Impact on Australian broadacre agriculture of widespread adoption of organic farming: Some preliminary estimates[1]

Els Wynen[2]
Eco Landuse Systems, Canberra
CRES, ANU, Canberra

Presented at:
40th Annual Conference of the Australian Agricultural and Resource Society
11-16 February 1996

1. Introduction

The occurrence of blue-green algae (Blue-Green Algae Task Force 1992) and of pesticides (Bowmer 1990) in Australian waterways have focussed attention on the off-farm effects of agriculture. It has become clear that action will need to be taken to alleviate some off-farm problems. Regulations restricting the rate of use of some of the inputs, such as synthetic fertilisers and pesticides, are options for consideration. Although they may seem some way off in Australia, some European countries (Wynen 1994a, 1994b; 1994c) and the United States have adopted regulations. Australia's image of a clean, green supplier of agricultural commodities may well require similar policies in the future.

Another way to abate the negative externalities associated with farm inputs such as synthetic fertilisers and pesticides is a widespread adoption of organic farm management practices. Studies in Australia (Wynen 1989; 1994d) and overseas (Lampkin and Padel 1994) show interesting figures of the financial consequences of such a change for individual farmers. However, the question arises what would happen when a sizeable number of farmers would

---

[1] This project was carried out with funding from the Rural Research and Development Corporation. David Vanzetti helped with the modelling.

[2] GPO Box 3200, Canberra, 2601

change to organic management.

In this paper the aim is to analyse the effects of a move toward organic agriculture on aspects of farming in Australia including:

- input use (such as fertilisers, pesticides, fuel, land);
- total production of different enterprises; and
- returns to producers and the total sector.

For players such as farmers and the input and output industry the size and direction of the changes are of importance. For policy makers the consequences of legislation encouraging or discouraging certain farm practices would be of interest.

2. Literature review

Lampkin and Padel (1994) gathered a number of studies in which the implications of large-scale changes in farming systems were examined. These are briefly reviewed here.

Zerger and Bossel (1994) set up a model in which three scenario's were traced:

- intensification of agriculture
- business as usual
- ecologisation of farming, which kept reasonably close to developments in organic agriculture.

The authors modelled typical farms for different areas, aggregated the figures, and compared them with demand details which take into account population development (such as a 20 per cent decrease in food consumption mainly due to demographic reasons) and changes in consumption patterns (such as from proteins derived from animals to those derived from plants). Production activities (cropping, stocking) were characterised by 30 parameters describing specific material and monetary inputs and outputs, at 5 different levels of intensity. Assumed changes in technical and monetary data over time related to inputs and output were included. Evaluation of the final results was undertaken with criteria of national food security and viability objectives in mind.

Impact of widespread adoption of organic farming was, as compared to 'business as usual', found to lead by 2025 to:

- increase in grain legumes (crop rotation demands), with less sugarbeet and more potatoes being grown;
- no bio-fuels, as arable land will be needed for food production;
- increased fodder crop production;
- less dairy cows and pigs, and milk and pig meat;
- more cattle and cattle meat;
- more farms and a larger labour force;
- decreased farm incomes, without premium prices;
- lower nitrogen fertiliser and pesticide use;
- decreased level of erosion.

In a comparative-static analysis, Braun (1994) used an lp-model for the German state of Baden-Wuerttemberg. Representative farms were modelled, with four different sizes of farms and four enterprises (making 16 different combinations) being analysed for each region. The total figures after aggregation were considered sufficiently close to the actual figures.

Assumptions were made including:

- all farmers went organic;
- foreign trade protection remained the same;
- no premium prices are paid for organic products;
- yield increases will be due to breeding efforts only;
- grain yields assumed to be 30-40 per cent lower than under conventional management, root crop yields 20 to 40 per cent;
- number of farms and distribution of farm size will not change;
- some conversion costs are included;
- fixed costs remain the same;
- crop rotation practices are taken into account

The outcome of this study was as follows:

- land-use:

  increased activities included grain legumes and temporary grass;

  decreased activities: cereal cropping (by 39 per cent), oilseed production (to 5 per cent), bull beef (by 21 per cent), pigs (by 82 per cent) and poultry (by 67 per cent);
- output:

  decrease in cereals by 56 per cent, and in oilseeds by 66 per cent;

  increase in grain legumes and root crops;
- farm income decreases by 29 per cent, with big differences between types of farms

