Organic Farming in Australia

By Kondinin Group

Rural Industries Research and Development Corporation
Organic Produce Research and Development
Foreword

Increasing global concern over the use of chemicals in agriculture is behind a growing trend of using organic methods of agricultural production. While adoption of organic practices doubled from 1990 to 1995 it is believed this rate of adoption would increase if there was a greater level of understanding achieved throughout the agricultural community about the factors involved in organic farming. But the absence of a clear understanding of the issues involved with organic farming and the opportunities available continue to impede adoption of these methods by conventional producers.

Organic Farming in Australia is therefore aimed at farmers interested in potentially converting to organic production, and new organic farmers who are looking to source information on organic production. The anticipated affect of promoting organic farming to the wider farming community will be the potential to increase the number of farmers entering into organic farming which will benefit the industry as a whole.

This project was funded from RIRDC Core Funds, which are provided by the Federal Government.

This report, a new addition to RIRDC’s diverse range of over 600 research publications, forms part of our Organic Produce R&D program. This program aims to optimise the profitability of Australian organic production in both domestic and overseas markets and to promote the utilisation of organic farming systems as a means of enhancing the sustainability of Australian agricultural systems.

Most of our publications are available for viewing, downloading or purchasing online through our website:

• downloads at www.rirdc.gov.au/reports/Index.htm
• purchases at www.rirdc.gov.au/eshop

Peter Core
Managing Director
Rural Industries Research and Development Corporation
Acknowledgments

The Organic Retailers and Growers Association of Australia (ORGGA) has played an integral part in this project, supplying professional advice and technical information. ORGGA’s expertise will also be important in developing a consultancy “hotline” and video lending library which will deliver advise and additional technical information for specialist inquiries.

The authors would also like to acknowledge the following people for their contributions and advice in writing the technical articles which make up this publication; Chris Alenson, Tim Marshall, DeAnn Glenn, Paul Kristiansen, Phillip Newton, Robyn Neeson, Pat Coleby, Liz Clay, Andrew Monk, Michael Burlace, Ian Lyall, Els Wynen, Chris Penfold and Viv Burnett.

Thanks also to Liza Cowper who was responsible for so much of the initial research and co-ordination for this report.

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFOAM</td>
<td>International Federation of Organic Agriculture Movement</td>
</tr>
<tr>
<td>NASAA</td>
<td>National Association for Sustainable Agriculture Australia</td>
</tr>
<tr>
<td>ORGGA</td>
<td>Organic Retailers and Growers Association of Australia</td>
</tr>
<tr>
<td>BFA</td>
<td>Biological Farmers of Australia</td>
</tr>
<tr>
<td>IOIV</td>
<td>Interim Organic Industry Council</td>
</tr>
<tr>
<td>COGS</td>
<td>Canberra Organic Growers Society</td>
</tr>
<tr>
<td>OPEC</td>
<td>Organic Produce Export Committee (previously OPAC)</td>
</tr>
<tr>
<td>AQIS</td>
<td>Australian Quarantine Inspection Service</td>
</tr>
<tr>
<td>DPI</td>
<td>Commonwealth Department of Primary Industry</td>
</tr>
<tr>
<td>OHGA</td>
<td>Organic Herb Growers of Australia Incorporated</td>
</tr>
<tr>
<td>OFA</td>
<td>Organic Federation of Australia</td>
</tr>
<tr>
<td>BDRI</td>
<td>Bio-Dynamic Research Institute</td>
</tr>
<tr>
<td>TOP</td>
<td>Tasmanian Organic-dynamic Producers</td>
</tr>
<tr>
<td>OVAA</td>
<td>Organic Vignerons Association of Australia Inc</td>
</tr>
<tr>
<td>OAS</td>
<td>Organic Advisory Service</td>
</tr>
<tr>
<td>OBG</td>
<td>Organic Beef Group</td>
</tr>
<tr>
<td>ACF</td>
<td>Australian Conservation Farming</td>
</tr>
<tr>
<td>ACA</td>
<td>Australian Consumers’ Association</td>
</tr>
<tr>
<td>ANZFA</td>
<td>Australian and New Zealand Food Authority</td>
</tr>
<tr>
<td>SCARM</td>
<td>Standing Committee on Agriculture and Resource Management</td>
</tr>
<tr>
<td>ROFO</td>
<td>Riverina Organic Farmers Organisation</td>
</tr>
</tbody>
</table>
Contents

Foreword ....................................................................................................................... iii
Acknowledgments .........................................................................................................iv
Abbreviations ............................................................................................................... iv
Executive Summary ...................................................................................................... vii
1. Introduction .................................................................................................................. 1
   1.1 Resource fears spurred organic pioneers .......................................................... 1
   1.2 Organic farming growing in Australia ............................................................... 3
2. Conversion .................................................................................................................. 6
   2.1 Commitment crucial for organic conversion ..................................................... 6
   2.2 The conversion plan ......................................................................................... 7
3. Pest and Weed Management ................................................................................... 13
   3.1 The organic way to pest and weed management ............................................. 13
   3.2 The future is integrated pest management ...................................................... 15
   3.3 Working with nature for weed control ............................................................ 18
   3.4 Look at all options for pest management ....................................................... 25
4. Organic Production Systems ................................................................................... 31
   4.1 The living soil provides a vital resource ......................................................... 31
   4.2 Nutrient inputs in organic systems .................................................................. 34
   4.3 Soil analysis can prove a useful tool ............................................................... 36
   4.4 Organic farm fertility: it’s natural ..................................................................... 39
   4.5 Compost: turning waste into gold ................................................................. 43
   4.6 Storing organic produce ................................................................................. 48
   4.7 Livestock plays a vital role ............................................................................. 48
   4.8 Animal health – the natural approach ............................................................. 54
5. Certification .............................................................................................................. 57
   5.1 Certification of organic products in Australia ............................................... 57
6. Marketing ................................................................................................................. 62
   6.1 Demand based marketing is the key ............................................................... 62
   6.2 Adding value to organic produce ................................................................. 65
7. Economics .............................................................................................................. 72
   7.1 Economics stack up for organic farming ....................................................... 72
   7.2 Trial shows concerns at bottom line .............................................................. 78
   7.3 Conversion process under the spotlight ......................................................... 81
8. Appendices .............................................................................................................. 86
   8.1 Wholesalers and Retailers of Organic Produce ............................................. 86
9. References - Further reading .................................................................................. 91
List of Tables

Table 3.3.1: Reproductive and vegetative characteristics of plant species commonly considered to be weeds .................................................................19
Table 4.2.1: The benefit that a green manure crop can play in nutrient supply ..........35
Table 4.4.1: Nitrogen contents of selected agricultural crops..................................41
Table 4.4.2: Nutrient removal in grain from different crops ..................................41
Table 4.4.3: Nitrogen fixed by legume and green manure crops .............................42
Table 4.5.1: Carbon - Nitrogen ratio of some organic wastes ...............................45
Table 4.5.2: Troubleshooting ..............................................................................46
Table 5.4.3: Analysis and application rate of two types of compost ......................47
Table 7.1.1: Input use on organic and conventional farms in south-eastern Australia ..74
Table 7.2.2: Financial aspects of organic and conventional farms in south-eastern Australia 76
Table 7.3.1: Rotation at organic Rutherglen site 1994 - 1999 .................................81
Table 7.3.2: Soil chemical data for organic 1995 - 1999. .......................................82
Table 7.3.3: Grain production from the cereal phase of the rotation, 1995 - 1999 ......82
Table 7.3.4: Wool weights and stocking rates ....................................................82
Table 7.3.5: Earthworm numbers 1995 - 1999 .....................................................83

List of Figures

Figure 3.3.1: Weed management planning cycle ..................................................20
Figure 4.1.1: Soil structure ..................................................................................32
Figure 4.5.1: Composting ...................................................................................44
Figure 4.5.2: The difference between a layered pile and a pre-mixed pile .............45
Figure 6.2.2: Percentage of retail dollar to each layer .........................................67
Figure 7.3.1: Organic Steering Committee at AV Rutherglen (2/7/99) ..................84
Figure 7.3.2: Early emergence of wheat (Rosella) sown by direct drilling ..........84
Figure 7.3.3: Rutherglen Field Day ....................................................................85
Figure 7.3.4: Spreading worm casts (3/6/99) on perennial pasture block ..........85
Executive Summary

With a growth rate exceeding twenty per cent per annum, it seems the potential of the organic farming industry in Australia is only just being realised. Consumers are becoming acutely aware of the possible chemicals contamination in products they eat, drink and wear and there is subsequently a growing demand for products guaranteed to be chemical-free. With increased demand comes increased supply, and since the 1980s researchers in Australia have been looking in detail at the long term potential and viability of organic farming. Much of this research, including this report, has been aimed at finding ways to encourage producers into this industry to help match supply with the rapidly increasing worldwide demand.

To determine the content of this report, market research was carried out and included the discussions at a number of focus group meetings held in Western Australia, New South Wales, Victoria and Queensland and a survey being sent to over 1000 farmers (organic and conventional growers). The aim of the survey was to help direct the content of the package and confirm the specific areas of organic farming the report needed to cover.

The results of the focus group meetings and survey were used to develop an outline for the report on a chapter by chapter basis. The survey results were incorporated into the outline for the manual to ensure the report is a true reflection of the information farmers want to see included in the manual, and this information will be applicable to all agricultural industries.

This report, Organic Farming in Australia, has been compiled for conventional farmers who are thinking of converting to organic farming, and for producers who have recently become organic farmers and who would like more detailed information on any aspects of their production. The report provides a step-by-step guide to organic farming, and technical articles give a detailed explanation of organic farming principles and accreditation, certification procedures, pest and weed management, soil health, crop and livestock production, potential marketing strategies, industry contacts and an economic evaluation of organic farming.

Following a brief introduction outlining the development of the organic industry in Australia, the report looks at issues facing a farmer wanting to convert to organic production. Suitable land and a high level of motivation and commitment are essential for a farmer looking to convert. Once the decision has been made to begin organic production, it is suggested the farmer draws up a detailed conversion plan to aid the change from conventional to organic farming. This plan is made up of a thorough farm assessment or audit to establish the current situation and a step-by-step action plan. The action plan must address issues such as information gathering, soil fertility improvement, rotation design, weed, pest and disease control, farm infrastructure, livestock requirements, cultivation and tillage, labour requirements, financial implications, marketing requirements, and a risk assessment, as applicable.

The next section of the report looks at pest and weed management in an organic production system. This is an area, which often poses the most problems for organic farmers, during both the conversion phase, and once an organic system has been established. However, the report offers many solutions for pest and weed control, and offers a new way of thinking to help farmers work with nature rather than against it. Rather than simply replacing synthetic pesticides with naturally occurring products, it is suggested that design and management are the key to success in controlling pests and weeds.

The report details the use of integrated pest management (IPM) as part of a pest control programme, and gives suggestions for cultural, biological and allowable natural pesticides control for various common pests. There is also a detailed list of products available to the organic farmer for pest control, although each certifying agency may vary this list according to their own requirements.
Similarly, suggested methods of weed control outlined in the report include cultivation, competition, thermal weeding, solarisation, crop choice, sowing density, fertilisation, irrigation, hand weeding, suppression, mechanical control, crop rotations, the use of livestock and biological controls. It is interesting to note that no herbicides are currently permitted for use on certified organic farms, although transitional farmers may use pine or citrus oil-based herbicides.

The section of the report devoted to organic production systems is broken down into three subsections: soil health, crop and pasture management and livestock production.

Healthy soil is an essential part of any farming system. In an organic farming operation, an effective nutrient cycle becomes even more important as producers are limited to being able to use only certain approved fertilisers. However, by correctly managing the inorganic elements and organic matter in their soil, and ensuring there is sufficient aeration and moisture, organic farmers can grow as healthy crops and pastures as any other farmer. Many inorganic elements are an allowable input on certified organic farms, and there is a large range of commercial mixes or single elements available. Organic matter can be provided to the soil through composts, green manure or cover crops, well composted animal or poultry manure or composted industry waste free of unallowable contaminants.

The crop and pasture management section of the manual details the allowable inputs for use in soil fertilisation and soil conditioning on organic farms. It also looks at suitable green manure crops and strategies that can be used for enhancing soil fertility. These strategies include accurate fertiliser placement, reducing weed competition, timing application with moisture, minimising cultivation and water-logging and doing extensive soil tests first so nutrient inputs are matched to existing soil conditions and anticipated plant needs. There is also a detailed section on large scale composting and how to make and apply compost on farm to enhance the nutrient cycle.

Livestock can play a vital role in an organic production system as they provide an effective form of weed control, pest management, nutrient cycling and help crop establishment. The livestock production section of the report looks at how to incorporate livestock into an organic farming system so they too can be sold as organic produce. Livestock management in this situation can differ from conventional livestock management as synthetic chemicals can not be used to maintain animal health without the loss of the livestock’s certified organic status. However, the report suggests a number of ways to minimise the likelihood of a disease outbreak and control pests in livestock, much of which has to do with getting soil and pasture health right first.

One of the most daunting parts for any farming converting to organic production is the conversion process. This section of the report looks at domestic and international certifying bodies, why there is a need to be certified, what is meant by the ‘organic in conversion period’, what paperwork is involved in certification and the overall cost and benefits of certification. There are currently seven different certifying bodies in Australia, with some being more industry-specific than others. A brief description is given of each agency and their contact details are included in this section.

Marketing is undoubtedly one of the keys to a successful organic farming system, and this section of the report looks at providing for an industry in which demand is currently far outstripping supply capability. The three essential rules to marketing organic products are knowing the market culture and its regulatory requirements, knowing the specifications and demands of the customers and knowing your products performance and nature. The second part of this section looks at ways to add value to organic production, at various points along the production chain ranging from the type of produce grown to conducting tours of the enterprise. Also included are some detailed examples of investing in value-adding techniques and the various benefits and costs these will result in. Finally there is a small article on the potential for exporting organic produce, and some of the international certification and quarantine requirements imposed on organic goods.
The final chapter of **Organic Farming in Australia** looks at the economics of organic farming compared to conventional farming. Evidence available from several studies implies that organic cereal-livestock farming can in some cases be financially as rewarding as conventional farming, both for individual farmers and for the sector as a whole. This is studied in more detail in an article which compares input costs, crop yields, output prices and overall returns for a number of neighbouring organic and conventional farms. Two other trials are discussed in this chapter, including a trial at Roseworthy College in South Australia, which compares soil fertility, weed control and financial returns on conventional and organic trial sites. A similar trial was carried out at Rutherglen in Victoria and the results, which include analysis of soil composition, grain production, wool production and earthworm numbers are also discussed in this section.

