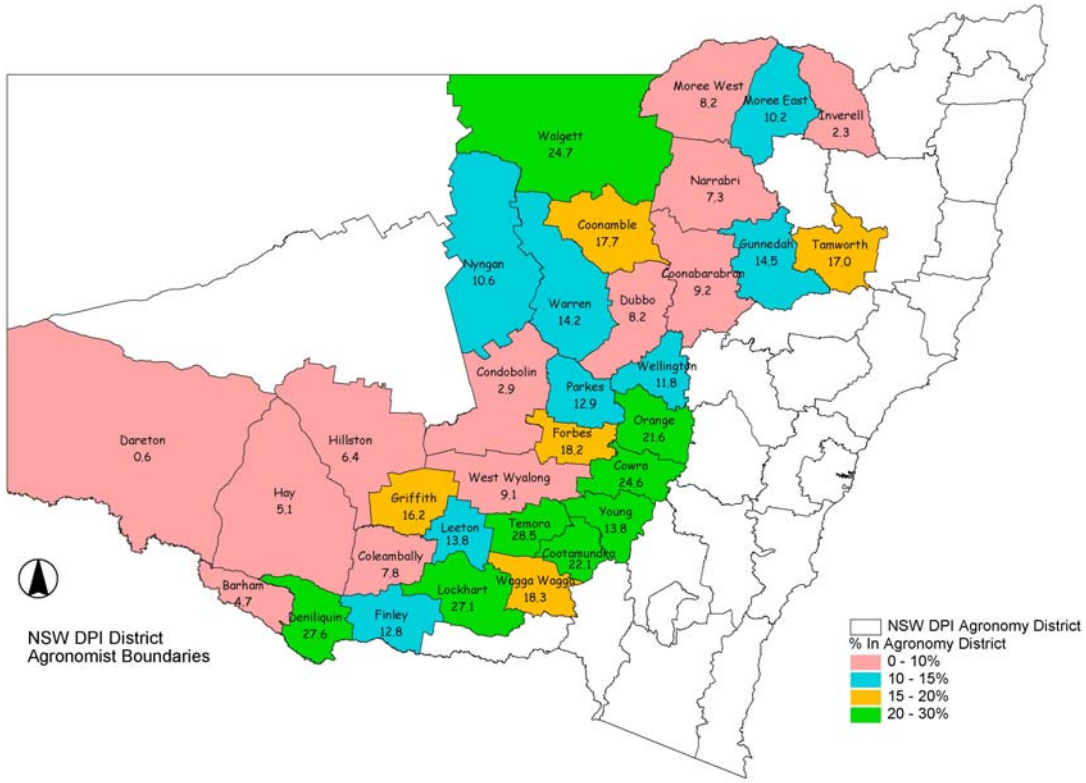
North East	North West	South East	South West
Coonabarabran	**Coonamble**	**Wellington**	**Parkes**
Gunnedah	**Dubbo**	**Orange**	**Condobolin**
Inverell	**Moree West**	**Cowra**	**West Wyalong**
Moree East	**Nyngan**	**Forbes**	**Yanco***
Narrabri	**Walgett**	**Young**	**Coleambally***
Tamworth	**Warren**	**Cootamundra**	**Deniliquin***
Manilla		**Temora**	**Barham***
Armidale		**Wagga**	**Griffith***
Glen Innes		**Lockhart**	**Hay**
Mudgee		**Albury**	**Hillston**
Scone		Bathurst	**Dareton**
Casino		Goulburn	**Finley***
Kyogle		Tumut	
		Yass	
		Cooma	

Significant cropping districts are in **bold**

* Districts with significant irrigated winter cropping

The Agronomy Districts are illustrated in Figure 2, where the relative importance of broadleaf crops as a percentage of total crop area in 2001 is shown. The wide regional differences in levels of importance of broadleaf crops are evident. While broadleaf crops are more important in the south-east in 2001, there are some parts of the north where broadleaf crops are also important.

Figure 2: Broadleaf Crop Percentage, by NSW Department of Primary Industries Agronomy Districts, 2001



Source: Map prepared by Peter Worsley, NSW Department of Primary Industries

At the regional level, there are also some wide differences in the direction of change in the relative importance of pulse and oilseed crops. The changes in the area of winter crops are shown in (Table 5) and are illustrated in Figures 3 and 4. More detailed figures on the area sown to each crop in each region are shown in Appendix B.

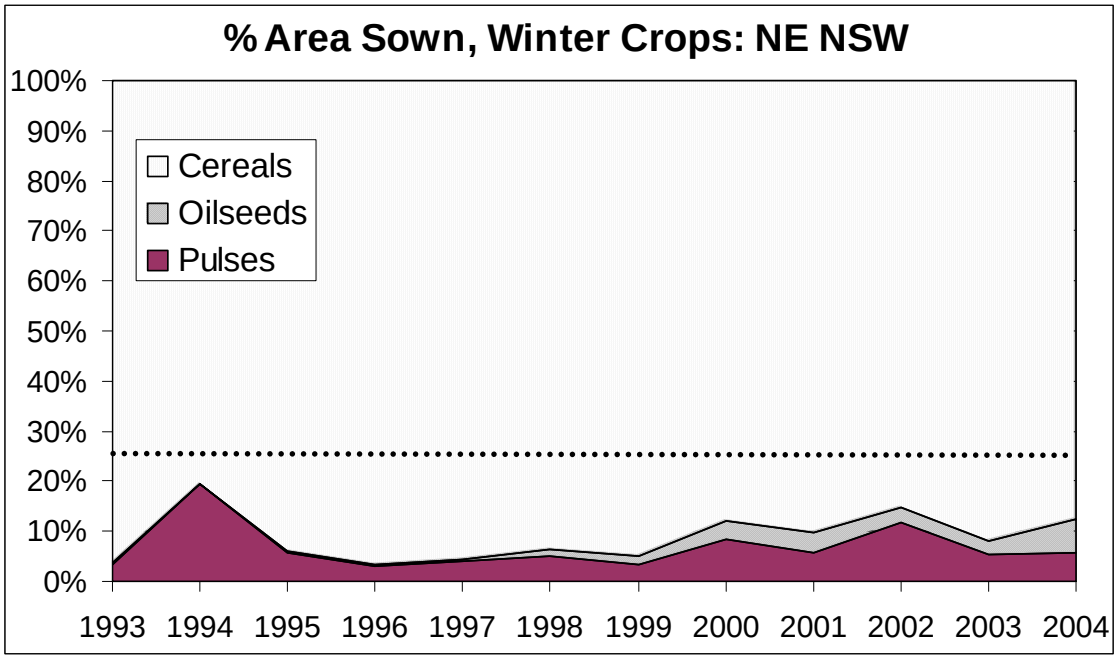
Pulses are relatively more important in the northern areas, with rapid growth in recent years in both the north-east and the north-west regions. This has been due to growth in chickpeas and faba beans. Winter oilseeds (ie, canola) have become particularly important in the south-east region, and have grown from very low levels in each of the other regions.

Thus, the percentage of the area sown to winter pulse and oilseed crops in the north-east region has increased since 1993, although there was a relatively high proportion in the drought of 1994 (Figure 3). Similarly, in the north-west region the percentage of winter crops sown to pulses and oilseeds has increased steadily since 1993. For instance, the role of chickpeas increased substantially in the drier Walgett area in 2001 and 2002, but production will be variable depending on the availability of stored subsoil moisture.