Lampkin (1994) looked at the implications of a 10 per cent change of land into organic management in the United Kingdom and noted the following in connection with changes in output and land-use:

- a reduction in wheat and barley (5 per cent) and an increase in oats (25 per cent;
- a reduction in potato (2 5 per cent) and sugarbeet (over 6 per cent) production;
- an decrease in oilseed rape production (7.4 per cent) and an increase in field bean production (3 per cent);
- a decrease of livestock output of between 2 and 5 per cent.

Midmore (1994) discusses linkage effects, such as on income and employment in the context of two examples, the evaluation of different environmental protection schemes including an organic aid scheme in England and Wales, and a comparative study of multipliers of a shift towards organic farming in Wales. The comparison with the different schemes shows that conversion to organic farming methods is more costly in income and employment effect than some schemes, and less costly than one other. The multiplier effect project shows a similar picture. One enterprise (sheep) has higher multiplier effects (for output, income and employment). Another enterprise (sheep) shows lower multiplier effect for all three measures, and a third (cattle) creates lower employment, though higher output and income.

In summary, the effects of a substantial shift towards organic farming, both on and off-farm, differ between enterprises.

3. Data and methodology

In this paper the scenario is examined where a certain percentage of farmers becomes organic. This is compared to the situation where all farmers are conventional. Effects on input use, total production of different crops, product prices, and returns to producers are estimated.

The situation where all farmers are conventional is reflected in the figures published by the Australian Bureau of Statistics (ABS). For the purpose of this paper a conventionally managed farm in different regions in the wheat-sheep zone (as defined by the Australian Bureau of Agricultural and Resource Economics (ABARE)) is constructed from ABS data. At present only New South Wales is included, although it is the intention to include all states at a later stage[3].

An average, as opposed to a typical farm, is modelled. This was done in order to be able to verify the model by comparing it to aggregate state and Australia-wide figures. The disadvantage of such an approach is that such a farm can be totally different from a farm which could typically be found in the region. For example, an average farm in southern New South Wales has as its main crops wheat, barley and oats, and a small amount of rice. A typical farm is more likely to have either dryland grains, or irrigated rice.

For area cropped and yields, the average of ABS data for 1992, 1993 and 1994 are employed. Data for input use are taken from the budget handbooks published by NSW Agriculture (Patrick 1995a, 1995b; Wall 1995; Curthoys 1995a, 1995b; Ramsey, not dated). Data for one of the regions, southern New South Wales, are shown in Table 1.

A linear programming model is used to derive output of various activities and to calculate farm income. On each farm (representing one region) activities are varied to maximise net profit subject to a land constraint. In addition, cropping activities are constrained not to

---

[3] The report is to be published by the Centre for Resource and Environmental Studies (CRES) at ANU.

Table 1: Variable inputs, outputs and output prices on an average conventional farm in southern New South Wales

Crop	Area cropped	Yield	Price*	Variable Costs											
				Sowing	Fert	Herb.	Insect	Levies	Insure	Machinery				Other	TOTAL
										Sowing	Harvest	Cartage	Other		
	ha	t/ha	$/t	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha
Wheat	56.6	2.6	110	27	48	50	0	9	6	19	5	0	11	0	174
Oats	20.7	1.9	90	40	36	26	0	5	4	12	5	0	8	0	136
Barley	23.5	2.0	118	24	64	51	0	5	5	12	5	0	23	0	190
Maize	0.8	8.4	160	112	307	58	16	3	54	60	5	(	19	231	863
Rice	14.3	8.3	180	23	152	94	2	0	8	61	5	54	50	190	639
Triticale	4.4	2.7	115	30	60	47	0	3	7	12	5	0	23	0	187
Soybeans	0.9	2.4	360	81	45	35	39	12	48	13	5	0	23	116	417
Lupins	8.7	1.6	150	35	32	45	0	3	8	12	5	0	11	0	151
Canola	6.8	1.7	290	10	60	28	12	8	16	14	5	0	37	0	189

Source ABS data

* equilibrium price at zero adoption of organic management practices

exceed actual cropping pattern. Once each lp is solved with prices set exogenously, production in each region is added to give total output. This is used to generate a new set of prices assuming a constant elasticity equation according to the following formula:

$$Q = cP^e$$

where:

Q = quantity of product

c = constant

P = product price

e = price elasticity of demand.