Included at the end of the report is a list of some of the organic wholesalers and retailers in Australia as well as helpful contacts for information for interested farmers, especially when considering potential markets for their produce.
1. Introduction

1.1 Resource fears spurred organic pioneers
by Chris Alenson, ORGAA

From a fledgling industry in the 1980’s, organic farming in Australia is now estimated to have a growth rate of more than 20 per cent per annum. The industry currently turns over $200-$250 million annually and is driven by domestic and international consumer demand.

The pioneers of organic farming tried to produce wholesome food from soils that had been almost destroyed by poor agricultural practices. Contamination by pesticides was not their primary motive, rather they feared that their resource base would become bankrupt.

Organic agriculture has both a philosophical and practical base where its proponents seek to farm in a manner that does not impact on the environment. Farmers avoid the direct or routine use of readily soluble chemicals and all synthetic pesticides that might be toxic to man or the environment.

Weed control involves a range of techniques such as controlled grazing, timely cultivation, mulching, rotational control, thermal techniques and sowing density. Organic farmers use some of the latest technologies that science has to offer, including prescription mix fertilisers, new seed varieties, microbial inoculants, innovative equipment and biological pest control.

The goal is to increase soil fertility in the context of overall farm management and to ensure the production of healthy uncontaminated food. Practices adopted to build soil fertility include composting, wide rotations, green manure and cover crops, legume based leys and mineral based fertilisers.

If problems arise they are managed by gaining an understanding of the cause and by seeking to solve the problem using management techniques that offer least disruption to the farming system and the immediate environment.

Supporters of organic agriculture would argue that its dynamic and flexible management systems may well be capable of addressing many of the problems that conventional agriculture is faced with today.

Conventional concerns
As the environmental movement gained momentum in the 1960’s and 1970’s farmers, researchers and consumers became increasingly concerned about the direction and speed at which agrochemically dominated modern agricultural systems were heading. Agriculture, especially in the western world, when measured by its output and its profits has been enormously successful. But it appears this success has come at a cost.

Some of the major concerns included:

- The impact of pesticides on human health.
- Land degradation issues such as erosion, salinity and acidification.
- The energy intensiveness of agriculture in the production of food.
- The environmental impacts of farm practices, in particular the use of agrochemicals.
- Loss of diversity of plant species in production.
- The continual battle to overcome pests and weeds.
- The cost of farm inputs.
• Ethical concerns regarding intensive animal husbandry methods.

**Organic agriculture**

Organic farming is described in the Australian National Standard for Organic and Bio-dynamic Produce (the national standard) as ‘systems which include those which are referred to as bio-dynamic or biological.

The basic principles are to achieve optimum quantities of produce and food of high nutritional quality without the use of artificial fertilisers or synthetic chemicals.

Organic farming requires the nurturing and maintaining of land for future generations. Emphasis is placed on the use of renewable resources, the need for conservation of energy, soil and water resources and the maintenance of environmental quality. The production cycle is as closed as possible, with limited use of external inputs permitted by this standard.

Although many factors have led to the recent development of the organic industry perhaps two key research reports gave it the recognition it needed.

The first of these was the 1980 report on organic farming by the United States Department of Agriculture. The report covered a range of activities and case studies and concluded, ‘that many of the current methods of soil and crop management practiced by organic farmers are also those which have been cited as best management practices for controlling soil erosion, minimising water pollution, and conserving energy.

These include sod based rotations, cover crops, green manure crops, conservation tillage, strip cropping, contouring, and grassed waterways.

Moreover, many organic farmers have developed unique and innovative methods of organic recycling and pest control in their crop production sequences.

Because of these and other reasons outlined in this report, the team feels strongly that research and education programs should be developed to address the needs and problems of organic farmers.

Certainly much can be learned from holistic research effort to investigate the organic system of farming, its mechanics, interactions, principles, and potential benefits to agriculture both at home and abroad’.

The second report, which was widely publicised in scientific journals and in the media, was Reganold’s 1987 study on the ‘Long term effects of organic and conventional farming on soil erosion’. Reganold compared matched pairs of organic and conventional farms. The results demonstrated that organic farming had positive contributions to make in the area of land degradation problems and the maintenance of soil fertility.

This scientifically reputable study found that organic farming could match conventional farming in yields, production and costs and provided evidence that the soil resource was sustained above and beyond the soils studied on neighbouring conventional farms.

**At a glance**

Organic farming seeks to:
- Preserve and improve soil fertility.
- Recycle wastes for conversion to humus.
- Maximise moisture retention in soil.
- Prevent pest and disease occurrences.
Useful definitions:

**Bio-dynamic**
Bio-dynamic agricultural practices are a form of organic farming based principally on the work of Rudolf Steiner and subsequent developments derived from practical application, experience and research. Today the term organic often encompasses bio-dynamic farming practices, although it is in fact an enhanced method of organic farming which also accepts the influence of the cosmos on the farming process.

**Certification**
Certification means the procedures by which an approved certifying organisation provides written assurance that an operator has been determined to conform to the national standard for organic and bio-dynamic produce (the national standard). Certification is based on the inspection of practices used, sampling of product and verification of records maintained by the owner.

**Certified organic**
Certified organic or Level A, means a farm has fully converted to organics. This farm has been farmed organically, usually for a minimum of three years under the watchful eye of the certifier. No artificial chemicals are used and the farmer is managing in a way which cares for the environment and for the quality of produce.

**Certified in conversion**
The ‘in conversion’ level or level B produce is from a farm which practises to the same standard as level A but only for a year or two.

**Organic**
Organic goods have been produced by specific management practices, which take care of the environment and soil. Synthetic chemicals (including pesticides and fertilisers) are not permitted other than those listed in Annex 1 of the national standard.

1.2 Organic farming growing in Australia
by Chris Alenson, ORGAA

Interest in organic farming has been gaining momentum since the 1980’s with consumers expressing a desire to purchase food with minimal chemical residue.

Problems associated with conventional farming systems had been getting more coverage in the media with cases of food contamination, environmental pollution and land degradation being highlighted.

The development of the environmental or green movement and alternative lifestyles, combined with concern about how our food was being produced, initiated a demand for organic food not previously seen. Each reported incident of food or farm contamination resulted in a corresponding demand for organic food.

As certification organisations were established to develop standards and to certify organic and bio-dynamic production systems, more research was becoming available to justify organic agriculture as a sustainable approach to food and fibre production.

In the 1980s, researchers began to survey organic producers to examine both farm viability and the nature of producers across Australia. This research, coupled with the active lobbying of the organic groups in Australia led to both state and federal governments becoming aware of this industry and the potential for increased production.
As the world domestic demand for organic produce increased, governments of the day were attracted to this market for the economic potential that it might have. In Australia the Primary and Allied Industries Council produced a report titled ‘Implications of increasing world demand for organically grown food’.

Its aim was to review increasing world demand for organically grown food and to consider ways in which sustainable agriculture can be developed in Australia to meet both the domestic and export demand.

The outcome was that an expanding domestic and export market existed and that further study should be conducted into certification issues and overseas quarantine requirements and that the federal government adopt a higher profile on sustainable agriculture.

The development of the Australian organic industry, although not as rapid as that in the USA or Europe, has been impressive. With very little support from government, extension or advisory services, the organic industry is now high on the political agenda in Australia.

Public recognition and demand for organic products are increasing while all forms of the media are keen to discuss many facets of the industry. Trading partners such as Japan, Europe and the west coast of America have an unsatisfied demand for organic produce. In the USA organic foods have become the fastest growing sector of the food industry. Over the last seven years growth has exceeded 20% per annum. Sales of organic foods are predicted to exceed US$6.5 billion by 2000.

In Europe, retail sales of organic foods in 1997 were estimated to be worth US$4.5 billion. Growth is estimated to be 20-30% per annum.

Future projections for organic farming

<table>
<thead>
<tr>
<th>Description</th>
<th>1995</th>
<th>2000</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of organic producers</td>
<td>1429</td>
<td>1657</td>
<td>1920</td>
</tr>
<tr>
<td>% of all agricultural producers</td>
<td>1%</td>
<td>1.4%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Total organic area ('000ha)</td>
<td>336</td>
<td>546</td>
<td>887</td>
</tr>
</tbody>
</table>

The above industry projections were based on information available in 1995(Hassels & Associates). The issue of genetically modified foods has placed the organic food industry on a growth curve of about 30% across the world where demand cannot be currently satisfied. This trend is likely to continue for some time.

Consumers are now able to access a wide range of produce to satisfy their consumption patterns. The range and quality of organic produce had increased not only in the area of fresh fruit and vegetables but also in dried and packaged goods such as cereals, grains, flour, nuts, dried fruits, meat and dairy products.

It is important to recognise that producers have gone to some trouble to produce food under a strict code of operating standards which prohibit synthetic pesticides and fertilisers from the production process. The guarantee of authenticity for consumers is the accompanying certification logo that the produce carries into the market place.

Today there are more than 50 groups across Australia that keenly promote the message of organic and bio-dynamic agriculture. Included in these are seven certification organisations audited and accredited by the Australian Quarantine Inspection Service (AQIS) to advance the production of organic products.
Government support is available for research through the Rural Industries Research and Development Corporation (RIRDC) which funded an organic programme to the tune of $250 million in 1998 and again in 1999. Although small in comparison to research spending on conventional agriculture it is recognition that the organic industry has significant growth potential.

The growth of ‘organics’ from a movement to an emerging economic industry has taken many decades and a great deal of dedication from many practical farmers and grass roots organisations. These farmers have actively promoted organic farming as a viable alternative agricultural industry.

Agricultural producers in Australia now are in a position to supply a demanding domestic and export market for certified organic produce while sustaining their resource base into the future.
2. Conversion

2.1 Commitment crucial for organic conversion

by Chris Alenson, ORGAA

The challenge in converting to organic agriculture is to apply information and practical experience gained so that the farm is economically viable and sustainable.

Conversion refers to the process of changing from a more conventionally managed agricultural system to one managed according to organic methods.

While the conventional system may rely on inputs of synthetically produced fertilisers and pesticides to provide fertility and pest and disease control, the organic system relies more on the development of natural biological cycles involving microorganisms, soil fauna, plants and animals.

It is important to remember that many conventional systems particularly stock-based ones will not be dissimilar to an organic system and conventional farmers will already use many techniques used by organic farmers. These practices might include the use of rotations, chisel ploughing or soil aeration, green manuring, waste or stubble retention.

Challenges

Some of the major challenges when converting to organic agriculture are:

- An understanding of what an organic system means in the context of nutrient supply.
- Management of pest, disease and weed problems through whole farm management rather than simply accessing and using proprietary chemicals.
- Justifying the move to organic agriculture to the many friends, neighbours and scientists that may see the decision as unnecessary.

There are many factors to be considered and integrated in the conversion process. Some of these are economic, environmental, infrastructural and social factors.

Farmers should be aware of the National Standard for Organic and Bio-dynamic Production with regard to conversion. Under the national standard, ‘organic in conversion’ means a production system which has adhered to the standards for at least one year and has been certified as such but does not qualify as fully organic for reasons such as:

- The conversion system has not been operated within the requirements for the specified period (usually three years).
- The farm does not meet the quality standards, such as the soil structure considered appropriate and necessary for organic farms or the overall organic management system is not sufficiently developed.

The conversion process should only be undertaken after a thorough assessment of the farm and the formulation of a well-designed plan which gives consideration to factors mentioned above. In this way any risk to the farm enterprise is minimised.

Why consider changing?

In western societies conventional high technology agriculture is hailed as most successful and cost efficient.

But for some time many farmers and scientists have felt something was wrong. There is increasing concern about how our resource management results in land and water degradation along with the effect chemicals used on food crops has on the health of the environment and on ourselves. There is
consumer concern over possible residues, food nutritional quality and also what is perceived to be an antagonism between agricultural production and the general care of the environment.

Organic produce at the present time commands good prices and demand is increasing from supply agents such as retailers, wholesalers and supermarkets. Consumers are becoming more educated to both health and environmental benefits of buying organic food and this is reflected in the 20 per cent increase in demand over the past couple of years.

**Successful conversion**

Successful conversion depends on two factors.

1) Suitability of the farm for conversion
2) Motivation, commitment of the farmer and family

There will always be properties which are more difficult to convert to organic agriculture than others. Organic farms generally are mixed farms with a diverse range of crops, trees and livestock.

This is the opposite of a monocultural system where pest, disease control and nutrient cycling would be very difficult to manage unless substantial changes were made.

It would also be almost impossible for intensively housed animal enterprises such as poultry, pigs or cattle to comply with organic guidelines.

Climate and geographic location such as areas of high salinity, high watertables, contamination from previous land use or even distance from suitable markets may preclude a farm from being suitable for organic farming.

A farmer undertaking the conversion process may feel isolated, with little technical help to work through the many areas that need addressing.

The need for a holistic or systems approach to farm management is essential in overcoming these obstacles, as is a strong belief that the course being pursued is the correct one.

There is a lot of learning to be done and perhaps many mistakes to be made before a successful system is established, remembering that agriculture deals with biological systems where change is always occurring. Family support is an essential ingredient for the farmer while pursuing these objectives.

**2.2 The conversion plan**

by Chris Alenson, ORGAA

The conversion plan involves a thorough farm assessment and an action plan.

The farm assessment involves an audit of the farm, detailing paddock size, layout, irrigation, soil fertility and nutrient status (including fertilisers used). It will also cover soil structure, pest and weed management (including chemicals used), stock and crop health, rainfall, length of growing season and equipment.