Table 5: Area Sown to Winter Crops, NSW Regions, 1993 to 2004

	Area sown (000 ha)					% of total area			
	Total crops	**Cereals**	**Pulses**	**Oilseeds**	**Total Broadleaf**	***Cereals***	***Pulses***	***Oilseeds***	***Total Broadleaf***
North-East									
1993	712	686	24	2	26	96%	3%	0%	4%
1994	79	63	15	0	15	80%	19%	0%	20%
1995	601	564	34	3	36	94%	6%	0%	6%
1996	878	849	27	2	29	97%	3%	0%	3%
1997	675	646	27	2	29	96%	4%	0%	4%
1998	567	532	29	7	36	94%	5%	1%	6%
1999	640	608	21	10	31	95%	3%	2%	5%
2000	402	353	33	16	49	88%	8%	4%	12%
2001	712	643	41	28	69	90%	6%	4%	10%
2002	186	159	22	5	27	85%	12%	3%	15%
2003	549	505	29	16	45	92%	5%	3%	8%
2004	748	655	43	50	93	88%	6%	7%	12%
North-West									
1993	816	796	15	4	20	98%	2%	1%	2%
1994	85	81	3	0	4	96%	4%	0%	4%
1995	690	672	14	4	18	97%	2%	1%	3%
1996	830	806	22	2	24	97%	3%	0%	3%
1997	913	889	20	5	24	97%	2%	1%	3%
1998	794	756	20	18	38	95%	3%	2%	5%
1999	887	789	68	29	98	89%	8%	3%	11%
2000	691	609	54	28	82	88%	8%	4%	12%
2001	982	837	114	31	145	85%	12%	3%	15%
2002	177	146	24	7	31	82%	14%	4%	18%
2003	763	694	44	25	70	91%	6%	3%	9%
2004	1,179	1,070	66	43	109	91%	6%	4%	9%
South-East									
1993	927	780	71	76	147	84%	8%	8%	16%
1994	488	403	43	43	85	83%	9%	9%	17%
1995	876	716	57	103	160	82%	7%	12%	18%
1996	947	859	30	58	88	91%	3%	6%	9%
1997	1,014	819	58	137	195	81%	6%	13%	19%
1998	1,107	867	87	153	240	78%	8%	14%	22%
1999	1,181	892	65	224	289	76%	6%	19%	24%
2000	1,177	903	43	231	274	77%	4%	20%	23%
2001	1,174	903	43	228	271	77%	4%	19%	23%
2002	956	774	33	149	182	81%	3%	16%	19%
2003	1,107	940	36	131	167	85%	3%	12%	15%
2004	1,180	1,001	29	150	178	85%	2%	13%	15%
South-West									
1993	1,224	1,170	36	18	54	96%	3%	1%	4%
1994	331	314	5	12	17	95%	2%	3%	5%
1995	1,206	1,129	32	45	77	94%	3%	4%	6%
1996	1,258	1,202	25	31	56	96%	2%	2%	4%
1997	1,214	1,142	29	43	72	94%	2%	4%	6%
1998	1,304	1,207	29	68	97	93%	2%	5%	7%
1999	1,267	1,173	30	64	95	93%	2%	5%	7%
2000	1,447	1,321	39	86	125	91%	3%	6%	9%
2001	1,436	1,317	40	79	119	92%	3%	6%	8%
2002	628	585	17	26	43	93%	3%	4%	7%
2003	1,132	1,087	19	25	45	96%	2%	2%	4%
2004	1,068	1,006	21	41	63	94%	2%	4%	6%

Figure 3: Relative Importance of Broadleaf Winter Crops, NSW Northern Regions, 1993 to 2004



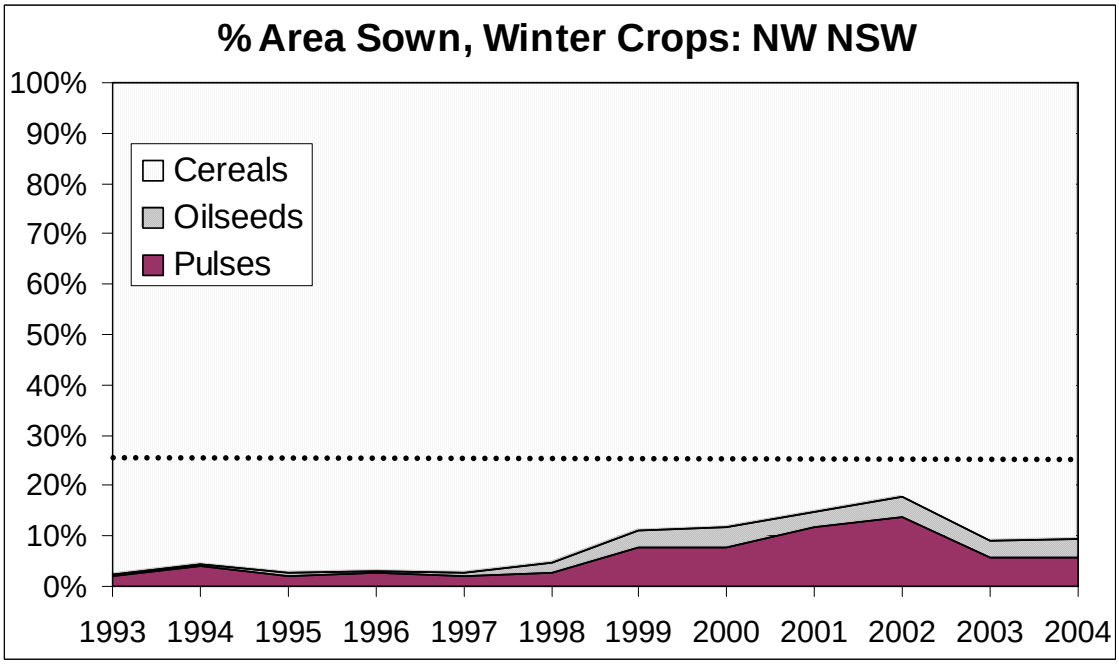
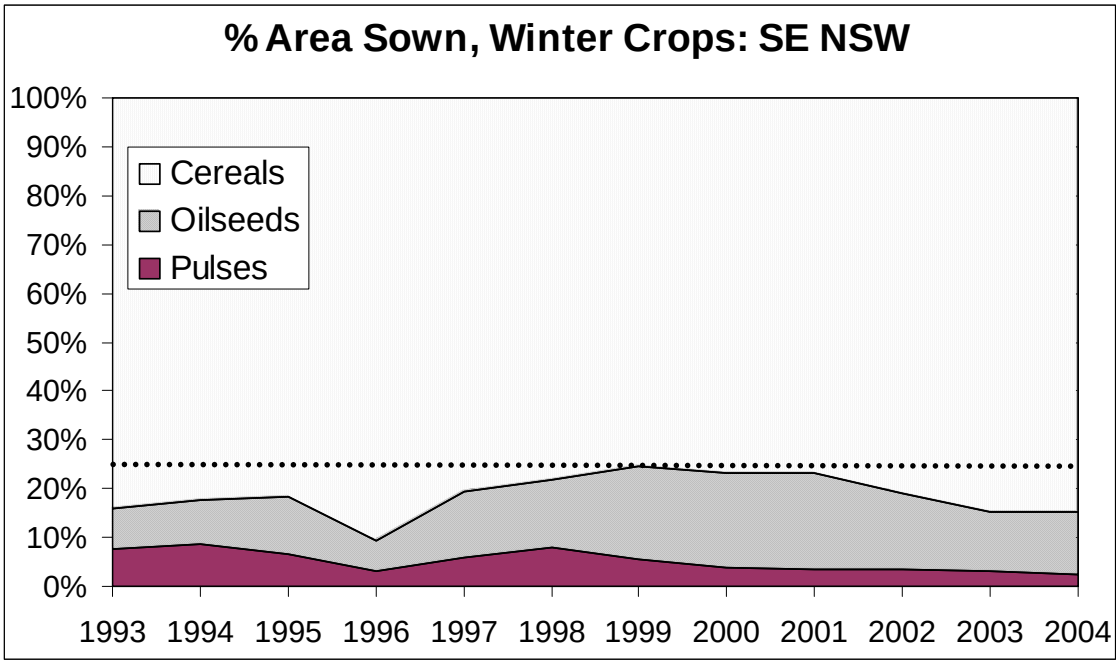
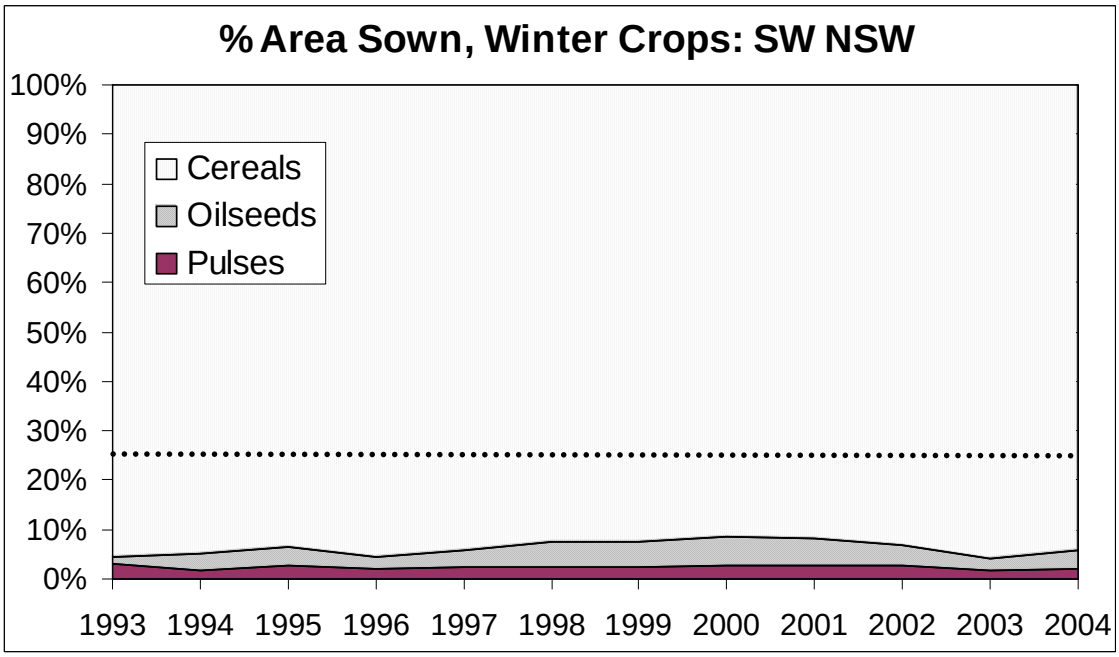