The constant is calculated with the aid of observed prices and quantities. The initial equilibrium is consistent with these values.

The price elasticities of demand for the different commodities are taken mainly from the ORANI model (see Kenderes and Strzelecki 1990). However, as they do not pertain to the 'newer' crops, rough estimates are included for those, based on discussions with relevant people. Elasticities included are shown in Table 2.

Table 2: Elasticities of demand for crops

Crop:	wheat	sheep	oats	barley	rye	sorghum	maize	rice	triticale
Elasticity:	-12.5	-5	-5	-10	-3	10	-10	-3	-3

Crop:	mung beans	navy beans	soybeans	cotton	linseed
Elasticity	-10	-10	-10	-10	-10

Crop:	lupins	peas	chickpeas	canola	safflower
Elasticity	-3	-3	-10	-3	-10

Source: Kenderes and Strzelecki 1990 for wheat and coarse grains.

In this paper, input prices are assumed to be constant, although it is intended to endogenise them in the final report.

Data for an average **organic farm** were obtained by adjusting figures for an average conventional farm in accordance with differences between conventional and organic farming analysed by Wynen (1989).

Variable inputs, such as fertilisers, pesticides and fuel are adjusted, with relevant coefficients shown in Table 3. The differences for those inputs are accounted for in the different models, and are not constrained.

Table 3: Inputs used per hectare cropped or operated

		Conventional	Organic	Percentage Org./Conv.
Per hectare cropped:				
Fertilisers	$/ha	26.9	8.8	33
Pesticides	$/ha	16.7	0.2	1
Fuel	$/ha	33.1	35.4	107
Per hectare operated:				
Labour	$/ha	40.9	34.9	85
Land cropped	%	52	33	64

Source : adapted from Wynen (1989) and from unpublished material.

Note : figures for land cropped: NSW; for other inputs: South-eastern Australia.

The percentage of area cropped in the rotation was found to be a major difference between the two farming systems, and is constrained in the model. Data for New South Wales (Wynen, unpublished) shows that, in 1985-86, surveyed organic farmers cropped on average 64 per cent of what conventional farmers cropped. This figure is used in the model.

Yields for crops grown on the organic farm were assumed to be 80 per cent of those on conventional farms, with the exception of cotton, where 50 per cent yield was assumed. Although some of the available data do not justify such a drop in yield in Australian broadacre agriculture (see Wynen 1989), those data pertain only to one year and were obtained by farmers who had farmed organically for almost 20 years on average. It is assumed that, with more farmers adopting organic practices yields could well decrease, at least for some time. Stocking rates on the two farms are assumed to be the same.

Output prices are assumed to be 15 per cent higher for all organic produce, with the exception of livestock products, when adoption is negligible. For grain, organic farmers report a premium of between 15 to 25 per cent, though it is not clear what percentage of farmers can obtain this. An oilseed exporter of organic produce quoted 20 per cent increases for oilseed products such as safflower oil to be available for all present organic farmers, and a capability for the export market to absorb considerably more while maintaining that premium (R. Fountain, Seedex, personal communication, April 1995). Although some farmers receive premiums for organically grown wool and meat, at present they are the exception, rather than the rule.

Hassall and Associates (1995) surveyed farmers on premiums received, and analysed farmers' responses. The answers are shown in Table 4.

Table 4: Premiums received for some agricultural products (1995)

Main product type	Premium (percentages)				
	0	10-20	20-50	50-100	over 100
Grains / cereals	23	44	31	2	0
Meat	86	10	5	0	0
Fibres	33	33	22	0	11

Source: Hassall and Associates (1995, p.22).

A reduction of 1 percentage point in premium for the increase of 2 per cent of numbers of farmers was included, thus eliminating the premium when 30 per cent of farmers have become organic.