A whole farm plan encompassing all aspects of the property is highly desirable. The aim of the farm assessment or audit is to understand where the farm currently sits in relation to its on-farm resources. This will then provide the data that can be compared with the requirements of the organic system.
This is a complex task and requires the experience of an individual who is conversant with whole farm planning, risk assessment, and all the component parts that are necessary for a successful organic farming system. A consultant skilled in this area may be required.

The initial farm assessment may show a need to act on key issues such as degraded areas of the property that require remedial treatment for soil erosion or salinity, fencing realignment, water reticulation, tree plantations or soil fertility improvement.

A key objective of organic standards is to manage the farm to ensure environmental sustainability, these factors are important when property assessment by certification agencies takes place.

Once a farm assessment is complete the development of an action plan is the next stage in the conversion process.

**Development of an action plan**

The plan for cropping enterprises will be based around establishing an effective rotation. It is important when conversion is initiated that a suitable paddock is trialled. This should be no larger than a grower can afford to risk. The field should be large enough to see whether the change in management has made a difference but small enough to avoid significant economic losses if results are not as expected.

The following elements will generally have to be considered as part of the conversion process for both annual cropping and perennial based operations:

1. **Information gathering**
   The intending organic farmer will need to know about organic production standards, the requirements for certification, the agency they wish to obtain certification from and markets for various products. Knowledge will be needed in nutrient and soil management, inputs allowed for pest and disease control and simply what organic agriculture is all about.

   Interested farmers should gather as much information as possible from other growers, certification agencies, grower groups, agriculture departments, advisory services, books and attendance at field days, etc.

2. **Soil fertility improvement**
   The development of a sustainable system will depend on how soil fertility enhancement is pursued. Both the supply of nutrients and the soils own structural development are equally important and will require management strategies to ensure that they are addressed.

   As organic systems are generally low input systems it will be necessary to look at how nutrient supply will be managed without recourse to the synthetic fertilisers.

   A full soil assessment which includes examination of soil structure, tilth and soil analysis and an assessment of crop and animal health and other biological indicators should be undertaken. This will indicate where soil nutrient levels, structure characteristics and crop health need to be improved. The farmer may be able to carry out much of this on-farm assessment, although appropriate advisory personnel or consultants may be required.

   Rotational strategies will be important in ensuring the build-up of organic matter in the soil and additions of mineral elements may be necessary where a demonstrated need is established. Biological foliar sprays to supply trace elements and to build plant resistance to disease would be advantageous.
3. Rotation design
It is essential to understand the role that rotations play in underpinning the fertility building cycle so important in achieving a sustainable system of agriculture. A good rotation is the foundation on which a successful organic system is based.

Continuous cropping without resting the ground will result in difficulties. These may include a decline in soil nutrients, imbalance in soil pH, a build-up of soil pathogens, a decline in soil structure and quite possibly land degradation in the form of wind and water erosion and the introduction of salinity problems.

The rotation should have a balance between fertility building crops (grass or clover pasture) which provide good quantities of root bio-mass for earthworms and micro organisms, and exploitive crops (cereals, canola). Crops that have natural weed germination inhibitors such as rye and sorghum may be used.

The rotation design should cover nitrogen needs, the use of legumes and green manure crops. Organic matter improvement might be enhanced through deep rooting pasture species, legumes, mature green manure crops, stubble or compost.

Crops which are susceptible to weeds can follow weed suppressing crops such as rye and sorghum. The rotation must also produce sufficient feed for livestock.

Green manures play an important role in the rotation process where they are a prime source of nitrogen, supply forage for stock, reduce weed seed banks and supply organic matter to the soil. Planting a diverse range of crops through each rotation should be effective in reducing plant pathogens and in preventing insect populations from becoming established.

Other factors that need to be considered when planning the rotation are whether there is a market for the crops planned in the rotation and if they are suitable for the climate and soil type.

4. Cereal and livestock farms
In Australia it may be easier to convert a sheep, cattle or cropping farm than an intensive horticultural operation due to legume pastures already being employed and less reliance on synthetic fertilisers and chemical pesticides.

5. Horticulture
The conversion of a horticultural property is more difficult given the reliance on synthetic fertilisers and pesticides to maintain yields. The use of compost and bought-in wastes for composting, form an important part of nutrient management when animal manures are not available.

In this situation it is essential that the rotation include legumes and green manure crops to provide nitrogen and organic matter and that provision is made for bought in waste products.

6. Weed, pest and disease control
Likely weed and pest problems will already be identified through past experience. It is often the case that a dependence on agricultural chemicals has caused an increase in particular pest problems which has been exacerbated by the destruction of possible beneficial predator insect populations.

Crop rotation is important for insect control and the use of natural predators should be encouraged through the planting of herbaceous vegetation. The use of botanical sprays could be considered although any chemical usage by those intending to seek organic certification should be ratified by reference to organic standards or through consultation with a certification agency.
The removal of current agricultural chemicals for the control of such problems as weeds should now be exercised primarily through the development of a good rotation although planting density, the grazing of stock, mechanical and thermal weed control may also be used.

Reducing weed competition by sowing wheat more densely at rates of 150-175kg/ha has produced yields of 3.3 t/ha from 150kg/ha of organic fertiliser. Equipment needs for both weed and insect control should be addressed at the planning stage of the conversion.

General fertility improvement will help to overcome soil imbalances where weeds are favoured.

7. Farm infrastructure
Conversion to organic agriculture may require different equipment and infrastructure to be in place to support the particular enterprise. It may be a change to cultivation equipment or to packaging, that is required to market the intended produce, cool rooms to store it in or changes to more basic needs such as paddock re-design and irrigation supply. This is an important part of the planning required for successful conversion.

8. Livestock and stocking rates
On a mixed farm there should be a balance between livestock and crops. Under organic management stock numbers may need to be reduced to ensure that stock are fed from on-farm produced foodstuffs. Mixed livestock may assist in parasite control and pasture management and recycling of nutrients.

Poor soils are a legacy of Australia’s geological history, being an old continent. As a consequence our soils are very fragile, suffer from poor structural development and can be compacted very easily. Given this situation, stocking rate is very important to allow pastures to develop properly and to avoid compaction and erosion problems through over grazing.

Farmers need to consider if the current stock on hand will satisfy the intended organic markets or if some stock will need to be sold on the conventional market as well.

9. Cultivation and tillage
The often repeated axiom for organic agriculture is deep loosening and shallow turning. Depending on the enterprise, equipment needs may differ from conventional agriculture.

Long standing use of either mouldboard or disc ploughs may have resulted in hard-pan structures at plough depth which may be inhibiting the penetration of plant roots to access both moisture and nutrients.

Similarly the trampling of pastures by stock over many years causes soil compaction which could benefit from deeper loosening. Chisel ploughs and soil aerators are often used for opening up the soil while weeding requirements may require a completely different set of equipment.

10. Marketing requirements
It is essential preliminary market research is carried out to see what opportunities exist to supply the given produce. Is the product in demand and what are the packaging and market supply requirements? Will the market accept misshapen produce? Transportation and market location whether local or interstate or overseas are other considerations. Inquiries should be addressed to organic wholesalers around Australia, as well as exporters, supermarkets, retailers or others in the supply chain to determine demand and their supply requirements.
11. **Labour requirements**
Organic agriculture is often more labour intensive as it does not rely on agricultural chemicals for pest and weed control. For example, additional cultivation, hand hoeing, and more on-farm evaluation of how the whole farm is operating, can be expected. Is there sufficient labour for the enterprises being considered and will seasonal labour be available when required? The additional costs of labour requirements need to be factored into the cost of conversion.

12. **Financial implications**
All financial considerations for plant, machinery, and labour must be investigated. And is there an adequate buffer for the initial years when income may be reduced.

During the conversion process, a decrease in production may be expected of 10-15 per cent due to the changing nature of nutrient supply to the crop from a chemical-based system to one of optimising soil-based fertility.

Once the organic system has been established and a good level of soil fertility has been achieved, production may not be dissimilar to conventional management.

Recent research on the Rodale Research Farms in the USA demonstrate that a fall in yields did not accompany the rotation being trialled in their conversion plots and that organic plots outperformed the conventional ones in a time of very low soil moisture.

13. **Risk assessment and cost**
A competent authority or farm consultant should perform a thorough risk assessment for the intended enterprise. The risk assessment should take into consideration all past chemical uses, and may require gathering information from past owners of the land to get an accurate picture of possible chemical residues.

The rest of the assessment should take into consideration all aspects of the conversion, particularly the initial three-year conversion period with the likely decrease in income. It should also include the cost of any new capital equipment and infrastructural changes necessary to ensure the success of the operation.

The cost of conversion will depend on how much the current system differs from the organic one proposed and the amount of restructuring that may have to take place. The efficiency of the conversion and the time taken for conversion will both affect the cost to the farmer.

14. **Inputs in horticultural operations**
Although organic agriculture is generally a low input system, horticultural operations on occasions use compost and mineral fertilisers. The use of these mediums, and biological preparations such as seaweed sprays and fish emulsions, will aid crop nutrition and health.

The organic standards insist that all off-farm wastes be composted before use, to minimise contamination and to transform nutrients into a more acceptable form.

It is important in the transition planning to anticipate what inputs are required and how they will be provided.

Pest and disease management is achieved through sound rotations, cultural methods, soil fertility enhancement, the fostering of biological control and occasionally direct action with approved low toxicity pesticides.
Don’t move too quickly
A change to an organic system requires both a philosophical change and the adoption of many new management techniques. It is important not to move too fast. As attainment of a soil high in fertility is paramount to a successful organic enterprise, it is likely that some time will elapse before that point is reached.

Remember that organic farming is not about substituting one allowed input for a prohibited input, but putting into place a management regime that works towards a regenerative system. To suddenly stop using chemicals may not be the best approach, rather a slow weaning may be the best way of achieving goals in the long term.

As mentioned earlier, try out the management techniques on a small area first where mistakes are unlikely to be too costly. A big mistake on a small acreage may not prove too expensive, whereas a small mistake on a large acreage may turn out to be very costly.

The development of effective rotations is the key to successful conversion of cropping and horticultural operations. Monocropping with little diversity can only be maintained through the use of synthetic fertilisers and pesticides.

At a glance
• Is there a strong commitment to organic farming?
• Seek information and explore all options, standards, certification, conversion information and markets.
• Farm assessment of current enterprise and changes needed to convert to organics.
• Soil fertility restoration, including rotations and nutrient planning.
• Proceed slowly (progressive conversion) while adapting to a change in management.

Information and assistance
Don’t be afraid to seek advice - there are many organic organisations, extension personnel in agriculture departments, advisory services, and growers themselves who will be only too pleased to offer advice and encouragement.
3. Pest and Weed Management

3.1 The organic way to pest and weed management
by Tim Marshall, Organic consultant

A well-planned management program will help organic growers control pests, diseases and weeds without synthetic chemical fertilisers.

Active management and planning are necessary to ensure that the ‘last resort’ chemical controls which conventional growers use are not needed on the organic farm.

Organic growers have access to many management tools and methods, some of these are common practice on any well-managed Australian farm, others may be traditional approaches (pre-chemical) or leading-edge adoption of new research and technology.

Good observation skills, willingness to experiment with novel approaches and attention to local conditions, including internal variations within a paddock, are common characteristics of successful organic growers.

A combination of several major control methods and good farm hygiene is usually required for successful organic pest control. Before referring to the specifics of control methods, it is useful to understand the context in which they are used. The ‘outlook’ or ‘worldview’ of the organic grower will significantly influence how individual control methods are selected and used. Bio-dynamic growers may refer to this as ‘the organisation’ of the farm.

The organic outlook

All potential inputs into crop production may influence pest development, severity of damage to the plant and recovery from pest attack. Water from irrigation or rainfall, fertilisers, pesticides and general cultural practices may all affect the pest regime in the crop by changing the ecological conditions in the field.

All these factors need to be taken into account in the design of the system and the special techniques or recipes used by organic growers may only be effective in a sympathetic environment.

Organic growing systems have as a prime goal, to grow healthy plants with good balanced nutrition and the ability to resist or outgrow pest damage and weeds. Nutrition is essential to ensure crop plants can compete with weeds and build strong cell walls and epidermis, which will resist insect mouthparts and disease attack.

Organic growing systems also:

- Avoid large areas of monoculture as much as possible.
- Use good quarantine and hygiene practices to avoid introducing pests.
- Preserve plant communities such as native vegetation which may harbour beneficial insects.
- Avoid pesticides which can accumulate in food webs and which kill natural enemies.
- Exploit knowledge of the biology and life-cycle of the pest or weed, to identify the time of year or phase of growth when ‘cultural’ practices or other techniques will be most effective.

‘Cultural’ practices are any routine operations, which are applied to the crop, such as cultivation, irrigation, mulching, pruning, or other ‘physical’ interventions.

Ecosystem diversity is particularly important as many pests can complete their full life-cycle requirements within the crop but beneficial insects will often require different environments for parts
of their development. Refuge areas for predators must be provided to enhance natural biological control.

An example is the generalist wasp predators, which may feed on nectar or pollen in their adult life, while development of eggs and larvae occur within an insect host. To encourage beneficial wasps, organic growers often:

- Retain flowering native vegetation, especially understorey plants.
- Plant windbreaks with species selected to extend the flowering season for as long as possible.
- Allow flowering ground covers to develop as a living mulch or ground cover.

If the wasps are to remain active for the longest period possible, windbreak or groundcover plants should be selected to extend the flowering season. Wasps generally prefer yellow and white flowers. They also have short feeding tubes, so flowers with exposed stamen and anthers are best.

Dragonflies are another example of an insect that is a useful predator in two stages of their life cycle, in completely different habitats. Dragonfly larvae live in water, where they are an effective predator of mosquito larvae. In the adult phase, they are a voracious generalist predator, and take a wide range of prey ‘on the wing’.

Organic growers benefit from a willingness to research or observe insect behaviour to this level of detail. They accept the necessity to allow room for these ‘natural’ controls to operate (such as refuge areas for predators) and ‘wild’ areas are viewed not just as a concession to nature, but as an integral part of the farm.