Figure 4: Relative Importance of Broadleaf Winter Crops, NSW Southern Regions, 1993 to 2004





Both the south-east and south-west regions have also shown an increase in the area sown to winter pulses and oilseeds (Figure 4). In both southern regions, oilseeds (in this case, canola) have become the most important crop other than cereals since 1993. The impact of the widespread drought in 2002 is evident in the area sown to winter crops, particularly in the northern and south-west regions. In those regions, NSW Department of Primary Industries extension activities will be focused on promoting new upright field pea and mustard varieties that are more tolerant of drought conditions.

By 2002, both northern regions had over 15% of the winter crop area sown to broadleaf crops, while the south-west region had only about half that level. In the south-east region, the proportion of broadleaf crops reached 24% in 1999, but has shown some signs of decline since. The extent to which this is a result of the drought or other factors remains unclear at this stage.

4. Factors Affecting the Importance of Pulses and Oilseeds

4.1 Influential Factors in Role of Pulses and Oilseeds

There are several factors that can affect the relative importance of pulse and oilseed crops in a farming system. The relative economic returns, as indicated by gross margins, from the different crops play a critical role in the farmers' decisions on which crops to include in their farming systems, as well as the rotational benefits from the pulse and oilseed crops. The two main components of change in gross margins are relative yields and relative prices. These two factors are explored in some detail in the following sections.

4.2 Changes in Relative Yields of Pulse and Oilseed Crops in NSW

The relative level of yields per hectare, and the rate of yield improvement over time, are important factors in determining the relative importance of pulse and oilseed crops in a farming system. A brief examination is made of the relative yields for pulses and canola crops in NSW in relation to wheat yields, to determine if there are any significant trends and issues emerging.

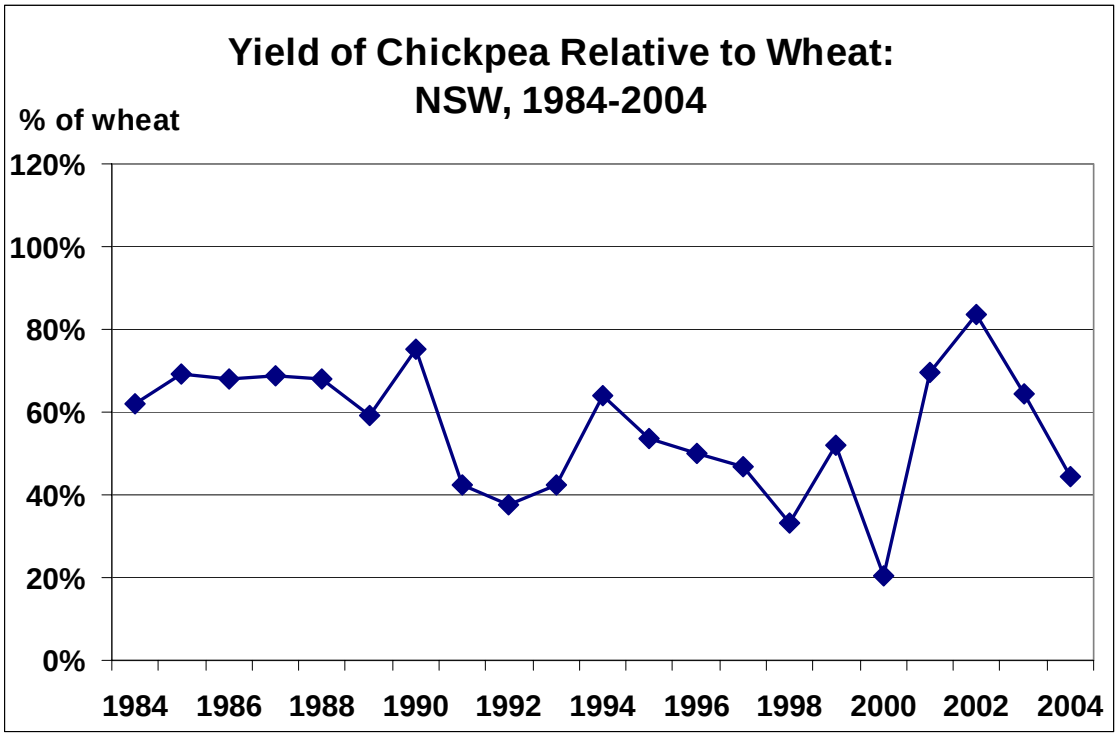
The average yield of the main pulse crops and canola as a percentage of average wheat yields in recent years for NSW is shown in Figures 5 and 6. Any such aggregated comparisons can be confounded by differences in crop location, differences in the use of irrigation, etc. However, they can provide a broad indication of trends in the relative competitiveness of these crops. Apart from faba beans, which for most of the period prior to 1995 had yields between 80% and 100% of wheat yields, pulse crops have generally been in the range of 50% to 70% of wheat yields, except for the 2002 drought. In the five years to 2001, the average ratio of canola to wheat yields was 70%, while pulse yields averaged somewhat lower: chickpeas 44%, faba beans 65%, lupins 64% and field peas 58% of wheat yields.

At the aggregate state level, canola yields exceeded wheat yields in 1989, but have been below wheat yields in recent years. The yield of canola was more than 80% of wheat from the late 1980s to the mid 1990s, but has declined since that time.

The success of canola as an alternative crop in rotations has been related to the development of *napus* varieties that have lifted yield levels substantially, in addition to well-defined rotation benefits. While canola appears to be reaching its potential level in some regions, notably in the south-east region of NSW, in other areas it still has considerable potential for growth. On the other hand, most of the pulse crops have not achieved a similar yield break-through in NSW, so that pulse crops are awaiting further research and development before they can achieve similar prominence.

Apart from the 2002 drought, there has been a tendency for the yield ratios to decline slightly, implying that wheat yields have been increasing more rapidly since 1984 than pulse and canola yields. These slower rates of yield improvement have been one of the factors affecting the slow rates of increase in the area sown to pulse crops. In addition, the decline in recent years in the yields of canola in many producing areas has had a major impact on slowing the rate at which canola area has been growing. Conversely, the yield increase of wheat can be partly attributed to the role of broadleaf crops in the rotations.