In Table 5 a farm is shown similar to that in Table 1, adapted for:

- input use : according to figures in Table 3;
- yields : a reduction of 20 per cent, with 50 per cent reduction for cotton;
- output prices : an increase of 15 per cent at negligible adoption rates of organic practices, decreasing to zero at 30 per cent adoption; livestock products do not receive any premium.

The model is designed to consider the present situation, and does not take into account expected technological changes, nor changes in farm numbers. Constraints are imposed taking into account the rotational limits as recognised by present rotation practices, and reflected in the average farm data. Upper limits of areas in crop are therefore set equal to actual data. The non-cropped area is allocated to livestock activities.

4. Results

Input use:

Input use changes with an increase in adoption of organic management techniques. For the purpose of this paper reduction on expenditure on inputs are assumed according to percentages as indicated in Table 3 and are shown in Table 6.

Calculated on 1985-86 prices, an adoption of organic management practices by 30 per cent of farmers drops expenditure on variable inputs to between 70 per cent (pesticides) and 91 per cent (fuel). The reason that fuel consumption decreases despite a slightly higher use of this input per hectare cropped is that organic farmers in New South Wales only crop 64 per cent of the area cropped on conventional farms. For fertiliser, the 6 percent accounted for by organic farmers is spent on a different product than that used in the conventional sector, such as on rock phosphate instead of on super phosphate.

Table 5: Variable inputs, outputs and output prices on an average farm in southern New South Wales, adapted for organic management

Crop	Area cropped	Yield*	Price	Variable Costs											
				Sowing	Fert.	Herb.	Insect.	Levies	Insure	Machinery				Other	TOTAL
										Sowing	Harvesti	Cartage	Other		
	ha	t/ha	$/t	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha	$/ha
Wheat	36.5	2.1	126	27	16	1	0	8	6	20	5	0	11	0	93
Oats	13.3	1.5	103	40	12	0	0	4	4	13	5	0	8	0	86
Barley	15.1	1.6	135	24	21	1	0	5	5	13	5	0	23	0	96
Maize	0.5	6.7	184	112	100	1	0	3	52	64	6		19	231	587
Rice	9.2	6.7	207	23	50	1	0		7	65	5	43	50	190	433
Triticale	2.8	2.1	132	30	20	1	0	3	7	13	5	0	23	0	101
Soybeans	0.6	1.9	414	81	15	0	0	11	46	14	5		23	116	311
Lupins	5.6	1.3	207	35	10	1	0	3	8	13	5	0	11	0	86
Canola	4.4	1.4	337	10	20	0	0	7	16	15	5	0	37	0	109

Source ABS data

* as in Table 1 plus 15 per cent

Table 6: Percentages of expenditure on, or use of, inputs with different levels of organic management

		Organic management (%)			
		1	5	10	30
Per hectare cropped:					
Fertilisers	$	99	96	92	76
Pesticides	$	99	95	90	70
Fuel	$	100	98	97	91
Per hectare operated:					
Labour	$	100	99	99	96
Land cropped	%	99	97	94	82

An adoption of organic management practices by 30 per cent of farmers means that 82 per cent would be cropped as compared to if all farmers practised conventional management.

These calculations assume constant input prices. If prices were endogenised, fertiliser and pesticide use would probably not fall as much as indicated here.

Total production:

Effects on a shift towards organic farming for the major products are shown in Tables 7a to 7f. For all crops the quantity produced is limited by the upper limit set on the area which could be under a particular crop and by the yield restrictions. For example, when 30 per cent of farmers are organic, 70 per cent of farmers still produce a similar amount of crop, adjusted for the (marginal) change in price. The organic farmers (30 per cent) produce 0.64 (percentage of area cropped) times 0.8 (percentage yield) equals 15.4 percent produce 15.9

Table 7a: Wheat quantities ('000 tonnes) and prices ($) with different adoption levels of organic farming

	Conv.	Org.	Conv.	Org.	Conv.	Org.	Conv.	Org.
	0.99	0.01	0.95	0.05	0.90	0.10	0.70	0.30
Region 1	1,125	6	1,080	29	1,023	59	795	176
Region 2	1,085	6	1,041	28	986	57	767	170
Region 3	1,144	6	1,098	30	1,040	60	809	179
Total	3,354	17	3,218	87	3,049	175	2,371	524
Price	110	126	110	124	111	122	112	112