Other strategies permitted under organic systems include:

- Resistant plants.
- Biological controls including diseases, parasites and predators.
- Sex attractants (pheromones).
- Light traps, pit traps, attractant baits and sticky surfaces.
- Interplanting and the use of trap crops.
- Plant based repellents such as garlic and chilli.
- Hand picking or mechanical removal.
- Certain natural substances and/or botanical insecticides.

It is important not to regard organic growing as simply the replacement of synthetic pesticides with naturally occurring products. Design and management are the key to success. The use of any pesticide product is always a last resort and potentially a threat to the sustainability of the system.

**Certification requirements**

Certified organic farmers are required to maintain accurate records of pest and weed control activities, especially ‘inputs’ such as botanical pesticides. The certification organisation may review records to establish that even the allowable inputs have not been used too frequently or carelessly. They may also require evidence that a ‘holistic’ pest control program has been developed to reduce reliance on permitted chemical options.

Chemical controls should always be the last choice. Botanical pesticides do not last long in the environment and do not accumulate in the food chain, but they may kill beneficial organisms or harm the applicator.

Cultural, physical or biological controls are preferred because they force the grower to come to a greater understanding of the ecological processes at work on the farm, and to work with natural systems as much as possible.
3.2 The future is integrated pest management
by DeAnn Glenn, Natural Resources and Environment

Managing pests effectively using biological control options is often more complicated than conventional pesticide regimes. It takes more planning, requires a better understanding of agro-ecosystems and involves more innovative approaches to farm management. An Integrated Pest Management (IPM) approach can be extremely useful for effective implementation of biological control.

IPM has been developing over the past 20 years in response to environmental concerns and pesticide resistance issues. IPM has become more difficult to define over time, as it becomes different things to different people.

Perceptions of IPM range from a focus on integrated whole-farm organic practices to improving some aspect of a standard chemical program. IPM is generally defined as a dynamic, knowledge-based scientific approach to pest management, based on best available techniques and information adapted to different regions, conditions and management requirements.

IPM provides more options
Emphasis is given to implementing more strategic use of treatments including better timing, monitoring and effective application. It also encompasses the use of softer alternatives such as augmentative release of biological control agents. It becomes a series of management options depending on conditions rather than one easy answer. The emphasis is on correct identification and diagnosis, monitoring, incorporating available management options and on effective timing and targeting of necessary control measures.

This approach to pest management requires a long-term perspective with accumulation of knowledge and understanding of the agro-ecosystem gained over time. It is important to monitor and keep effective records which can be used to gain a historic perspective of the property, and help to implement, refine and adapt responses to different circumstances and seasons.

The IPM approach involves understanding the pest or disease, so it can be targeted at its most vulnerable point. This means that strategies are developed to consider the particular conditions growers’ face. Often the key to successful management is having the right information available at the right time and the confidence to act upon it. If we have the correct information available from monitoring, the control measures can be more effective and the risks of pest outbreaks from reduced spraying can be substantially diminished.

The following example illustrates issues faced when developing an IPM strategy incorporating bio-control of a particular pest into one cropping system.

Moth control in grapevines
This example illustrates the development of *Trichogramma* wasps for commercial use against lightbrown apple moth (LBAM) in grapevines. This strategy could be adapted for development of bio-control in other agricultural systems.

LBAM is an Australian native leafroller that has adapted to grapevines and other horticultural and ornamental crops, especially in wetter, cooler regions such as Coonawarra, South Australia and the Yarra Valley, Victoria. The larvae cause damage to grape berries by feeding in bunches, as well as providing entry sites for bunch rots. LBAM numbers can be extremely variable between seasons and vineyards and monitoring is important to prevent surprise outbreaks.
There are two generations of LBAM within the growing season in cooler regions, with an additional generation in warm regions in some years.

They overwinter as larvae, harbouring in broadleaf weeds such as capeweed and dock. LBAM moths tend not to be migratory and prediction of peak egg laying times is possible using day-degree models.

LBAM are relatively vulnerable to egg parasitism as they lay masses of 20-50 eggs which take from seven to 21 days (depending on temperature) to hatch, providing time for egg parasitoids to locate the eggs. There are three native species of \textit{Trichogramma} wasps which commonly prey on LBAM eggs on grapevines.

Field trials using the native egg parasitoid \textit{Trichogramma carverae} resulted in rates of parasitism of LBAM egg masses on sentinel cards from 40-50 per cent at 20,000 wasps per hectare, 75-80\% at 70,000 per hectare and 90-95\% at 100,000 per hectare when the weather was favourable. Cool temperatures, rain and sulphur were found to be disruptive to the \textit{Trichogramma} wasps and 0-10\% parasitism was recorded in some trials under these conditions. Paper 'capsules' containing parasitised eggs with pinholes for the wasps to escape as they hatched were effective in protecting release material from predation. Protective release containers raise the cost of inundative releases but increase reliability and facilitate handling.

Pheromone traps or port wine lure pots can be useful in indicating timing of LBAM flights, as eggs were generally found in vines about seven to 10 days after moth numbers increase in pheromone traps. Monitoring eggs in the vines is important for accurate timing of \textit{Trichogramma} releases as egg laying can be delayed due to variable weather conditions or the stage of vine development.

Pheromone trap catches of LBAM usually increase in the spring around bud-burst in grapevines. If vine leaves have not yet expanded before the spring moth flight, high trap catches may not reflect egg lays since LBAM females lay eggs on expanded leaves.

Cold, rainy weather can also delay or prevent oviposition even when trap catches have increased. Monitoring of eggs on vines can also be used to determine relative egg density, assess rates of parasitism and to determine timing of \textit{B. thuringiensis} sprays. The risk of control failure is reduced when eggs can be assessed for parasitism and follow-up sprays can be applied as necessary.

Commercial trials on growers’ properties have shown that egg monitoring can be a useful estimate of LBAM activity in vines. Many grape growers have reduced chemical inputs significantly by treating only when LBAM are present and at the right development stage.

**IPM gives 90\% control**

There have been a number of reports of successful control of LBAM with \textit{Trichogramma} releases in commercial vineyards, with rates of parasitism of 60 - 90\%. The success of \textit{Trichogramma} releases can be assessed by monitoring egg masses which are white if unparasitised and black if parasitised.

In cases where releases of \textit{Trichogramma} have not been effective, reasons suggested include: high temperatures during shipment, damaged wasps, numbers released were too low, timing of releases did not coincide with presence of LBAM eggs, weather was cold and wet and sulphur was sprayed prior to wasp release.

As illustrated by this example of a bio-control strategy, the major drawback to adoption of IPM is the need to simplify complex IPM concepts and to tailor the management options more closely to grower needs.
Growers are often faced with the task of developing a broader management perspective as well as the complicated task of interpreting research methods and outcomes from publications or seminars and incorporating them into their particular farm system.

Understanding the variation in local and regional conditions and adapting the system to fit the situation is critical to successful use of IPM. Ongoing interaction between the IPM developer and the user is crucial to the successful adoption of bio-control.

**IPM in Viticulture**

In response to grower requests for more information on pest and disease management, a series of regional workshops was developed to improve the development of IPM strategies in viticulture.

The exchange of information between growers and researchers helps incorporate research outcomes and new technology into practical and economically feasible management strategies for pests and diseases in each region. Many workshops have been run in major viticulture regions where researchers participated in teaching situations and hands-on demonstrations. This approach could be adapted to most other agricultural industries.

The collaborative approach to development of information gives growers and crop consultants a better chance of success with pest and disease management through strategies tailored to their regions.

The complexity of a dynamic IPM approach, based on a better understanding of the vineyard ecosystem has stimulated participants to think and discuss together new ways to manage pests and diseases in their vineyards.

Variability across regions and between seasons means that the IPM approach provides tools to develop customised pest management programs. Participants recognise that IPM is a long-term approach to better pest management, and that historic information, preparation and planning are important. Researchers also receive feed-back on their work, and gain insights into industry needs and priorities in research directions.

**The future of IPM**

IPM is a relatively new approach to pest management in vineyards and agricultural industries in general. As growers become more experienced and confident using IPM processes, improved economic returns can be expected in the short term and a better understanding of its potential for meeting the demands of a changing marketplace, the potential for resistance management and environmentally sustainable viticulture practices.

IPM itself is a dynamic process, between growers, researchers, chemical companies, and others in the industry. It continues to change in light of new observations, evidence and experiences. We have become more aware that IPM requires an extensive support system including targeted research, monitoring, diagnostic and information services as well as trained consultants.

The reduction in government provision of extension services has hampered the implementation of IPM in recent years but has resulted in more commercial services being developed.

It has become more apparent a best practice IPM program can be very complex. A clear and comprehensive understanding of all the pests and diseases and management options available is an immense task. This is most often coupled with a similar approach to other aspects of integrated crop management (ICM) which includes vine nutrition and soil and water management.
Although it is difficult to estimate the number of growers who have begun to adopt IPM practices, the most common comment about the effects of the IPM viticulture workshops is that it has changed the way they look at their vines.

Many growers have realised that the broad knowledge base of IPM makes it easier to get planning and management decisions 'right' and avoid unanticipated problems and costly ad hoc solutions. Several growers who would have normally applied sprays reported that they had begun regular monitoring of lightbrown apple moth, and after finding no sign of lightbrown apple moth, did not spray. This has resulted in many thousands of dollars in savings.

Closer involvement of growers and crop consultants in research, training and technology transfer gives IPM the greatest chance of adoption.

To further integrate pest management across the agro-ecosystem, we need to continue to explore the options for management of soil, weed, cropping, water and associated practices and to consider the effects of different practices on the overall fauna, nutritional state, and balance of local ecosystems.

3.3 Working with nature for weed control
by Paul Kristiansen, Horticultural Researcher, University of New England.

With experience and persistence, weed management for organic growers becomes easier and less expensive as grower confidence and skills increase. Weed management can be a difficult and expensive part of any farming operation.

For organic growers, controlling weeds can seem like an endless tail-chasing exercise.

In any agricultural production system, the management of weeds must be based on a long-term strategy that combines knowledge about the weeds, the crop, the farming system and local conditions. It can be a difficult and expensive part of any farming operation.

The understanding required to successfully manage weeds can be gained through reading, talking and listening but the main source of knowledge is experience. As each season passes, the farmer's skills improve and the weed problem decreases.

Each farm, perhaps even each paddock, is unique and ready-made solutions are not necessarily available. Nevertheless, common principles and practices can be developed from the experience of other growers, and these can be adopted to suit a particular property.

During the conversion phase, from conventional farming to organic production, growers can usually expect an increase in weed infestations and a change in the species of weeds occurring.

While it is not uncommon for new organic growers to succumb to weeds and give up within the first three years, this may often be due to the existing weed seed bank becoming activated through different management practices. Sensible planning and persistent effort can eventually reduce the seed bank to manageable levels.

In this review of organic weed management, the general principles of organic weed management will be introduced, followed by a discussion of the various weed control methods available to organic growers during preparation, cropping and between crops.

Understanding weeds
Weeds come from a wide variety of plant families, although they share some common features (Table 3.1). In agriculture, a plant becomes a weed when it is perceived to be interfering with the
production cycle, or causing crop yield reductions, contamination, stock poisoning, access difficulties or some other problem. But growers differ in their attitudes to which species are weedy and which are not.

Not all weeds are equally undesirable. Some weeds may not be highly invasive or may not cause problems in crop production. In the context of limited time and money, some weeds may not need to be controlled. Weeds also can be beneficial for the farm by providing erosion control, habitat for beneficial insects and wildlife, nutritional and medicinal value to stock.

Table 3.3.1: Reproductive and vegetative characteristics of plant species commonly considered to be weeds

<table>
<thead>
<tr>
<th>Reproductive strategies</th>
<th>Vegetative strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>- quick to reproduce</td>
<td>- vigorous growth</td>
</tr>
<tr>
<td>- simple pollination requirements</td>
<td>- smothering growth habits</td>
</tr>
<tr>
<td>- high seed production</td>
<td>- allelochemical suppression of neighbouring plants</td>
</tr>
<tr>
<td>- extended seeding periods</td>
<td>- toxicity to discourage browsing by insects and animals</td>
</tr>
<tr>
<td>- effective dispersal mechanisms</td>
<td>- brittle stems and roots</td>
</tr>
<tr>
<td>- seed dormancy</td>
<td></td>
</tr>
<tr>
<td>- long seed viability periods</td>
<td></td>
</tr>
<tr>
<td>- persistent vegetative parts</td>
<td></td>
</tr>
</tbody>
</table>

The features listed in Table 3.3.1 don’t necessarily cause weediness. Weed infestations are often encouraged by the landscape disturbance which is typical of agricultural activity. Annual cropping systems with repeated tillage, fertiliser application and irrigation generally promote annual weeds. Perennial farming systems, with less frequent disturbances, tend to include both annual and perennial weeds. Weeds often have the ability to move quickly into newly created niches and establish themselves. They may then require a similar on-going disturbance pattern to maintain their presence, otherwise a new group of weeds may take over.

This process of succession may be manipulated on a farm by varying weed management methods over time to disadvantage the weeds and favour the crop.

Long term and dynamic

No single weed management strategy will apply to all organic farms. The repeated use of any one method can have harmful effects on other aspects of the farm, such as excess tillage causing erosion. Also, different weed species respond to different control methods. For example, while many annual weeds are susceptible to control by tillage, weeds with tuberous roots, such as oxalis, resist removal and desiccation due to tillage. It is important to develop an integrated strategy based on the crops being grown, the weeds that are present and the local soil, terrain and climate.

Management based on short-term considerations, such as one season or one year, is flawed because it ignores changes in weed populations over longer time spans and possible negative environmental side effects. Therefore, weed management should be planned as a long term, dynamic process. Figure 3.3.1 illustrates the cyclic nature of weed management planning and lists many of the principles.
Assessment of the situation
Identification of weeds is a first step towards managing weeds. By accurately identifying weeds on a property, a farmer can then seek information about suitable control methods for that species. Although common names are often easier to remember and pronounce, scientific names are more reliable and don't vary between states and growing regions. Once a weed is identified, observations and knowledge about its establishment, growth and spread (does it flower quickly, how long do the seeds last) can be used in the weed management planning cycle.