Figure 5: Yield of Pulse Crops as a Percentage of Wheat, NSW, 1984 to 2004



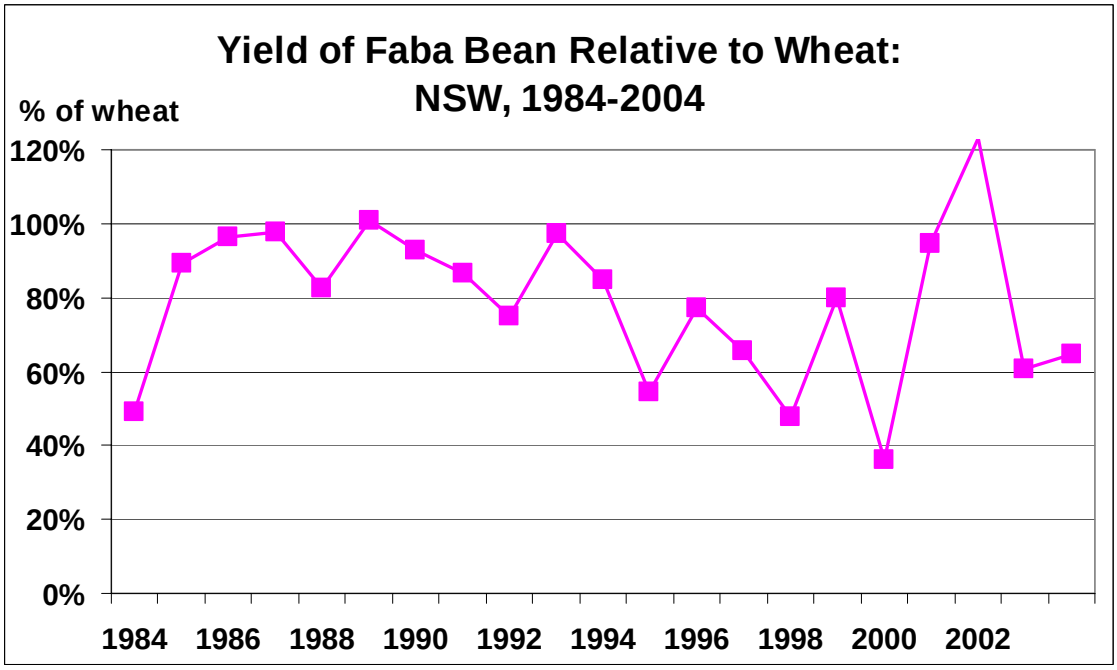
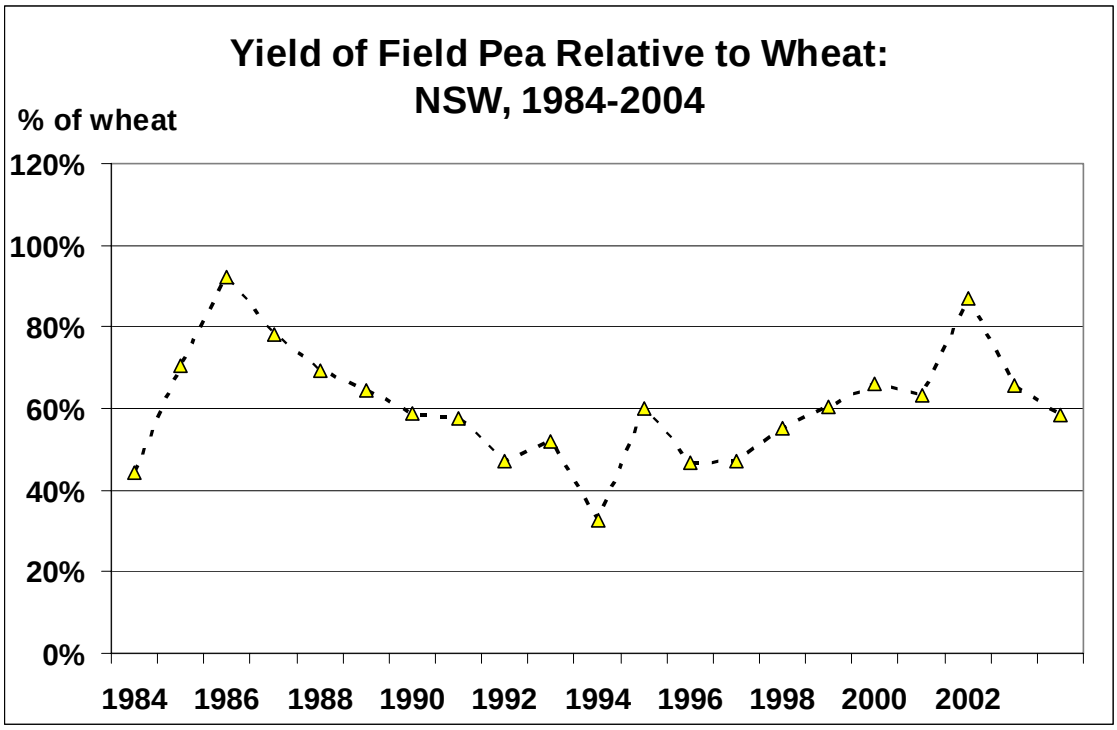


Figure 5 (continued): Yield of Pulse Crops as a Percentage of Wheat, NSW, 1984 to 2003



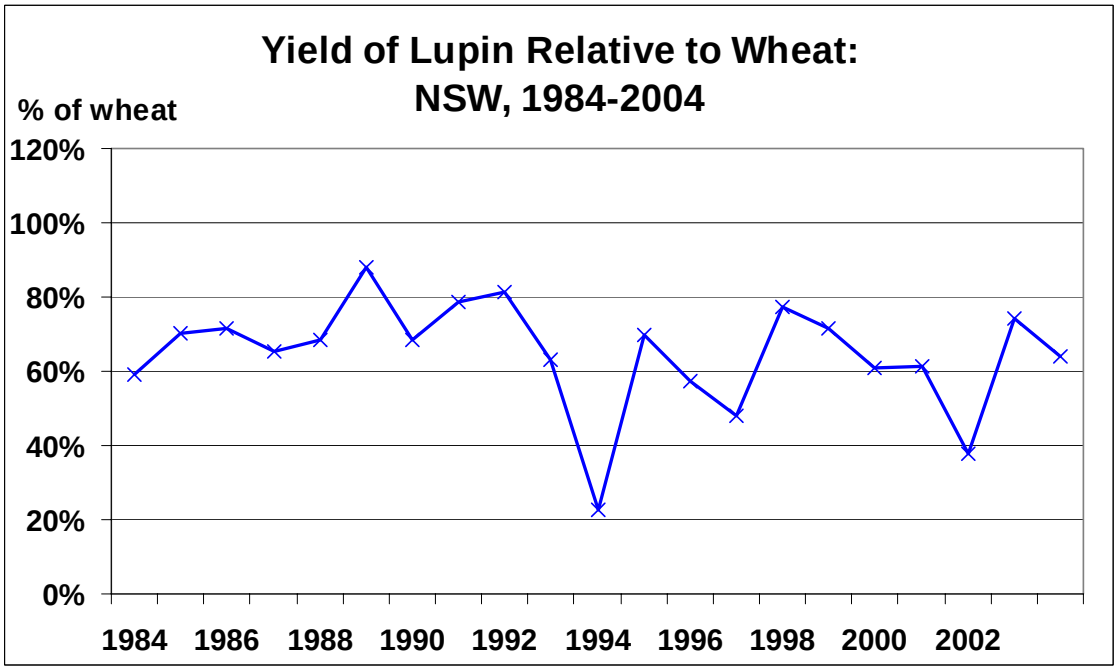
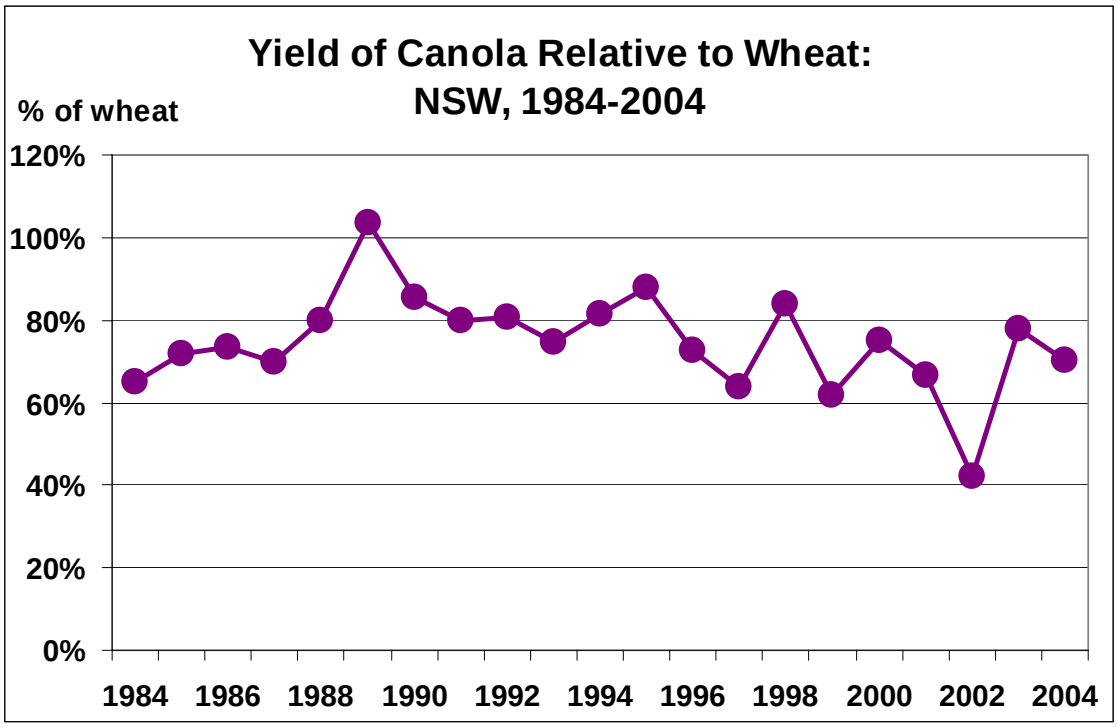


Figure 6: Yield of Canola as a Percentage of Wheat, NSW, 1984 to 2003



There has been a tendency for an overall downward trend in the yields of the main pulse crops relative to canola yields during the 1990s, but that trend has increased in more recent years. It is unclear whether this change in trend reflects a recent decline in canola yields, or whether it merely reflects the fact that the areas where the drought has had its most severe impact have been in the main canola-growing areas.