Table 7b: Numbers of sheep equivalents ('000) and prices ($ per animal) with different adoption levels of organic farming

	Conv.	Org.	Conv.	Org.	Conv.	Org.	Conv.	Org.
	0.99	0.01	0.95	0.05	0.90	0.10	0.70	0.30
Region 1	13,347	142	12,808	709	12,134	1,419	9,437	4,256
Region 2	10,868	116	10,429	582	9,880	1,165	7,685	3,495
Region 3	17,716	188	17,000	938	16,105	1,876	12,526	5,629
Total	41,931	446	40,237	2,230	38,119	4,460	29,648	13,380
Price	23	23	23	23	23	23	23	23

Table 7c: Oats quantities ('000 tonnes) and prices ($/tonne) with different adoption levels of organic farming

	Conv.	Org.	Conv.	Org.	Conv.	Org.	Conv.	Org.
	0.99	0.01	0.95	0.05	0.90	0.10	0.70	0.30
Region 1	40	0	38	1	36	2	28	6
Region 2	274	1	263	7	249	14	193	43
Region 3	301	2	289	8	274	16	213	47
Total	614	3	589	16	558	32	434	96
Price	90	103	90	102	91	100	93	93

Table 7d: Barley quantities ('000 tonnes) and prices ($/tonne) with different adoption levels of organic farming

	Conv.	Org.	Conv.	Org.	Conv.	Org.	Conv.	Org.
	0.99	0.01	0.95	0.05	0.90	0.10	0.70	0.30
Region 1	323	2	310	8	294	17	229	51
Region 2	284	1	273	7	259	15	201	44
Region 3	366	2	351	10	333	19	259	57
Total	974	5	934	25	885	51	688	152
Price	118	135	118	133	118	130	120	120

Table 7e: Lupin quantities (tonnes) and prices ($/tonne) with different adoption levels of organic farming

	Conv.	Org.	Conv.	Org.	Conv.	Org.	Conv.	Org.
	0.99	0.01	0.95	0.05	0.90	0.10	0.70	0.30
Region 1	0	0	0	0	0	0	0	0
Region 2	23,468	122	22,520	611	21,335	1,223	16,594	3,669
Region 3	109,133	569	104,724	2,843	99,212	5,687	77,165	17,061
Total	132,601	691	127,244	3,455	120,547	6,910	93,759	20,730
Price	183	209	184	207	185	204	192	192

Table 7f: Canola quantities (tonnes) and prices ($/tonne) with different adoption levels of organic farming

	Conv.	Org.	Conv.	Org.	Conv.	Org.	Conv.	Org.
	0.99	0.01	0.95	0.05	0.90	0.10	0.70	0.30
Region 1	8,703	45	8,352	227	7,912	454	6,154	1,361
Region 2	45,933	239	44,077	1,197	41,758	2,394	32,478	7,181
Region 3	91,435	476	87,741	2,382	83,123	4,765	64,651	14,294
Total	146,072	761	140,170	3,806	132,793	7,612	103,283	22,835
Price	289	331	291	327	293	322	304	304

per cent. The differences in price elasticity of demand which faces Australian farmers (see Table 2) for the different crops accounts for the differences in changes in prices with the different quantities produced.

Although more area can be used by livestock on organic farms (36 per cent of cropped area), in absolute terms this is a small area. The percentage growth of the livestock sector is marginal at 1 per cent.

Returns from farming:

When only a small percentage of farmers practice organic management the (unweighted) average of net farm cash income (excluding interest payments) in the three regions in New South Wales is estimated at approximately $47,100. This is 12 per cent lower for organic farmers than for conventional farmers, whose income is over $50,000 at that stage (see Table 8a). The largest difference is in region 1, where irrigated cotton growing accounts for a large part of the gap, which is considerably larger than in the other areas. The income from organic farming decreased to $40,700 when 30 per cent of farmers have adopted organic practices, which is 19 per cent of the original income of conventional farmers.