The total weed population on a farm is determined by the number of actively growing plants and the number of seeds and regenerative plant parts (propagules) in the soil. On-going efforts should be made to reduce the number of weed propagules in the soil and prevent any further addition from plants that are producing new seeds. This is generally achieved by killing or removing the weeds when young and by slashing the flowering tops before they set seed.

Hygiene and quarantine
Maintaining a high standard of farm hygiene also helps to ensure off-farm inputs are free of weed propagules. Composting organic materials thoroughly may be necessary to kill seeds, likewise a germination test on any introduced composts can be used to ensure they are weed free before purchase. Farm machinery and other equipment should be cleaned regularly, especially after working in areas with large numbers of weed propagules present.

Organic weed control principles
1) Timeliness: Carry out all weed control activities when it is optimal to do so. For example before seed set, before the weeds get too large and while the ground is dry enough to work.
2) Persistence: Leaving just one weed or one patch uncontrolled could mean returning next year to repeat the same or an even bigger task. Spending the extra time to be fussy now will mean time saved in subsequent seasons.
3) Observation: Keeping an eye on where, when and which weeds occur on the farm. Making notes to help remember the details can highlight areas in need of greater attention in the current year and help planning for subsequent years.
4) Flexibility: Seasons, weed infestations and weed control methods vary in their level of success. Therefore, it is important to adopt the weed management strategy to suit the changing conditions.

Reducing the seed bank
Weeds have been the downfall of many aspiring organic growers and this may often be due to poor preparation. Reducing the weed seed bank, especially when previously uncultivated land such as pasture is going to be used, is an important part of preparing an area for cropping.

It is easier to control weeds when there is no crop to avoid because more management options are available and more intensive operations can be carried out. If a significant decrease in the weed seed bank can be achieved, then there will be fewer weeds when the cash crop is grown. An integrated strategy developed for a specific property is the most suitable approach to preparing land for organic farming.

Cultivation
In the preparation phase, long bare fallows with repeated tillage over 1-2 years are commonly used before planting a cash crop. The aim is to encourage weed germination by inverting the soil to bring buried weed seeds closer to the soil surface. These weed flushes are controlled with further tillage, gradually getting shallower and less aggressive.

Deep rippers are sometimes used initially to break up the sub-soil and control some perennial weeds. Chisel or disc ploughs are then used to further prepare the soil and remove weeds.

They are replaced by scarifiers, which are then replaced by lighter cultivators such as ticklers and brush weeders. Timing of the cultivations is critical. It is important to allow maximum weed germination but not allow the weeds to become large enough that they will survive the tillage operation by avoiding uprooting or re-rooting afterwards.

Rotary hoes may also be used to hasten the breakdown of plant residues and soil clumps. Several short term green manure rotations in association with well timed cultivations can dramatically decrease the weed load before establishing a cropping sequence.

It should be stressed that the heavy reliance on tillage beyond this initial preparation phase is not recommended as an on-going weed management option. Over-reliance on tillage can have significant detrimental effects on soil structure, biology and nutrient levels.

During the cropping phase, mechanical tillage is often the most common method of weed control for many organic growers. Numerous implements are available for in-crop weeding such as ticklers, spring tine harrows, brush weeders and many other variations.

These implements vary in their level of crop damage, distance from the crop row, travel speed, depth of tillage and level of weed control.

Cultivations should be undertaken when the weeds are at the most vulnerable stage for a given implement and when weather conditions permit. Cultivating early on a hot day will be more successful than late in the day followed by rainfall.

Speed of travel should also be considered. Travelling too slow may not dislodge weeds enough to kill them, while travelling too fast may dislodge crop plants and cause soil damage.

Carrying out tillage operations in the dark, either at night or using lightproof covers over the implement, has been reported to reduce the amount of subsequent weed germination. Results have
been inconsistent, although some control has been noted for weed species which require light for germination.

**Competition**
Green manure or cover crops are also a key part of both the preparation and cropping phases, especially in orchards, vineyards and on some vegetable farms. Low-growing, dense ground cover species are used including varieties of clover and peanut. In addition to suppressing weeds, cover crops provide nutrients and organic matter to the soil, provide habitat or food for beneficial organisms, and can improve soil structure.

Vigorous cover crops are aimed at out-competing the weeds and then smothering them. Considerable skill is required to grow both the cash crop and the smother crop together successfully. Some cover crops also produce allelochemicals which inhibit the germination and growth of certain weed species.

Dense sowing rates and careful management are essential to provide sufficient ground coverage, otherwise a poorly established cover crop may not suppress weeds at all. Care should be taken to turn in cover crops which have the potential to become weedy themselves, such as mustards. Several varieties are generally suitable as cover crops depending on local conditions, including the cereals rye and barley, and the legumes vetch and lupin.

**Thermal weeding**
Thermal weeding methods, including flame, infra-red and steam, have been receiving more attention from growers and equipment manufacturers over the past few years. These techniques have the ability to control newly emerged weeds in both the preparation and cropping phases without causing the level of soil disturbance common to tillage.

The equipment is normally used towards the end of preparation phase, once the seedbed has been prepared and further tillage is undesirable. Effective knockdown of certain weeds can be achieved in the lead up to sowing or planting, and even into the early stages of crop growth, without encouraging a new flush of weed emergence.

These methods can be practised further into the growing season by fitting shields to the implements to protect the plants in the crop rows as they get larger. To get worthwhile weed control with thermal methods, several issues must be considered, including timing, tractor speed, distance from heat source to target, application pressure or volume, types of weeds and climatic factors.

A variety of thermal weeding implements are available for broadacre application, but are still being tested to determine the best conditions for use, and the range of weeds which are susceptible. Thermal weed control may include burning of stubbles to remove weeds or seed, although this strategy will not be favoured because the organic matter content is destroyed.

**Solarisation**
Solarisation of seedbeds can be carried out during the hotter months of the year, before planting a crop. This technique involves the laying and sealing of clear plastic sheeting over prepared and moistened beds for a period of at least 6-8 weeks.

The energy from the sun heats the soil and kills weed seeds and emerged plants. Not all weed species are controlled, and success can vary depending on soil type, soil preparation, type of plastic and climate.
Most reports indicate that weeds are killed to a soil depth of only 5cm. Solarisation may be an appropriate method for small to medium scale properties seeking to reduce their level of tillage. This method may also assist with pest and disease reduction through soil sterilisation.

Cultural techniques
The management of weeds by cultural methods involves a range of strategic decisions. Careful and informed choices should be made about cultivar selection, timing of operations, fertiliser rate and application method, irrigation method and various other agronomic factors.

The ecosystem of a paddock can also be manipulated to amend the conditions in the field, so that pests and diseases are not favoured. For example, many weeds with taproots, such as dock (Rumex spp.) grow well in waterlogged or low pH soils. Improving drainage or raising pH removes some of their competitive advantage. Some other cultural techniques are:

1) Crop Choice
Strategic cultural methods that advantage the crop and disadvantage the weeds begin with the selection of appropriate crop species and varieties. Varieties which lack early growth vigour may be swamped by weeds. Narrow-leaved crops such as onions are poor competitors, so they would be unsuitable in weedy paddocks.

2) Sowing
The sowing or planting density of many crops, such as cereals and pulses, can be increased to achieve quicker canopy closure and enable more of the crop (and less of the weeds) to capture the available light, water and nutrient resources. Transplanted seedlings rather than direct seeding also gives the crop a head start. Vigorous, well-grown transplants will establish and develop quickly, while newly emerging weeds will be at a competitive disadvantage for resources.

3) Fertilisation
Fertiliser can be applied strategically to maximise nutrient uptake by crop plants and minimise uptake by weeds. This can be done by applying the fertiliser in bands along the planting rows or around individual plants, and by providing fertiliser at key times in the crop’s growth cycle. Excessive fertiliser application is more likely to assist weeds.

4) Irrigation
Strategic irrigation also may be used to advantage the crop against weeds. Careful timing and placement of water during the cropping phase will assist the crop, while excessive and widespread irrigation will assist the weeds. A light irrigation can be used to deliberately encourage weeds to germinate before controlling them through cultivation.

Hand weeding
For organic farmers, hand weeding and chipping are the most widely practiced weed management methods. When all else fails, the final choice in the cropping season is manual weeding. No other in-crop method can achieve such accurate and thorough results, however, the cost of manual weeding often make up the bulk of weed management expenses. Numerous hand tillage tools are available and preferences vary from person to person.

Chipping-type hoes are more suited to heavy work, while stirrup-type hoes are better for very young weeds. Wheel hoes make the task easier and more accurate, although they are not as versatile as hand-held tools.

Like mechanical cultivation, timing is crucial in hand weeding - too early and un-germinated weeds are not controlled, too late and the weeds may be too large to kill without considerable effort. Many weed infestations start small. Vigilance and willingness to use hand methods are well rewarded.
Suppression
Weed control can also be achieved using suppressive techniques, the most common being mulches. Mulches are usually limited to smaller, intensive horticultural operations where the cost of materials and labour can be justified. A variety of organic mulches are used such as hay, straw, compost, paper and cardboard. These materials vary in their cost, durability, ease of laying, ability to suppress weeds, effects on soil moisture and fertility.

Synthetic mulches such as weed matting (woven black plastic) and plastic film are also used occasionally in organic production. The latter is discouraged as it is non-renewable, poses disposal problems and has negative effects on soil health. Commercial carpet and underfelts are generally not acceptable due to treatment with insecticides.

Mechanical control
Weeds remaining towards the end of the cropping phase and between cropping phases should be slashed or mowed in order to prevent seeding. Depending on the cropping system, mowing may be carried out after harvest to avoid damaging the crop or before harvest if between-row access is possible.

Crop Rotations
Changing the land use of any given paddock helps to break established cycles of weed regeneration. Numerous options are available to organic producers depending on the cash crops that they normally grow and their local conditions, including green manure crops, fallowing, pasture or fodder crops and other cash crops. Well-planned rotations can help to manage weeds by a number of processes.

Using vigorous cover crop species in crop rotations can suppress weed growth directly through resource competition or allelochemical activity. Rotations also can be effective by disrupting weed lifecycles and preventing regular annual seed production.

Use of Livestock
Use of grazing animals is a very important strategy for weed control on organic farms, because of their low economic cost and high sustainability. Intensive grazing using sheep, cattle or goats during fallow periods can control a wide range of perennial weeds and prevent seeding of annual species. Mob stocking (extra grazing pressure for short periods) and running different types of stock can increase the range and number of weeds controlled.

While the health of animals needs to be considered, a tactic like spraying low-palatability, non-toxic weeds such as African daisy with molasses dissolved in warm water will improve control by cattle. Sheep will assist with control of ragwort, buttercup, scotch thistle, barley grass, gorse and salvation jane. The particular breed can make a big difference, for instance Dorsets are better than Merinos for controlling barley grass.

Other grazing animals such as geese, ducks and even native animals have been integrated into many organic farms (eg bandicoots for soursob). Growing fodder crops such as cereals, pulses and mustards followed by grazing is another option for suppressing and interfering with weed lifecycles.

Biological control
Biological control methods are a useful option for longer-term control of some specific weed species. Insects, fungi or other organisms which are harmful to a weed's growth or reproduction can provide ongoing weed management without incurring significant costs to the grower.

Most biological control agents have been developed for herbaceous broadleaf and perennial woody weeds rather than weedy grasses. In annual cropping systems, whether broadacre or intensive,
suitable host plants for bio-control agents are unavailable for much of the year and insect lifecycles tend to be disrupted by tillage and other cropping operations.

These constraints are less common in perennial-based pastures, orchards and vineyards. Maintaining refuge areas, such as fallow paddocks, in the farm rotation sequence can partially overcome these problems by providing a diversity of habitats.

**Tackling weeds on an organic vegetable farm**

Here is a description of how a typical organic vegetable farmer might attempt to control weeds on a property. This example has been used successfully in carrot production, but the basic principles apply to other vegetables and to broadacre production also.

1) Crop rotation using vigorous green manure crops to smother and out-compete weeds in the preceding fallow period.
2) Six-eight weeks before sowing, mechanically cultivate the soil to a moderate depth (150-250 mm). This will kill existing weeds and bring new weed seeds closer to the surface. Repeat once or twice.
3) Two to three weeks before sowing, shallow cultivate so that the soil is not turned, but new flushes of weeds are killed. Timing is important - get the weeds when they are young.
4) Final shallow preparation (no deeper than 20-30 mm) of the field before sowing the crop
5) Sow seeds in straight rows to enable close, accurate cultivation later.
6) One day before the crop emerges, flame any weeds that are present.
7) Fertilise only with compost or manures that are free of weeds seeds
8) 14 days after crop emergence, mechanically cultivate with fine tines or brushes as close as possible to the rows.
9) Two weeks later, carry out a second cultivation.
10) Place fertiliser as close as possible to the plants in the crop row.
11) Follow up the mechanical cultivation with hand weeding where necessary, using a chipping hoe or stirrup hoe.

This is not a recipe for all situations, but rather an example that can be adapted to the problems of any particular crop. Soil type, cropping history, existing weeds and climate will also need to be taken into account. A key goal is to reduce the number of weed seeds in the soil, which may take several years to achieve.

**3.4 Look at all options for pest management**

by Tim Marshall, Organic Consultant

Organic farming requires a much different approach to pest management than is used in conventional operations. More planning is required along with a longer-term focus. A choice of control methods should be made after consideration of:

- Pest or weed biology and life cycle (a basic understanding of this will aid selection and timing of pest control methods).
- The possibility that natural controls will be effective (weather, predators etc).
- The likely economic and ecological consequences of no control (damage threshold).

**No control**

Organic growers may well accept higher levels of pests than usual for the district or farming enterprise. The concept of a ‘control threshold’ is replaced with the concept of an ‘injury threshold’. If there is no significant injury, no control may be an acceptable response.
Hygiene and quarantine
Good farm hygiene is essential to avoid transfer of pests. Hygiene includes strategies such as ensuring that any equipment brought onto the property is clean and use of a quarantine paddock for all stock brought onto the farm.