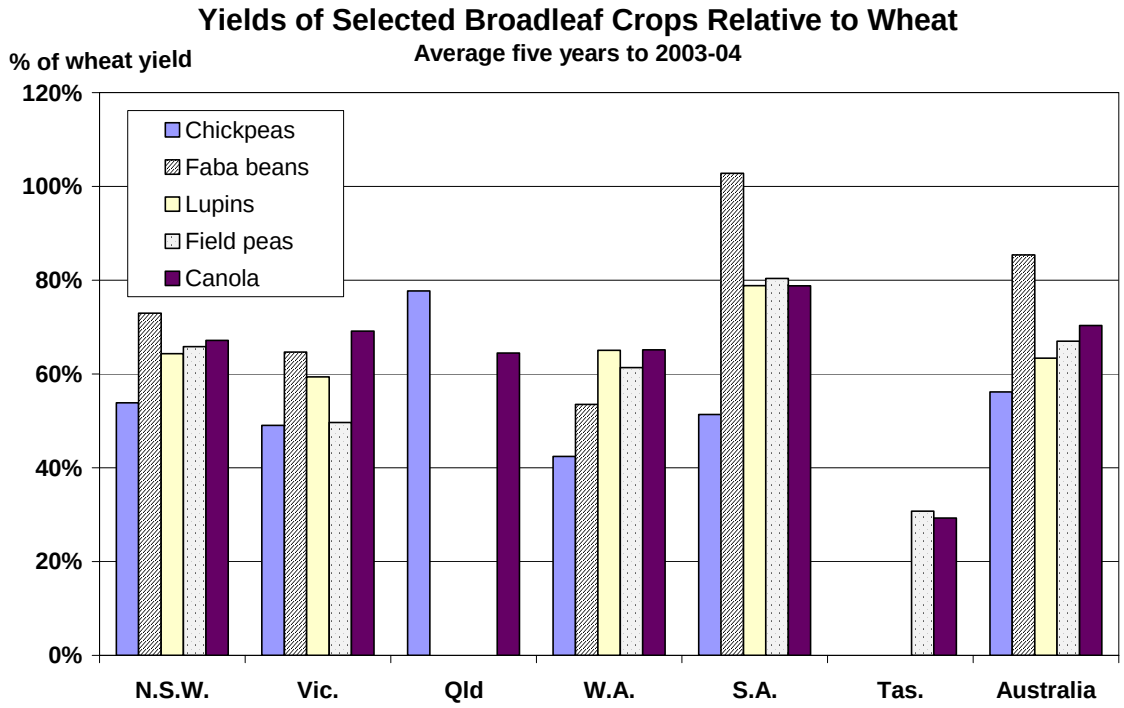
4.3 Changes in Relative Yields Across States

In terms of yield relativities, NSW shows a broadly similar pattern to most other states (Figure 7). Over the five years to 2002-03, NSW pulse yields relative to wheat averaged markedly lower than in the South Australia, but generally marginally higher than in the other main grain-producing states. NSW canola crops generally yielded higher, relative to wheat, than other states, again apart from SA. These differences may at least partly reflect the different rates of wheat yield improvement in the different states in recent decades (Brennan and Quade 2000).

4.4 Changes in Relative Prices of Pulse and Oilseed Crops

Farmers generally have little influence on the prices that they receive for their grains. The greatest influence affecting profit comes in crop management where choice of species and variety, as well as the quality of grain produced, can be critical. However, it is useful to consider price trends in assessing the alternatives from which farmers can choose.

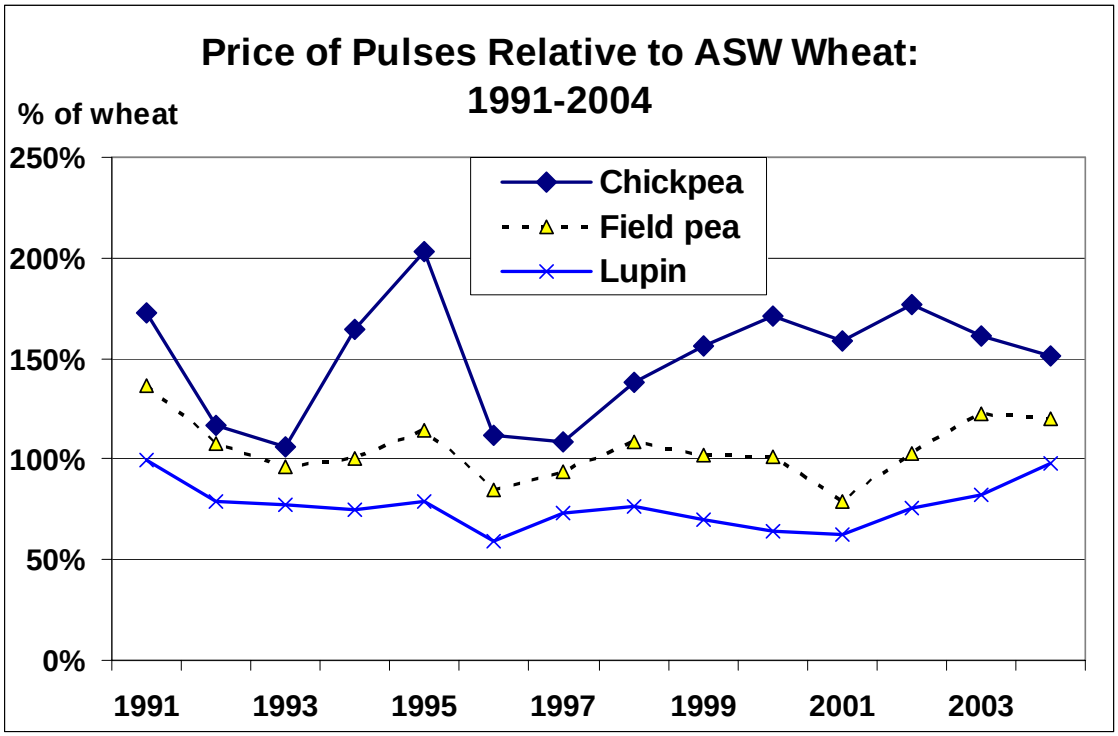
Figure 7: Relative Yield of Pulse and Canola Crops, by State, 1984 to 2003