However, when the total net farm income is calculated for New South Wales under the different scenario's, the difference between negligible and a substantial adoption of organic management techniques is only $32.3 million per year (see Table 8c), which is 3.4 per cent of the total net cash income with low adoption rates. The main reason for this low decline in total net cash income to the sector is that, at 30 per cent organic management adoption rate, conventional farmers receive an increased income of $1200 each.

5. Conclusions

Several factors were identified as contributing to the changes in cost, production and farm returns, the main ones being a change in input use, rotations, yields and premium prices, and the effect of changes of quantities of inputs demanded and outputs supplied on input and output prices. An attempt is made in this paper to quantify some of the changes in demand

Table 8a: Estimates of farm cash income ($/farm) in New South Wales with different levels of adoption of organic farming

Farming method	Conv.	Org.	Difference	Conv.	Org.	Difference	Conv.	Org.	Difference	Conv.	Org.	Difference	ABARE Farm Cas Income*
Percentage	0.99	0.01		0.95	0.05		0.90	0.10		0.70	0.30		
Region 1	67,250	52,149	15,101	67,419	51,499	15,920	67,638	50,685	16,953	68,612	47,418	21,194	
Region 2	32,692	33,207	(514)	32,761	32,880	(119)	32,849	32,471	378	33,241	30,827	2,414	
Region 3	50,664	47,084	3,580	50,886	46,627	4,259	51,171	46,052	5,119	52,424	43,733	8,692	
Average	50,202	44,147	6,056	50,355	43,668	6,687	50,553	43,069	7,483	51,426	40,659	10,767	51,585

* : farm cash income for broadacre industries, average for 1992-93 and 1993-94 for NSW (ABARE 1995, pp.136-138). This figure excludes interest payments.

Table 8b: Total number of farmers in New South Wales, and numbers in two categories with different levels of adoption of organic farming

Farming method	Conv.	Org.	Conv.	Org.	Conv.	Org.	Conv.	Org.
Percentage	0.99	0.01	0.95	0.05	0.90	0.10	0.70	0.30
Region 1	5057	51	4852	255	4597	511	3575	1532
Region 2	5986	60	5744	302	5442	605	4232	1814
Region 3	7817	79	7501	395	7106	790	5527	2369
Average	18859	190	18097	952	17145	1905	13335	5715

Source: ABS data

Table 8c: Estimates of total farm cash income ($million) in the broadacre farming sector in NSW with different levels of adoption of organic farming

Farming method	Conv.	Org.	Total	Conv.	Org.	Total	Conv.	Org.	Total	Conv.	Org.	Total
Percentage	0.99	0.01		0.95	0.05		0.90	0.10		0.70	0.30	
Region 1	340.1	2.7	342.7	327.1	13.2	340.3	310.9	25.9	336.8	245.3	72.7	318.0
Region 2	195.7	2.0	197.7	188.2	9.9	198.1	178.8	19.6	198.4	140.7	55.9	196.6
Region 3	396.0	3.7	399.7	381.7	18.4	400.1	363.6	36.4	400.0	289.7	103.6	393.3
Average	931.8	8.4	940.2	897.0	41.5	938.5	853.3	81.9	935.2	675.8	232.2	907.9

of input, supply of output and effect on individual's farmers income and the regional income. The general assumptions made here are rather sweeping, and need to be adjusted for each crop seperately for the results to be more useful.

Input use decreases depending on the input, with a large drop in pesticide use, and the least effect on labour and fuel. Some of the demand for fertilisers used in conventional agriculture changes to nutrients allowed in organic farming. With a change of 30 per cent of farmers towards organic farming, there will be a decrease in area cropped of almost 20 per cent, which will then be under pasture. This is something to consider in the context of diminishing soil quality under present agricultural practices (see Hamblin and Kyneur 1993).

Changes in output are directly related to the stringent assumptions for rotational requirements and yield performance. However, the inclusion of some rough estimates of price elasticities of demand make the situation a bit more realistic. Refinement of the assumptions and actual elasticities is desirable, and will be attempted. A shift away from an average to a typical farm will be considered.