Cultural techniques
Many cultural activities will directly influence pest incidence and damage. Good crop rotation, selection of healthy planting material, avoidance of monoculture and correct fertilisation are examples of positive cultural techniques. Cultural practices that contribute to pest problems include growing large areas of susceptible plants, destruction of plant communities which harbour insect predators or growing unhealthy plants with unbalanced nutrition.

1) Use of resistant varieties
Common examples of using resistant varieties are Phylloxera resistant grape vines or lucerne aphid resistant lucerne.

2) Hand control
Like hand weed control, hand removing pests is slow but very selective.

3) Physical barriers
Physical barriers include total exclusion of pests by netting (orchards) or floating row covers (row crops).

4) Traps
Yellow painted boards coated with non-drying glue attract many insects, such as whitefly, which become stuck fast. Other traps are simply made from old containers baited with a variety of fermenting substances. Some traps are commercially available, such as traps for removing blowflies.

Light traps are permitted, but may be non-selective, so they should be carefully located.

Solarisation
As for weed control, solarisation is also effective at killing insect pests and diseases by using clear plastic sheet (40 -100 um thick) to capture the heat of the sun. The soil must be moist and the edges of the sheet must be secured. Solarisation works most effectively in the warm season. A minimum four weeks of treatment may be required, depending on temperature.

Cultivation
Cultivation can also have an influence on pest development. For instance rough cultivation inhibits movement of pests such as snails, while timely cultivation can destroy pupating larvae or expose them to drying sun and wind or to bird predators.

Biological controls
Classical biological control refers to the control of an introduced foreign pest where its natural predators and parasites are missing. Biological controls have been developed for many insect pests and some weeds.

Augmentative and inundative biological control generally refers to the release of mass-reared predators or parasites. The aim is to artificially increase the population of biological control agents to address the lag time between the increase in pest numbers and the build-up of the natural predators and parasites. In Australia we have a number of companies who rear insects for release, including egg and larval parasites of caterpillar pests such as heliothis, diamondback moth and lightbrown apple moth.
We also have available a range of beneficial bacteria, fungi and viruses which can be sprayed onto a crop to control insects and fungal pathogens. The microbial insecticide Bacillus thuringiensis is a very effective caterpillar control, used on many organic farms.

Other examples are nuclear polyhedrosis virus (NPV) for lepidopterous pests, fungi such as Metarhizium anisopliae for crickets and locusts, and Trichoderma spp. which are used against pest fungi such as Botrytis cinerea and others. Nematodes are also commercially available for use against a number of insect pests, including weevils and cutworms.

Many other biological control programs are in progress. Organic growers can use any of these in their pest and weed control program, as long as they have not been genetically manipulated.

Environmental enhancement
The provision of shelter for natural competitors beneficial insects and birds etc is a very important strategy. Mulches have been used to control slugs and snails by providing habitats for predatory centipede and ground beetle populations.

Natural chemicals
Some use of natural pesticides is permitted in organic farming. No herbicides are permitted for use on certified organic farms, although transitional farmers may use pine or citrus oil-based herbicides.

Examples of pesticides that are permitted include:
**Botanical/biological insecticides**
- Granulose virus preparations.
- Homeopathic and bio-dynamic preparations.
- Pheromones (sex attractants).
- Propolis
- Pyrethrum - an extract from *Chrysanthemum cinerariaefolium*. Synthetic pyrethroids and the synergist piperonyl butoxide are not permitted in certified organic farming (sesame oil is sometimes used as a natural synergist).
- Quassia - an extract from *Quassia armara*
- Rotenone - an extract from *Derris elliptica*.
- Ryania – an extract from *Ryania speciosa*.
- Vegetable oils including canola oil and essential oils from plants such as tea tree, citrus, pine, peppermint or neem, or Azedaractin (an extract from neem).
- Seaweed, seaweed meal, seaweed extracts, sea salts and salty water.
- Natural plant extracts from many sources, including garlic, onion, chilli, wormwood, tomato leaves, rhubarb etc. Tobacco extract may not be permitted.

**Natural products**
- Bordeaux or Burgundy mixtures – copper based products.
- Carbon dioxide and nitrogen gas.
- Light mineral oils (white oil).
- Naturally sourced, untreated ‘diatomaceous earth’ (the fossilised remains of a single celled organism).
- Potassium permanganate
- Pure natural soap or potassium based insecticidal soap.
- Sodium silicate.
- Sodium bicarbonate.
- Stone meal.
• Sulphur – dry or wettable formulations.
• Vinegar.
• Wetting agents – usually only plant and some seaweed products, as some commercial formulations may contain unacceptable products.
• Pyrethrum - an extract from *Chrysanthemum cinerariaefolium*. Synthetic pyrethroids and the synergist piperonyl butoxide are not permitted in certified organic farming (sesame oil is sometimes used as a natural synergist).
• Rotenone - an extract from *Derris elliptica*.
• Quassia - an extract from *Quassia armara*.
• Naturally sourced, untreated ‘diatomaceous earth’ (the fossilised remains of a single celled organism).
• Bordeaux or Burgundy mixtures – copper based products.
• Sulphur – dry or wettable formulations.
• Sodium silicate.
• Pure natural soap or potassium based insecticidal soap.
• Vegetable oils including canola oil and essential oils from plants such as tea tree, citrus, pine, peppermint or neem, or Azedaractin (an extract from neem).
• Seaweed, seaweed meal, seaweed extracts, sea salts and salty water.
• Natural plant extracts from many sources, including garlic, onion, chilli, wormwood, tomato leaves, rhubarb etc. Tobacco extract is not permitted.
• Vinegar.
• Carbon dioxide and nitrogen gas.
• Wetting agents – usually only plant and some seaweed products, as some commercial formulations may contain unacceptable products.
• Pheromones (sex attractants).
• Homeopathic and bio-dynamic preparations.


These chemicals should only be used as a last resort. They are an important strategy, but may have some negative effects. They may need to be used more frequently and at closer intervals than synthetic chemicals because many of them are not effective against insect eggs, and they are usually quickly degraded by sunlight.
### Examples of Organic Pest Control

<table>
<thead>
<tr>
<th>Pest</th>
<th>Cultural controls</th>
<th>Biological controls</th>
<th>Organic chemicals</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ants</td>
<td>Pour boiling water on the nest. Pyrethrum or derris may be added to the water, but a strong detergent is generally effective. Bait: mix equal parts of borax and icing sugar or jam (derris could be used instead of borax). Barriers: sticky bands (non-drying glue, tar or vaseline) physical barriers such as steel wool.</td>
<td>Echidna Some birds &amp; lizards Some spiders Some beetles and bugs may eat ant larvae Ant lions (lacewing larvae).</td>
<td>Pyrethrum Derris Diatomaceous earth (sprayed around or tipped into the nest).</td>
<td>Ants are extremely successful surface scavengers in Australian ecosystems and many species are very useful in the garden. First decide if they need to be excluded, or if they must be killed. Choose the method which will be effective with the least impact on other species and on soil.</td>
</tr>
<tr>
<td>Caterpillars</td>
<td>Hand picking. Intercropping and avoidance of monoculture. Barriers such as floating row covers or exclusion netting of fruit trees. Collar traps or paper traps for climbing caterpillars.</td>
<td>Encourage natural beneficial insect controls by providing habitat and withholding pesticide pressure. Trichogramma wasps. Bacillus thuringiensis. Some birds are very useful. Entomophthora fungi.</td>
<td>Garlic and chilli sprays. Pyrethrum or derris and rotenone. Pheromone sprays for codling moth or other lures sex attractant.</td>
<td>Cultivation can affect the population of many soil dwelling caterpillars, such as cutworm, or their pupae.</td>
</tr>
<tr>
<td>Snails</td>
<td>General hygiene to remove sheltering sites. Fine tilth soil is a highway for snails – leave soil rough. Handpicking. Traps: One of the simplest traps is a board placed over two bricks. Other good traps are clay pots, cabbage leaves and empty grapefruit halves. Beer traps are made from shallow containers sunk into the ground and filled with beer or other fermenting substances. Mix in a little cornflower for extra stickiness.</td>
<td>Toads, bullfrogs, lizards, some birds, turtles, small native marsupials and some other creatures eat snails. Some flies lay eggs on snails and the young become parasites. Poultry can be effective. Many small ground dwelling arthropods will attack small snails or slugs, before the shell hardens or the slime layer gets too thick. Rove beetles or ground beetles and centipedes eat snail eggs. Some native predatory snails</td>
<td>Copper sulphate and iron chelate sprays (commercially available). Diatomaceous earth. Quassia. Rotenone. Lime or alum sprays. Strong wormwood or garlic spray. Repellents: snails dislike wormwood, prostrate rosemary, acacia bark, and oak leaves. Stinging nettle as a companion plant.</td>
<td>The effectiveness of barriers is reduced when wet so locate them away from watering points. Feed poultry on greens before releasing them into the garden, they will then be seeking a protein diet. You may need to control their access to seedlings.</td>
</tr>
<tr>
<td>Pest</td>
<td>Cultural controls</td>
<td>Biological controls</td>
<td>Organic chemicals</td>
<td>Comments</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
<td>---------------------</td>
<td>------------------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td>Barriers: Hydrated lime, wood ash, sharp sand or any dry, dusty or sharp material. A band 20cm wide and one centimetre high is required. Snail fences made from galvanised metal, window screen wire and 30 mesh copper screen. and slugs, such as <em>Strangesta tumidula</em> are also effective. Although most of these will also consume growing plants, they do not reach the same populations as the pest snails, so they can be encouraged. Leopard slugs are another well known omnivorous slug.</td>
<td>The parasitic wasp <em>Encarsia formosa</em> (commercially available). Some small spiders, ladybird and mantid larvae, lacewings, hoverflies and damsel bugs.</td>
<td>Soapy water (use any plain soap) or insecticidal soap (eg potassium soap). White spraying oil. Eucalyptus or tea tree oil. Garlic, wormwood and nasturtium sprays.</td>
<td>Soap must be mixed with good quality water. High levels of salts will negate the effect of the soap. Traps are best used early in the season before pest numbers build up.</td>
</tr>
<tr>
<td>Whitefly</td>
<td>Yellow coloured sticky boards Adequate ventilation and air movement</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. Organic Production Systems

4.1 The living soil provides a vital resource

by Chris Alenson, ORGAA

A healthy fertile soil is a complex mixture of mineral, organic matter, biological organisms, air and water. All terrestrial life depends on this thin veneer of soil roughly 50mm thick over the surface of our planet.

The soil provides plants, animals and man with food and in turn by recycling manure and wastes the soil’s fertility is renewed. Continued growth of vegetation requires not only mineral elements for correct nutrition but biological activity to enhance this fertility.

The biological cycles of life, death and decay operate to restore the soils health. The intervention by humans through agricultural practices has broken this cycle resulting in soil degradation and fertility decline across the world.

Soil texture

The mineral skeleton of the soil is formed from rock that has been broken down by either chemical, physical or biological weathering. Some soils (loess) are wind blown deposits carried from great distances and other soils such as glacial soils were deposited after being carried by glaciers and ice sheets.

Notwithstanding the methods of deposition these fragments may be stone, gravel, sand, silt or clay. Sand and silt particles are roughly spherical while clays are platey. Clay particles are generally less than two micron in size and are termed colloids.

The composition of an average silty loam by volume might be 46 per cent mineral matter, 25% water, 25% air and 4% organic matter and biota. But in 75% of our surface soils there is less than 1% organic carbon.

The value of a soil as a medium for plant growth depends not only on its nutritional characteristics but also on its physical structure. There are two aspects to the physical structure of the soil. The first is soil texture, which is the particle size of the mineral matter, and the second is the structure, which is the arrangement of the mineral and organic components of the soil.

Soil aggregation

Intermediate products formed in the decay of organic residues can link clay particles together into water-stable, clay-humus complexes called aggregates. These products of decay are subject to further break-down but they are very important elements in the preservation of structure. Their presence depends on inputs of fresh organic residues, microbial activity sufficient to initiate decay and adequate soil mixing to bring organic agents into close contact with the mineral particles.

A soil with an ideal structure (often said to have good crumb structure) contains large pore spaces to aid drainage and facilitate the movement of oxygen and carbon dioxide and the entry of plant roots. It must also have micro pores capable of retaining an adequate reserve of soil moisture for plant growth.

The ideal structure will therefore consist of fine particles aggregated into water-stable crumbs. It is in the formation of these particles that organic matter plays such an important role. Grass and hay crops provide the basis for nurturing soil structure. The action of grass roots on the formation of soil aggregates should not be underestimated.
Good soil structure provides soil anchorage for plants, moisture, air and nutrients. It also provides a deep rooting medium for plants and an environment suitable for the activity of micro-organisms and earthworms.

The soil structure we are trying to achieve is found in the upper levels of the soil where there is the highest level of biological activity. By increasing the depth of this layer soil fertility can be increased.

**Good crumb structure**
There are a number of factors essential for the promotion of good crumb structure. These are:
1) Clay - minimum of 10% and ideally as high as 30%.
2) Adequate return of fresh organic residues.
3) A pH of 6.5-7.0 should be maintained.
4) An active microbial population promoting rapid decay of organic residues giving a continual supply of organic structure stabilising agents.

One of the principle agents responsible for the soil granulation is the action of grass roots, especially those associated with long term pastures. The earthworm must also be regarded as essential to the formation of good soil structure through the various gums it produces during the ingestion of soil.

![Figure 4.1.1: Soil structure](https://example.com/figure411.png)

**Organic matter and humus**
Organic matter in a soil is its life blood. Its content in a soil can vary from 1% (Australian average content) to 5% by volume. It may be the smallest percent of material present but it is of the utmost importance.