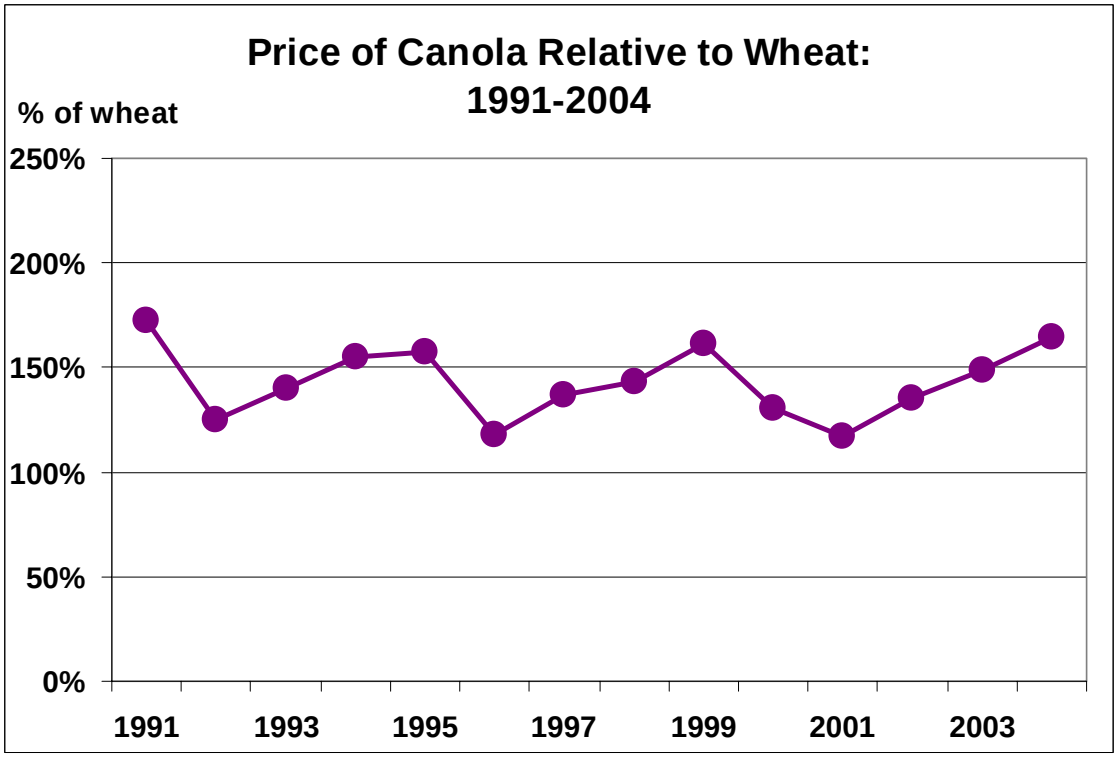


To provide a broad comparison, average prices of cereals, pulses and oilseeds in recent years from ABARE's *Crop Reports* were compared. Consistent quarterly price series are reported for a range of grains at a range of markets (local feed, export, etc), and a representative price series for each of the major grains was selected. Because some of the prices are for grain delivered to Sydney, Melbourne or Perth, and others are export prices, the level of prices cannot be compared directly. However, because they are consistent series over time, changes in relative prices can indicate changes in the relative returns from the different crops.

There has been a tendency (Figure 8) for lupin and field pea prices to decline relative to wheat since 1991, while chickpea prices have generally kept pace with wheat prices, although they have been variable. During that same period, the average canola to wheat price ratio has also tended to decline. The average ratio of lupin and field pea prices to canola prices declined slightly, while the ratio of chickpea to canola prices has generally increased.

Figure 8: Ratio of Pulse and Canola Prices to Wheat Prices, 1991 to 2004

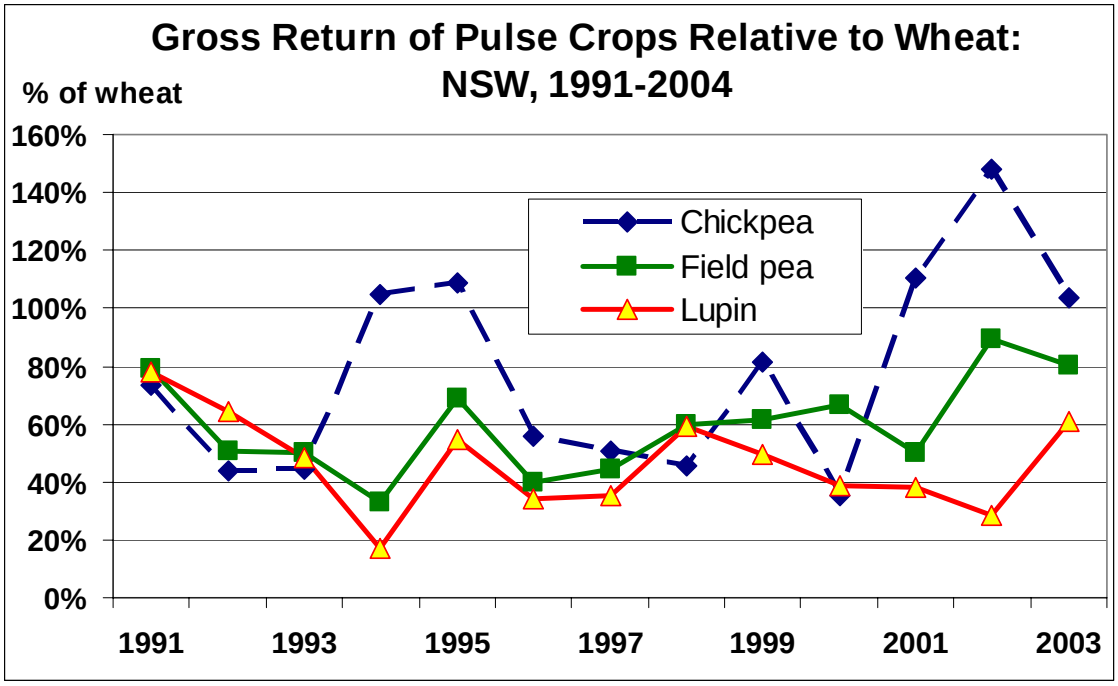


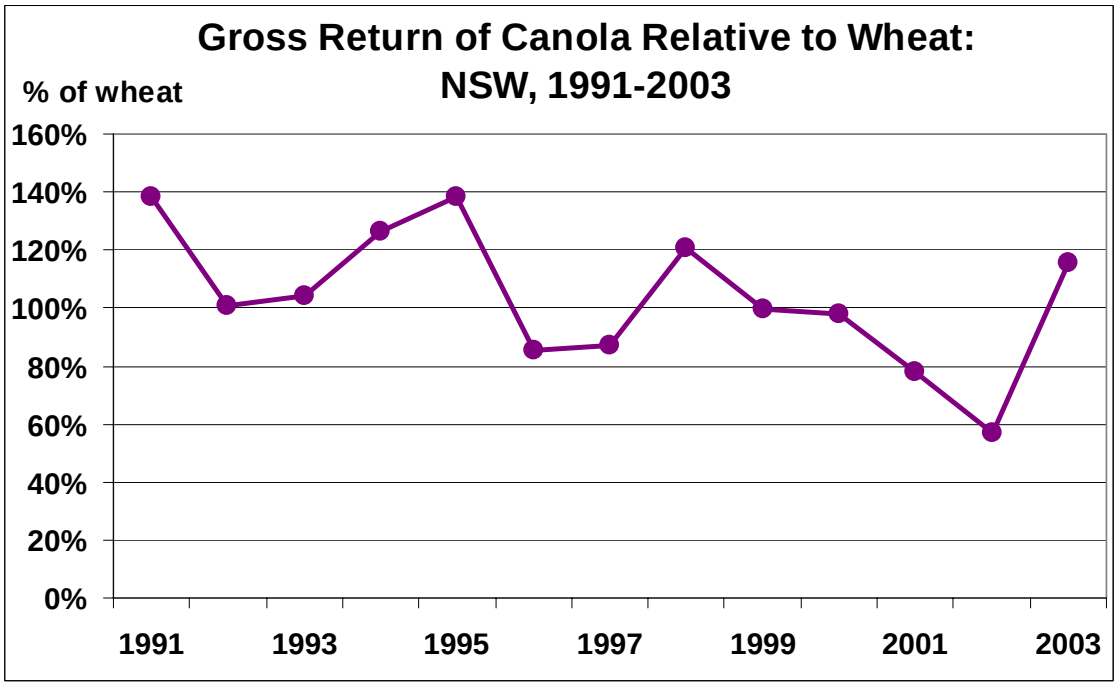


Bringing together the yield and price changes for pulse and canola crops relative to those for wheat, the changes in gross returns per hectare (yield per hectare times price per tonne) reveals some important changes in recent years (Figure 9). While there has been little change between 1991 and 2003 in field pea returns relative to wheat, relative lupin returns have

declined, and in more recent years chickpea returns have increased relative to wheat. During that same period, the average gross returns per hectare for canola have declined substantially relative to those for wheat. These changes in the level of gross returns would support a decline in relative importance of lupins and field peas over the 1990s and an increase in the relative importance of chickpeas since the mid-1990s if the decision were made solely on the average gross returns that have been received per hectare. They also support a decline in the relative importance of canola in recent years.

Figure 9: Gross Returns from Pulse and Canola Crops Relative to Wheat, NSW, 1991 to 2004





However, it should be noted that the comparisons used here preclude any significant analysis of the impact of relative prices on the relative importance of pulse and oilseed crops. For example, because the prices used are averages, any increase in quality or re-direction of production from a commodity-based bulk market to a niche market approach, for example from a feed grain market to a food grain market where higher prices can be obtained, would similarly not be reflected here. In recent years, efforts have been made to move field peas, faba beans, lupins (especially albus lupins) and chickpeas into more specialised quality production, and to aim for niche markets in the food sector. At the same time, there has been a strong movement towards the production of higher-protein wheats, especially in NSW, so that the average price received may have been increasing more rapidly than the ASW price series used here. On that basis, the non-niche market production of pulse crops may have received even more rapidly declining prices in relation to wheat than is shown in these comparisons.

While human consumption prices are higher than those for feed grains, the price variation can be greater for human consumption grains. Because of the high degree of substitutability between feed grains (for example see Brennan, Singh and Singh 2001), there are more alternative uses for them, and prices tend to be less variable. Niche markets, particularly those directed at human consumption (such as that for kabuli chickpeas), can be higher priced but highly variable from year to year. While farmers producing pulses or oilseeds for food use are likely to receive higher prices than those producing for the stockfeed market, the greater the diversity of marketing options available to farmers, the less variable are average prices received likely to be.