The net farm cash income per farmer shows a decrease of 12 per cent as compared to those of conventional farmers with negligible adoption rates of the organic management. This increases to just under 20 per cent when 30 per cent of farmers are organic. On a regional level, that difference between the incomes in the two situations is 3.4 per cent. The increased income of conventional farmers due to an increase in some of the product prices is partly responsible for this low figure. In absolute terms this amounts to $32.3 million. This figure should be considered in the light of comparative fixed costs and negative externalities. Depreciation of machinery and equipment was found to be considerably lower on organic cereal-livestock farms than on conventional farms (see Wynen 1989). Negative externalities resulting from organic farming are bound to be less than those related to from conventional management in areas such as human health and erosion.

References:

ABARE (1995), Farm Surveys Report, ABARE.

Blue-Green Algae Task Force (1992), Blue-Green Algae, Department of Water Resources, NSW

Bowmer, K. (1990), Herbicides in water: economics or Environment? Technical Memorandum , 90/4, Division of Water Resources, CSIRO.

Braun, J. (1994), 'Impacts of widespread conversion to organic agriculture in the state of Baden-Wurttemberg, Germany' in N. H. Lampkin and S. Padel (eds.), The Economics of Organic Farming - An International Perspective, CAB International, Wallingford, UK, (pp. 329-342).

Curthoys, C. (1995), Winter Crop Budgets 1995 - Western Riverina, NSW Agriculture.

Curthoys, C. (1995), Summer Irrigation Crop Budgets 1995 - Murrumbidgee and Murray Valley, NSW Agriculture.

Hamblin, A. and Kyneur, G. (1993), Trends in wheat yields and soil fertility in Australia, Bureau of Resource Sciences, Canberra.

Hassall and Associates (1995), The domestic market for Australian organic produce - An update, Report prepared for the Rural Research and Development Corporation, Canberra.

Kenderes, M. and Strzelecki, A. (1992), Listing of the 1986-87 ORANI Database, Internal Working Document, ORANI No.OA-569, Industry Commission.

Lampkin, N. and Padel, S. (1994), The Economics of Organic Farming - An International Perspective, CAB International, Wallingford, UK.

Lampkin, N. H. (1994), 'Estimating the impact of widespread conversion to organic farming on land use and physical output in the United Kingdom' in N. H. Lampkin and S. Padel (eds.), The Economics of Organic Farming - An International Perspective, CAB International, Wallingford, UK, (pp. 343-359).

Midmore, P. (1994), 'Input-Output modelling of organic farming and the rural economy of England and Wales' in N. H. Lampkin and S. Padel (eds.), The Economics of Organic Farming - An International Perspective, CAB International, Wallingford, UK, (pp. 361-369).

Patrick, I. (1995a), Summer Crop - Budget Handbook, Agdex 100/830, NSW Agriculture.

Patrick, I. (1995b), Winter Crop - Budget Handbook, Agdex 100/830, NSW Agriculture.

Ramsey, L. and Bootle, B. (undated), Sheep Enterprise Budget Handbook for New South Wales 1993/94, NSW Agriculture

Wall, L. (1995), Winter Crop Budgets 1995 - Eastern Riverina and South West Slopes, NSW Agriculture

Wynen, E. (1989), Sustainable and Conventional Agriculture: An Economic Analysis of Australian Cereal-Livestock Farming PhD, School of Economics, La Trobe University, Bundoora.

Wynen, E. (1994a), Agriculture and the Pest Reduction Scheme in Denmark, Eco Landuse Systems, Canberra.

Wynen, E. (1994b), Agriculture and the Pest Reduction Scheme in Sweden, Eco Landuse Systems, Canberra.

Wynen, E. (1994c), The Multi-Year Crop Protection Plan in The Netherlands, Eco Landuse Systems, Canberra. Report commissioned by the Bureau of Rural Resources.

Wynen, E. (1994d), 'Bio-dynamic and conventional dairy farming in Victoria: a financial comparison' in D. Small, J. McDonald and B. Wales (eds.), Alternative farming practices applicable to the dairy industry, Victorian Department of Agriculture (Kyabram) and Dairy Research and Development Corporation (Melbourne), (pp. Appendix 6).

Zerger, U. and Bossel, H. (1994), 'Comparative analysis of future development paths for agricultural production systems in Germany' in N. H. Lampkin and S. Padel (eds.), The Economics of Organic Farming - An International Perspective, CAB International, Wallingford, UK, (pp. 317-328).