In the USA Yearbook, Soils and Men (1938) the following telling extract illustrates the importance given to organic matter:

“There is no true soil without organic matter. The high productivity of most virgin soils has always been associated with their high content of organic matter, and the decrease in the supply with cultivation has generally been paralleled by a corresponding decrease in productivity. We can now
feed plants on diets that produce excellent growth, without the use of any soil whatever. Yet the
decaying remains of preceding plant generations, redissolved by bacterial wrecking crews into
simpler, varied nutrients for rebuilding into new generations, must still be the most effective basis
for extensive crop production by farmers. Soil organic matter is one of our most important national
resources; its unwise exploitation has been devastating and it must be given its proper place in any
conservation policy as one of the major factors affecting the levels of crop production in the future.”

Decomposing organic matter provides a well-balanced, slow release source of nutrients. It is
composed of plant foods, carbohydrates (sugars, starch and cellulose), proteins and lignins, gums,
resins and other organic compounds. Physically it provides a balance between free draining pores
for aeration and small water retentive pores.

Humus, like clay, is a soil colloid and is involved in nutrient supply via exchange mechanisms. It
has the ability to absorb trace elements such as copper and cadmium which might otherwise be toxic.
It has a moderating influence on nutrient supply where elements might be either too low or too high.

Humus is not merely organic matter, or the decaying remains of micro-organisms but the end result
of a living process where decaying organic matter is transformed by the action of soil organisms into
a jelly like substance with colloidal properties. The restoration of humus to the soil can improve the
nutritional value of our crops.

Good soil husbandry will ensure organic wastes are returned to the soil, adjust pH as required, while
protecting the surface soil against nature’s elements of wind and rain. Through judicious cultivation
it will maintain adequate oxygen supply to plant roots.

**Biological life in the soil**

By returning wastes to the soil we are stimulating microbial activity and ensuring the population of
soil organisms is maintained or increased. The vast majority of soil organisms, bacteria, fungi,
actinomycetes, protozoa, algae, mycorrhiza are creators of fertility and are invaluable aids to the
farmer. Nodule-forming bacteria in association with legumes can fix up to 60kg of nitrogen per
hectare per year.

Mycorrhiza are fungi-like threads that invade plant roots in a symbiotic relationship exchanging
carbohydrates from the plant in return for supplying phosphate and trace elements to the plant.
Mycorrhizal infection can more than double the root capacity of plants enabling them to source
nutrients from a wider area, increasing their productive capacity while also protecting them against
some soil-borne pathogens.

Conditions which are favourable for the maintenance of an active biological soil population are air,
water, food and warmth. Careful management of this soil through cultivation, the return of organic
residues and perhaps the occasional input of natural mineral nutrients will assist in maintaining and
enhancing the fertility of the soil.

Larger soil organisms like earthworms, springtails, termites and ants provide valuable services of
mixing soil with organic matter and aerating the soil.

Earthworms of course with their extensive tunnelling create passages for plant roots and moisture
penetration into the soil. Their ingestion of soil and its subsequent expulsion as worm castes
provides an enrichment process further mobilising soil elements. In one year the humble earthworm
can produce almost 4kg of castings. As Charles Darwin said “without the earthworm - no tillable
soil”. Referred to as the farmer’s friend this invertebrate animal is a perpetual soil builder, acting as
a chemist, cultivator, recycler and distributor of plant food.
4.2 Nutrient inputs in organic systems
by Chris Alenson, ORGAA

Sound rotations, correct stocking rates and recycling of nutrients are all part of the balanced approach to organic farming.

The management program should not only ensure correct nutrition for the crops but should also aim to encourage and increase the biological life of the soil.

Organic farming is not about replacing one less desirable input with a more acceptable one. An approach along these lines would demonstrate the lack of understanding of what an organic system involves.

It can be seen that in most situations the input of nutrients is essential to ensure productivity of the soil. The encouragement of the biological cycles operating within the soil is a key management strategy and as such the selection of fertiliser inputs and the use of organic matter will determine the success of increasing this living soil.

Based on a full soil assessment, a soil fertility building program can be designed to ensure full productivity while increasing the value of the soil for the future.

Do the research first
Before selecting a particular fertiliser or manuring program, an examination of all available information on the soil and the crops should be made.

Reference may be made to soil or plant analysis or other information on the soils of that locality. A physical examination of the soil and its fertility indicators may also be undertaken.

If the crop or stock suffer from pest or disease problems it is possible that the nutrient supply to the crop or forage may be responsible.

All the above information will help to indicate what is required in the way of nutrients, and what may be required in the way of a change in management strategy such as cultivation.

Nutrient input
In a very fertile soil with a high level of biological activity there may be little need for broad spectrum fertilisers. The mobilisation of nutrients from the sub-soil may be sufficient to supply the growing crops needs.

Certainly research on long-term biodynamic farms in Germany indicates that productivity has increased in what is almost a closed system of agriculture without outside inputs.

But a farmer must always be aware that the soil could be mined of scarce nutrient elements unless the law of return is adhered to.

Bearing in mind the age of most of Australia’s soils and their inherently fragile nature, the addition of some fertilisers may be necessary to give optimum productivity. A truly fertile soil is made up of two essential components:

1) Inorganic elements such as nitrogen, phosphorus, potassium, sulphur, calcium, copper, etc.
2) Organic matter decomposing to humus with all the diversity of biological life that accompanies it.

If the farmer can manage these two key areas of nutrient supply, and ensure maximum aeration and moisture supply, the crops should be healthy and productive.
1) The inorganic elements

Based on correct soil assessment there may be a demonstrated need for a broad spectrum mineral type fertiliser, or one based more on an animal or poultry manure source. Organic farmers are fortunate that there are available a number of commercial suppliers capable of providing mixes based on the needs of that particular soil. The addition of gypsum (CaSO4) may help to break up heavy clay soil and supply needed calcium and sulphur.

It is recognised that until a soil reaches a reasonable level of fertility there may be some nutrients that are unavailable to the plant due to either pH being too low or too high, or unbalanced soil nutrients causing antagonisms to other nutrients. The use of chelated foliar sprays in the short term may be required until the soil fertility is restored.

2) Organic matter

The supply of organic matter to the soil is an essential part of the management for the organic farmer. The organic matter used will also have a bearing on the type of humus that is eventually formed.

The organic matter could be provided through the use of composts, green manure or cover crops, well composted animal or poultry manure or composted industry waste that has been demonstrated to be free from undesirable contaminants. It should be noted that any material sourced from off the farm should be checked by one of the major certifying organisations to see whether its use is allowed.

Although the nutrient analysis of such products is useful in establishing a feeding program for a crop, their main role is in supplying organic matter to the soil for improving its structural characteristics and stimulating biological activity.

Green manuring

Green manuring enriches soil by the addition of undecomposed plant material either in place or brought in from a distance.

It is estimated that the contribution of organic matter for the soil following a green manure crop is comparable to the addition of 20-30 tonnes per hectare of manure.

Due to its nature it undergoes rapid degradation and stimulates biological activity, it therefore contributes more to the nutrition and less to the stable fraction of humus in the soil. Some stable humus is however provided. To provide more structural material the crop would have to be grown until it is more mature and hence more carbonaceous.

The following benefits can be attributed to green manuring:

1) Improvement of soil structure.
2) Increase soil biological activity.
3) Reduced nutrient leaching.
4) Weed suppression.
5) Reduction of disease and pest problems.
6) Usefulness for animal fodder.

Table 4.2.1: The benefit that a green manure crop can play in nutrient supply.
<table>
<thead>
<tr>
<th>Crop</th>
<th>5.26</th>
<th>0.47</th>
<th>0.41</th>
<th>0.08</th>
<th>0.48</th>
<th>0.24</th>
<th>0.02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rape</td>
<td>2.83</td>
<td>0.31</td>
<td>0.29</td>
<td>0.04</td>
<td>0.32</td>
<td>0.17</td>
<td>0.02</td>
</tr>
<tr>
<td>Mustard</td>
<td>3.24</td>
<td>0.34</td>
<td>0.43</td>
<td>0.05</td>
<td>0.41</td>
<td>0.20</td>
<td>0.03</td>
</tr>
<tr>
<td>Radish</td>
<td>4.05</td>
<td>0.45</td>
<td>0.46</td>
<td>0.08</td>
<td>0.36</td>
<td>0.20</td>
<td>0.03</td>
</tr>
<tr>
<td>White Lupin</td>
<td>3.24</td>
<td>0.38</td>
<td>0.46</td>
<td>0.06</td>
<td>0.33</td>
<td>0.17</td>
<td>0.02</td>
</tr>
<tr>
<td>Etch</td>
<td>5.26</td>
<td>0.54</td>
<td>0.48</td>
<td>0.08</td>
<td>0.48</td>
<td>0.20</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Adapted from Hasler & Hofer, 1975 in Green Manures, Elm Farm Research Centre, Practical Hanbook Series, 1982

**Foliar sprays**

The foliar applications of fish emulsion, seaweed sprays and other biological preparations are useful adjuncts to the main soil fertility building operations supplying valuable nutrient elements and other organic compounds which may assist in building stronger plants more capable of resisting pest and disease problems. Bio-dynamic preparations such as BD500 will assist in stimulating biological activity and improving soil structure.

**4.3 Soil analysis can prove a useful tool**

by Chris Alenson, ORGAA

Soil analysis is frequently carried out by farmers but questions should be asked as to how useful is the analysis for those pursuing organic management.

Soil analysis is still the most commonly used technique for assessing a soil and deciding what it might need in the way of fertiliser additions.

It is absolutely essential that a farmer understand that a soil analysis is only one of the many pieces from the jigsaw of information that should be obtained before undertaking management intervention.

Soil physical properties should be interpreted, the biological properties of a soil studied, weed species, animal and plant health investigated. All will provide information on which to base a management decision.

These observations together with the benefit of a soil analysis can provide valuable information on which management strategies can be implemented to improve the long term sustainability of the farm itself and its associated ecosystems.

Providing all the complexities of soil analysis are understood, and the interpretation of the analysis done with care, it can be a useful technique for developing a greater understanding of what is going on in the soil.

**Concerns**

There are four areas of concern that an organic farmer or any farmer should be aware of:

1) The difficulty of taking a representative sample.
2) The variation of results that can occur.
3) The value of a chemical analysis, especially for the organic farmer, and its ability to give an indication of biological activity in the soil.
4) The interpretation of the analysis, in particular how it relates to organic management of the property.

1) **Difficulty in taking a sample.**
A hectare of soil to a depth of 250mm weighs about 2500 tonnes. About 150 grams is sent to the laboratory of which about 5g is used for the analysis. This small sample is meant to be representative of the soil from possibly a 100 acre paddock.

It is therefore important that the soil submitted for analysis is representative of the paddock sampled. As many samples as possible should be collected and carefully mixed to avoid any particular area of the paddock influencing the results.

Soils from different fields, from different soil types and from different fertiliser treatments should be sampled separately. Avoid areas where animals have camped and where manure concentrations will affect results.

In the same way avoid areas where fertiliser may have been dumped on the ground. Avoid water troughs, dip tanks and stock yards where chemical residues may be found.

Paddocks can either be sampled in a random manner or a transect can be taken across the paddock. The minimum number of samples that should be taken would be 20-30 samples for a 10ha paddock.

It is important to take equal quantities of material from the top of the profile down to normal root depth of the crop grown.

2) Results can vary

It is generally accepted that there can be up to a 10 per cent variation in results from different laboratories analysing the same sample. This could be due to different methods used, different equipment used, the calibration of equipment and even the analyst who did the job.

Analysis of soils based on available nutrients will vary depending on the time of the year that the sample is taken. Depending on the level of biological activity, nitrogen, phosphorus, potassium and other nutrient elements will change.

An increase in soil temperature with sufficient moisture means greater biological activity which will lead to an increase in the availability of some nutrient elements. This is particularly true of nitrogen, phosphorus and potassium.

An analysis of soil sampled during the colder months will more than likely show low available nitrogen and phosphorus. Soil should therefore be sampled in colder areas during the spring when biological activity is increasing, particularly if the analysis is for nitrate nitrogen. Total nitrogen would be a better option.

There has always been controversy over whether analyses should show available or total levels of nutrients. By only analysing total nutrient levels, the soil fertility bank can be seen but the availability of these elements cannot be gleaned. This may result in deficiencies when crops are growing.

On the other hand an analysis indicating available nutrient levels runs the possibility of fertiliser recommendations being based on these levels despite the fact that good levels are actually held in the soil bank awaiting release. The farmer therefore may waste a great deal of money applying a fertiliser to a soil that contains a large store of that element which due to current management practices and soil constitution is unavailable at present.

If there is an increase in soil temperature with sufficient moisture, there will be greater biological activity which will lead to an increase in the availability of some nutrient elements. This is
particularly true of nitrogen, phosphorus and potassium. An analysis of soil sampled during the colder months will more than likely show low available nitrogen and phosphorus.

Soil should therefore be sampled in colder areas during the spring when biological activity is increasing, particularly if the analysis is for nitrate nitrogen. Total nitrogen would be a better option.

For some elements like phosphorus, it may be appropriate to request an analysis that provides both sets of data. This however will increase the cost. Phosphorus is a good example of the dilemma in Australia, where regular applications of super have built up high levels of soil phosphorus. An analysis showing low available phosphorus in acid soils is common in Eastern Australia while total phosphorus may be high. If this information is not available to the farmer, then based on the available analysis more super may be applied and the total phosphorus bank increases and money is wasted.

What is more disturbing is that if a liming agent has not been added to the acid soil, the addition of the phosphorus fertiliser will result in up to 75% of the phosphorus being fixed in the soil as aluminium or iron phosphates.

If both available and total phosphorus is supplied in the analysis then the farmer can see how a change in management practices may allow biological activity to increase the supply of available phosphorus from that held in the soil.

This may mean the addition of green manure crops or compost, which in decomposition may release organic acids and other organic compounds that will chelate (take up) the phosphorus from the soil and make it available to the crops. It will also stimulate biological activity that will result in similar acids being released, which will fulfil the same function.

The application of BD 500 and other biological preparations may build humus and also stimulate biological activity and increase the uptake of phosphorus from the soil.