One key component of the prices received for pulse crops is the extent to which crop losses and marketing problems are associated with fungal diseases or from wet weather at harvest. Research efforts are needed to reduce these losses before some of those marketing problems can be resolved.

5. Future Directions and Outlook

To assess the rate of change in recent years, trend analysis was carried out for the different regions. To minimise the difficulties caused by the annual fluctuations within the limited data available, the analysis was carried out to assess the trends in the proportion of the area of winter crops sown to cereals, rather than to broadleaf crops[3]. Broadleaf crops are then the difference between these figures and 100%.

A log-linear trend line was fitted to the data for each region in the form:

$$\log C_n = a + b\, n,$$

where C_n is the percentage of cereals in year n, b is the annual rate of growth in C, and n is the year. In this form, the parameter b defines the annual proportional rate of growth in the relative importance of cereal crops.

The results are shown for the percentage area sown to cereals for each of the regions and for NSW as a whole for the period 1993-2003 (Table 6). Because of the variability in the data, particularly in relation to the recent drought, and the limited number of years for which consistent data are available at the regional level, there are relatively large errors associated with these trends estimates. However, they indicate the direction of change and the relative of the rates of change in the mix between cereals and broadleaf crops for different regions.

Table 6: Rate of Change in Proportion of Area Sown to Cereals, and Projected Levels

		% crop area sown to cereals		
	Annual rate of growth	**Actual 2000**	**Projected 2010**	**Projected 2020**
North-east	-0.12%	88%	88%	86%
North-west	-0.65%	88%	77%	66%
- *Total North*	-0.41%	88%	82%	75%
South-east	-0.24%	77%	76%	72%
South-west	-0.08%	91%	92%	90%
- *Total South*	-0.18%	85%	84%	80%
NSW Total	-0.27%	86%	83%	78%

[3] Over the period 1993-2003, the mean of the cereal percentages ranged from 81% to 94% for the different regions, with a standard deviation of between 2% and 5%. The alternative measure of the percentage of broadleaf crops, therefore, had means from 6% to 19%, and standard deviations of 2% to 5%. Thus the relative variability was considerably lower for cereals, and it was therefore more convenient to apply the trend analysis to the percentage of cereals.

Overall, across NSW, the proportion of the winter cropping area sown to cereals has been declining at 0.27% per year over the period 1993 to 2003 (Table 6). The rate of decline in cereals has been greatest in the north-west (0.65% per year) and the south-east (0.24%), with the other two regions declining more slowly (0.1% per year). Overall in NSW the share of broadleaf crops has been increasing at a rate of 0.27% of the total area of winter crops per year.

On the basis that those same trends will continue in the future, the projected levels for 2010 and 2020 were calculated (Table 6). At the state level, the overall percentage of cereals in winter cropping of 86% in 2000 is projected to decline to 83% in 2010 and 78% in 2020 if the recent trends continue. Thus, the overall percentage of broadleaf crops (14% in 2000) is projected to increase to 17% in 2010 and 22% in 2020, slightly lower than the target of 25%. The levels are projected to be 20% in the south and 25% in the north by 2020. The north-east (14%) and the south-west (10%) regions are both not projected to have reached the target 25% by 2020, while the north-west (34%) and the south-east (28%) are projected to meet the target comfortably, if recent trends were to continue.

These results indicate that if the trends of the past decade can be continued, the role of broadleaf crops will increase further in the next 20 years, and can reach the target of 25% of the area sown to field crops in NSW by shortly after 2020. However, it is unclear the extent to which such recent trends can be continued. The areas where the largest gains in increasing the role of broadleaf crops can be made will need to be targeted carefully, although it is likely that the regions with lower proportions of broadleaf crops in recent years (that is, the south-west and the north-east) are likely to be the most difficult to increase the rate of change. Progress towards meeting these targets will be reviewed annually, as part of the on-going monitoring process to identify whether the target levels are likely to be achieved.

To achieve the desired target levels, it will be necessary to:

(a) develop varieties with improved yield potential, greater resistance to key diseases and increased harvestability (such as shatter tolerance and high pod height);
(b) develop crops that are preferred by human consumption markets and/or have a focus on quality to increase the prices received by farmers;
(c) develop specific research and extension programs to address those crops and regions where the trends indicate that the percentages of broadleaf crops are likely to be lowest.

These developments will improve the relative profitability of broadleaf crops in the winter cropping rotation and, if they can be achieved, are likely to provide increased incentives for farmers to include more of these crops in their rotations.

The efforts of scientists within the NSW Department of Primary Industries, the pulse and oilseeds industries and the farming communities more generally are being directed to achieving those objectives so that the targets can be met.

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Appendix A.1: Data on Winter Crops, NSW, 1984 to 2004, Area Sown
(000 ha)

	Total	Wheat	Barley	Oats	Triticale	Chickpea	Faba bean	Field pea	Lupin	Lentil	Canola
1984	4,651	3,603	605	312	72	1	0	7	35	0	16
1985	4,813	3,663	546	429	78	4	1	5	47	0	40
1986	4,202	3,118	414	491	74	11	2	17	37	0	38
1987	3,710	2,480	472	538	67	21	4	41	57	0	30
1988	3,485	2,316	416	555	55	21	3	47	48	0	24
1989	3,067	2,123	413	365	38	22	2	27	46	0	30
1990	3,224	2,166	463	374	42	39	4	28	55	0	53
1991	2,781	1,499	497	437	43	85	9	43	67	0	101
1992	3,102	1,800	560	448	49	28	16	32	99	0	71
1993	3,325	1,978	623	415	43	26	16	27	96	0	101
1994	2,611	1,444	410	375	55	20	20	27	107	0	153
1995	3,952	2,477	593	505	53	31	10	20	92	0	170
1996	4,801	3,316	668	393	125	31	9	15	64	1	179
1997	4,566	3,025	701	325	95e	51	21	18	80	1	250
1998	4,750	3,131	560	384	101e	75	26	24	106	1	343
1999	4,954	3,482	450	161	101e	66	17	17	135	1	523
2000	5,376	3,645	670	169	108e	90	45	21	72	2	554
2001	5,418	3,720	535	236	107e	116	37	26	102	3	536
2002	4,680	2,946	619	309e	120e	71	17	12	108	2	476
2003	4,630	3,250	610	290e	138e	61	15	27	42	2	195
2004	4,897	3,400	640	263	132	63	40	32	45	2	280

e Estimated by NSW Department of Primary Industries

Source: ABARE *Australian Commodities* and *Crop Report*

Appendix A.2: Data on Winter Crops, NSW, 1984 to 2004, Production
(000 t)

	Total	Wheat	Barley	Oats	Triticale	Chickpea	Faba bean	Field pea	Lupin	Lentil	Canola
1984	7,293	5,805	915	402	115	1	0	5	34	0	16
1985	7,539	5,916	821	538	153	5	1	6	53	0	46
1986	6,394	4,859	622	647	143	12	3	24	41	0	43
1987	5,812	4,025	755	723	133	23	6	52	61	0	34
1988	5,915	4,118	718	789	110	26	4	58	58	0	34
1989	4,833	3,423	656	504	81	21	4	28	66	0	50
1990	5,827	4,128	822	538	87	56	6	31	72	0	87
1991	3,874	2,183	740	560	97	53	11	36	76	0	118
1992	6,559	4,200	1,044	761	146	25	28	35	188	0	133
1993	7,573	5,086	1,310	613	110	29	40	36	156	0	193
1994	1,473	850	291	197	25	8	10	5	14	0	73
1995	6,865	4,508	1,074	711	120	31	10	22	117	0	272
1996	11,531	8,677	1,483	607	250	41	18	18	96	0	340
1997	8,388	5,893	1,365	488	167e	46	27	16	75	1	310
1998	9,664	6,700	1,150	716	198e	53	26	28	175	1	617
1999	11,372	8,641	1,052	280	214e	86	33	26	240	1	800
2000	10,891	7,890	1,340	247	313e	40	35	30	95	3	898
2001	10,254	7,450	1,135	331	229e	162	70	33	125	3	716
2002	3,450	2,535	397	115e	116e	51	18	9	35	1	173
2003	8,296	6,050	1,140	360e	281e	73	17	33	58	2	282
2004p	9,258	6,800	1,293	268	257	71	40	57	50	2	420

e Estimated by NSW Department of Primary Industries; p preliminary

Source: ABARE *Australian Commodities* and *Crop Report*

Appendix A.3: Data on Winter Crops, NSW, 1984 to 2004, Yield
(t/ha)

	Total	Wheat	Barley	Oats	Triticale	Chickpea	Faba bean	Field pea	Lupin	Lentil	Canola
1984	1.57	1.61	1.51	1.29	1.60	1.00	0.79	0.71	0.95		1.04
1985	1.57	1.62	1.50	1.25	1.96	1.12	1.44	1.14	1.14		1.16
1986	1.52	1.56	1.50	1.32	1.93	1.06	1.50	1.44	1.11		1.14
1987	1.57	1.62	1.60	1.34	1.99	1.12	1.58	1.27	1.06		1.13
1988	1.70	1.78	1.73	1.42	2.00	1.21	1.47	1.23	1.22		1.42
1989	1.58	1.61	1.59	1.38	2.13	0.96	1.63	1.04	1.42		1.67
1990	1.81	1.91	1.78	1.44	2.07	1.43	1.77	1.12	1.31		1.63
1991	1.39	1.46	1.49	1.28	2.26	0.62	1.26	0.84	1.15		1.17
1992	2.11	2.33	1.86	1.70	2.98	0.88	1.75	1.10	1.90		1.89
1993	2.28	2.57	2.10	1.48	2.56	1.09	2.50	1.34	1.62		1.91
1994	0.56	0.59	0.71	0.53	0.45	0.38	0.50	0.19	0.13		0.48
1995	1.74	1.82	1.81	1.41	2.26	0.98	0.99	1.09	1.27	0.50	1.60
1996	2.40	2.62	2.22	1.54	2.00	1.31	2.02	1.23	1.50	0.30	1.90
1997	1.84	1.95	1.95	1.50	1.76e	0.91	1.27	0.91	0.94	1.00	1.24
1998	2.03	2.14	2.05	1.86	1.97e	0.71	1.03	1.18	1.65	1.00	1.80
1999	2.30	2.48	2.34	1.74	2.11e	1.29	1.98	1.50	1.78	1.00	1.53
2000	2.03	2.16	2.00	1.46	2.91e	0.44	0.78	1.43	1.32	1.50	1.62
2001	1.89	2.00	2.12	1.40	2.14e	1.40	1.89	1.27	1.23	1.00	1.34
2002	0.74	0.86	0.64	0.37e	0.96e	0.72	1.06	0.75	0.32	0.50	0.36
2003	1.79	1.86	1.87	1.24e	2.03e	1.20	1.13	1.22	1.38	1.00	1.45
2004p	1.89	2.00	2.02	1.02	1.95	1.13	1.00	1.78	1.11	1.00	1.50

e Estimated by NSW Department of Primary Industries; p preliminary

Source: ABARE *Australian Commodities* and *Crop Report*

Appendix B.1: Area Sown to Winter Crops, NSW Regions, 1993 to 2004, North (000 ha)

	Total	Wheat	Barley	Oats	Triticale	Rye	Chickpea	Faba bean	Field pea	Lupin Albus	Lupin Ang.	Canola
North-East												
1993	712	493	138	50	4	1	11	9	1	1	1	2
1994	79	38	20	6	0	0	10	5	0	0	0	0
1995	601	343	172	49	1	1	22	9	0	1	1	3
1996	878	658	152	36	1	1	17	8	1	0	0	2
1997	675	472	124	48	1	1	17	9	0	0	0	2
1998	567	385	101	44	1	1	26	2	0	1	1	7
1999	640	494	75	37	1	0	15	4	0	1	0	10
2000	402	242	87	23	2	0	13	19	1	1	0	16
2001	712	468	132	40	3	0	25	12	0	3	1	28
2002	186	102	51	5	1	0	21	1	0	0	0	5
2003	549	353	128	22	2	0	22	5	0	1	1	16
2004	748	498	130	26	1	1	17	25	1	1	0	50
North-West												
1993	816	646	114	35	1	1	10	0	3	1	1	4
1994	85	62	14	5	0	0	1	1	0	1	0	0
1995	690	546	99	27	0	0	8	4	0	2	0	4
1996	830	697	69	36	2	1	19	1	1	1	1	2
1997	913	739	111	36	2	0	4	9	2	4	1	5
1998	794	635	69	49	3	0	8	2	3	6	2	18
1999	887	695	64	29	1	0	40	6	3	18	1	29
2000	691	524	59	25	2	0	23	9	2	19	2	28
2001	982	704	101	30	2	0	88	12	2	10	3	31
2002	177	114	26	4	2	0	21	1	1	0	1	7
2003	763	519	116	51	7	1	33	4	3	0	5	25
2004	1,179	896	145	23	6	1	44	9	4	8	1	43
Total North												
1993	1,528	1,139	252	85	4	1	21	10	3	3	2	7
1994	164	100	33	11	0	0	11	6	0	1	0	0
1995	1,291	889	271	76	1	1	30	13	1	3	1	7
1996	1,708	1,355	221	72	4	2	37	9	1	1	1	4
1997	1,588	1,211	235	85	3	1	21	19	2	4	1	7
1998	1,361	1,020	170	92	4	1	33	4	3	7	2	25
1999	1,526	1,189	139	66	2	0	55	10	3	19	2	39
2000	1,093	766	145	47	5	0	36	28	2	20	2	43
2001	1,694	1,172	233	70	5	0	112	24	2	13	3	59
2002	363	216	77	8	3	0	42	2	1	0	2	12
2003	1,313	872	244	73	8	2	55	9	3	1	6	41
2004	1,927	1,394	274	48	8	1	61	33	5	9	1	93

Source: Estimates by District Agronomists, NSW Department of Primary Industries

Appendix B.2: Area Sown to Winter Crops, NSW Regions, 1993 to 2004, South (000 ha)

	Total	Wheat	Barley	Oats	Triticale	Rye	Chickpea	Faba bean	Field pea	Lupin Albus	Lupin Ang.	Canola
South-East												
1993	927	515	111	112	39	2	1	0	14	9	47	76
1994	488	271	55	54	22	1	1	0	12	5	25	43
1995	876	451	88	131	43	3	1	0	7	8	42	103
1996	947	576	86	118	76	2	1	1	4	4	21	58
1997	1,014	536	95	110	77	2	1	5	7	5	41	137
1998	1,107	553	123	122	67	3	1	5	44	8	28	153
1999	1,181	613	84	110	85	0	1	3	6	23	31	224
2000	1,177	654	78	84	88	0	1	3	8	10	20	231
2001	1,174	663	76	74	90	0	1	5	9	9	19	228
2002	956	594	72	45	63	0	1	1	8	6	16	149
2003	1,107	694	97	62	86	1	0	1	11	7	16	131
2004	1,180	736	112	68	83	1	0	1	9	5	13	150
South-West												
1993	1,224	806	211	148	4	1	3	6	13	2	13	18
1994	331	223	68	22	2	0	1	2	1	0	2	12
1995	1,206	784	207	133	4	0	2	2	9	2	17	45
1996	1,258	867	197	134	4	0	2	2	7	2	12	31
1997	1,214	818	198	115	11	0	2	2	8	4	13	43
1998	1,304	861	204	135	8	0	5	2	5	3	14	68
1999	1,267	887	165	113	9	0	2	2	7	8	12	64
2000	1,447	997	192	118	15	0	2	8	12	6	11	86
2001	1,436	991	192	120	15	0	3	8	11	5	13	79
2002	628	443	100	32	10	0	2	5	3	2	5	26
2003	1,132	793	184	95	16	0	2	4	7	2	5	25
2004	1,068	818	137	36	15	0	1	7	10	1	2	41
Total South												
1993	2,152	1,322	322	260	43	4	4	6	27	11	59	94
1994	819	494	123	75	24	1	1	2	13	5	27	54
1995	2,081	1,235	295	264	47	3	3	2	15	9	59	148
1996	2,204	1,443	283	252	80	2	3	2	10	6	33	89
1997	2,228	1,354	293	224	88	2	3	7	15	9	53	180
1998	2,412	1,413	326	257	75	3	6	7	49	11	42	221
1999	2,448	1,499	249	222	95	0	3	5	13	31	44	288
2000	2,623	1,651	270	201	103	0	4	11	20	16	32	317
2001	2,610	1,653	267	194	105	0	4	12	20	14	33	308
2002	1,583	1,037	172	77	73	0	3	6	12	9	21	175
2003	2,239	1,487	281	157	102	1	2	5	17	9	21	157
2004	2,248	1,554	249	104	98	1	2	8	19	6	15	191

Source: Estimates by District Agronomists, NSW Department of Primary Industries

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