3) Interpretation is the key
The greatest problem for the organic farmer in interpreting the soil analysis is that it is difficult to get an idea of biological activity from a chemical analysis.

An organic farmer should closely examine the level of organic matter and interpret this along with the nitrogen level as an indication of cycling of the organic matter and see how it might be benefiting biological activity.

Calcium and phosphorus levels are also important as soil life needs these elements to build protoplasm.

An acid soil below pH 5.5 does not suit many species of earthworms or micro flora and fauna. Rhizobia bacteria, the nitrogen fixing bacteria associated with the nodules on legumes do not operate well in very acid soils. As the soil becomes more acid the availability of some elements also decreases.

It should be remembered that most soil analyses give supplies of available nutrients in order for the farmer to know what might be available for the coming growing season.

An organic farmer whose aim is to nurture and encourage biological activity also wants to know the best way to mobilise nutrients from the sub soil clay, rock particles and biota which forms the soil bank of reserve nutrients in the soil. If the available phosphorus is high or adequate it means mobilisation of this element is occurring and the fungi and bacteria which make this process possible must be functioning reasonably well.
By careful interpretation of the analysis some information on the biological activity can be gained.

4) Using results for organic management.

It was explained earlier in the article how soil analysis is only one piece of the information jigsaw that the farmer must examine. As long as this is understood then worthwhile information can be obtained which will enable farm improvement strategies to be implemented.

If analysis indicates low levels of elements, fertiliser applications should not be applied without first examining all available data.

Low nitrogen may indicate low biological activity during colder periods. It may mean that organic matter which can hold up to 90% soil nitrogen is not cycling correctly.

The farmer should regularly dig large soil pits for examination. If it is compact and doesn’t allow adequate oxygen penetration, then low biological activity is to be expected in this soil.

Corrective soil management

By opening up the soil with a chisel plough or soil aerator (non-inverting cultivation equipment) this allows oxygen and moisture to revitalise biological activity, thus cycling organic matter more efficiently and increasing nitrogen reserves.

Again it may be that an acid soil with pH of 4.5 is responsible for the low biological activity and consequently low nitrogen levels. The application of the correct liming agent will assist in making conditions more favourable for biological activity.

This example of the nutrient element nitrogen demonstrates how careful the farmer must be to ensure that the correct management strategy is followed.

Choosing the right liming agent is again another complex area of the analysis which needs to be understood. An understanding of the cation exchange part of the analysis is required to ensure that the correct balance between calcium, magnesium and potassium is maintained. This is a complex area and requires very careful consideration and experience to arrive at the correct levels.

4.4 Organic farm fertility: it’s natural

by Phil Newton, Agriculture Victoria – Rutherglen, Department of Natural Resources and Environment

One of the first twentieth century advocates of organic agriculture - following the use of chemical fertilisers - was Sir Albert Howard, who said ”the maintenance of soil fertility is the fundamental basis of health”.

Enhancing the processes of natural fertility

The underlying fertility of a given soil depends on the origin of the parent material and the processes that built the soil profile in the first place.

The fertility of a soil refers to its ability to supply nutrients. A fertile soil will have a range of physical, chemical and biological attributes that will enable adapted plants to grow without serious limitation or deficiency in a given environment. For instance, the amount of organic matter will
depend on rainfall and temperature (drier, hotter climates lower the capacity of soils to retain organic matter). The soil should be friable, without compaction by traffic, to allow roots to grow with minimal restriction. Nutrients should match the needs of plants being grown, without toxicity or deficiency caused by pH imbalance.

Some steps that can enhance fertility, especially in degraded soils are:

- Store and maintain the pH balance, ideally in the range 5.5 - 6.5 in calcium chloride.
- Ensure that organic inputs have a Carbon to Nitrogen (C:N) balance of 12:1 for rapid mixing in the soil.
- Match inputs to the export of nutrients in produce.
- Use soil management practices that minimise off-site transfer of nutrients via surface, deep drainage and lateral flow of water and soil erosion. Rainfall and irrigation should be carefully considered, and nutrients matched accordingly.

**Limitations to these processes**
The major limitations to the processes of natural fertility occur when components in the system are not in equilibrium.

There are 16 essential macro and micro-nutrients for plants in the soil. The macro elements (other than carbon, hydrogen and oxygen) at concentrations greater than 1g/kg are nitrogen (N), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), magnesium (Mg) and chloride (Cl). The micro-elements include zinc (Zn), iron (Fe), molybdenum (Mo), copper (Cu), manganese (Mn) and Boron (B), which are usually less than 100 mg/kg.

The essential micronutrients for animals include chromium (Cr), selenium (Se), iodine (I) and cobalt (Co). Too much of either the essential nutrients or non-essential elements would be toxic to plants or animals.

If any of these essential elements are not present at all or not in sufficient quantity, they must be supplied, whether in an organic or conventional system. In organic agriculture the organic matter layers and resident biota in the soil take on a much greater role in the maintenance of soil fertility than in conventional systems.

**What is allowed**
On organic farms, no artificial chemicals are used to prepare the soil, grow the crop, or to store and market the produce. An artificial chemical is one that has been processed chemically or manufactured. Rock phosphate is acceptable on an organic farm, but superphosphate is not. The difference is that superphosphate is rock phosphate with a manufactured chemical (sulphuric acid) added to make more of the phosphate soluble.

The national standard for organic and bio-dynamic produce explains that naturally obtained materials are not necessarily non-toxic. Where inputs are required they should be used with care and with the knowledge that even permitted inputs can be subject to misuse and may alter the ecosystem of the soil or farm. Use of any product has the potential to introduce unwanted residues and contaminants. Use of any organically certified products should be based on an assessment of need and with knowledge of chemical analyses of the material. Use of any materials must be recorded in the farm diary or logbook.


- Slurry from certified sources.
- Aerobic and anaerobic compost.
- Straw.
• Mined carbon based products such as peat, or coal.
• Blood and bone, fish meal, hoof and horn meal, or other waste products from fish or animal processing.
• Seaweed or seaweed meal.
• Plant and animal derived by-products of the food and textile industries.
• Sawdust, bark and wood waste, from untreated sources.
• Basic slag, tested for heavy metals.
• Dolomite and lime from natural sources.
• Gypsum (calcium sulphate) from natural sources.
• Calcined or rock phosphate and other crushed mineral bearing rocks, excluding those minerals which are more than 20 per cent soluble.
• Phosphoric guano.
• Rock potash and sulphate potash.
• Wood ash from untreated sources.
• Sulphur.
• Clay, bentonite.
• Attapulgite.
• Perlite.
• Trace elements include materials such as borax, not synthetically modified.
• Homeopathic preparations.
• Approved microbiological and biological preparations.
• Naturally occurring biological organisms (eg worms and worm castings), excluding products derived from genetic modification technology.
• Fish products.
• Zeolites.
• Vermiculite.
• Potassium glauconite.

Sources of fertilisers for organic uses include: certified manufactured fertilisers such as bio-dynamic preparations 500 – 507, animal manures, reactive phosphate rock (RPR), worm casts and guano.

Many of these inputs have the advantage of long term slow release to the soil, unlike the rapid release of the more soluble synthetic fertilisers. Producers also need to be aware that these inputs may not meet plant needs during rapid periods of growth in some crops such as canola.

**Legumes and green manuring**

Nitrogen is the nutrient extracted in the largest amounts by plants from the soil. The amount of nitrogen taken up depends on the crop (see Table 4.4.1).

**Table 4.4.1:** Nitrogen contents of selected agricultural crops.

<table>
<thead>
<tr>
<th>Crop</th>
<th>N content (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat, 6t/ha (grain and straw)</td>
<td>120</td>
</tr>
<tr>
<td>Grass, 10t/ha (dry matter)</td>
<td>250</td>
</tr>
<tr>
<td>Maize, 13t/ha (grain and stover)</td>
<td>360</td>
</tr>
</tbody>
</table>

Grain crops remove large amounts of the macro nutrients N, P and S (and some micro-nutrients) but most of the potassium (K) remains in crop stubbles, particularly the cereals, and is more readily recycled (Table 4.4.2). The K requirement for crops ranges between 100 - 300kg/ha.

**Table 4.4.2:** Nutrient removal in grain from different crops.
Typically, the range for calcium requirements is 10 - 100kg/ha and 5 - 25kg/ha for magnesium (50-60kg/ha for some high yielding crops).

Green manure legume crops are a prime source of atmospheric nitrogen, and the balance of nutrients with water encourages rapid re-cycling of the nutrients (Table 4.4.3). Green manures have the added advantage of being able to be selectively grazed and used to reduce weed seed banks.

Table 4.4.3: Nitrogen fixed by legume and green manure crops.

<table>
<thead>
<tr>
<th>Legumes</th>
<th>Kg N fixed per ha/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>60 – 90</td>
</tr>
<tr>
<td>Cowpeas</td>
<td>80 – 90</td>
</tr>
<tr>
<td>Clover</td>
<td>100 – 160</td>
</tr>
<tr>
<td>Lucerne</td>
<td>120 – 600</td>
</tr>
<tr>
<td>Lupins</td>
<td>150 – 170</td>
</tr>
</tbody>
</table>

**Strategies used for enhancing fertility**

- Accurate placement of fertilisers near the seed: the highest phosphorus requirement is in the early growth stages of the crop. Sowing machinery that allows placement 2-5cm below the seed can improve uptake efficiency.
- Reducing weed competition: sowing of wheat at rates of 150-175kg/ha has produced yields of 3.3t/ha from 150kg/ha of organic fertiliser.
- Timing of application with rainfall and soil moisture.
- Site preparation to optimise availability for plant or animal demand: heavy grazing pressure of 50-100 dry sheep equivalents (DSE) to turnover standing pasture and minimise crop competition.
- Minimum cultivation to reduce oxidative losses of carbon: 1 - 2 cultivations at sowing to kill standing weeds and reduce the opportunities for erosion.
- Waterlogging decreases worm numbers and depletes nitrogen.
- Green manure crops: legume crops (grazed or ungrazed) for green manure such as Balansa clover of 6t/ha dry matter (120 kg N/ha) are beneficial. They can be used with a single incorporation cultivation in spring (also preventing seed set in following weed population), followed by each way scarifying before sowing.
- Matching nutrient inputs to existing soil levels and anticipated crop needs. (Based on observations of organic conversion at the AV Rutherglen demonstration site).

**Animals and fertility**

Nutrients are removed at a slower rate by animals in grazed pastures due to metabolic and transfer limitations in the animal’s digestive system. Once grazing animals are fully mature they will recycle more of their nutrient intake. In (productive) grazed pastures, the availability of nutrients in the soil can be limited, as they are held in organic matter or are rapidly taken up by growing plants. But about 85% of the nitrogen is returned as faeces and urine, where it can be leached as nitrate, volatilised as ammonia or lost as nitrogen gases from denitrification. In contrast, the return of carbon to the soil from dung produced by dairy cows grazing productive pastures is 3.5 - 4.5t/ha/yr.
Getting soil fertility right

- Monitor regularly - know what you have and how to use it.
- Be aware of the amount of product removed and how these nutrients will be replaced.
- Plan for production levels - have alternative strategies ready if necessary.
- Stimulate nutrient cycling - remember to consider the C to N ratio of 12:1 for organic inputs.
- Don't let unproductive weeds tie up valuable nutrients in pastures or crops.
- Above all, maintain the standards for the organic product grown.

4.5 Compost: turning waste into gold
by Chris Alenson, ORGAA

Compost in one form or another has been made for thousands of years with the earliest references to be found in the Bible. But it wasn’t until the early 1930’s that Sir Albert Howard, a British agronomist made the first important advances in the science of composting. The Indore Process, named after the area in India where Sir Albert was working, involved creating a layered pile about 1600 millimeters high of garbage, night soil, animal manure, sludge and agricultural wastes.

The pile was turned twice to facilitate mixing, and composting was completed in three months. The Chinese have composted every conceivable organic waste for over 3,000 years. Their ability to feed such a large population has been largely due to their return of wastes to the soil as compost, and therefore preserving the fertility of their soils. Various methods have been used to compost wastes, such as the use of static piles, rotating cylinders, fixed chambers, and anaerobic methods (exclusion of oxygen).

The most common and cost effective method used today is the windrow system where shredded, well mixed, solid waste is deposited in windrows, utilising either quite simple handling equipment or more sophisticated machines.

Many countries are now finding composting a beneficial process, and a financial answer to the accumulation of solid wastes. Holland for example has been producing thousands of tonnes of compost from garbage for over 40 years. Local municipalities in the United States are composting as a means of disposing of wastes, and also as a supply source of all their landscaping and horticultural activities, thus saving thousands of dollars.

The composting process
Composting can be defined as the process where a collection of organic wastes of varying compositions are mixed together and undergo a fermentation due to biological processes. The resulting product is known as compost.

How composting works
When the correct mixing of ingredients has taken place and when the temperature, moisture and oxygen levels are favourable, micro-organisms will grow and start the process of decomposition. The micro-organisms use some of the available nutrients in the wastes, such as nitrogen, carbon and others, as a source of fuel. As their life cycle proceeds the temperature increases from the heat generated by biological oxidation, and the compost pile heats up (Figure 1). As the decay process slows down the temperature reduces.

The composition of the materials in the compost pile alters as a result of the biological activity and the resultant form of organic material is called humus.
The role of science in the commercial composting process has been to try and understand the biological processes and see how they can be controlled or regulated to achieve a finished product with a reliable consistency of composition.

![Image of temperature profile through a compost pile]

**Figure 4.5.1: Composting**

The temperature profile through a compost pile can be seen in Figure 4.5.1. The temperature starts at the surrounding air temperature, but as the micro-organisms grow the temperature increases.

The stage up to 40°C is termed the mesophilic stage, and it is at this stage that most initial microbes will die off and be replaced by those preferring higher temperatures. The stage from 40°C to 70°C is termed the thermophilic stage.

Well-built compost piles reaching these temperatures will have steam emanating from them. As Figure 1 shows, over time the temperature declines and eventually returns to the first stage.

Two important factors in the composting process are the supply of moisture, and oxygen to the pile. A lack of water will result in low biological activity and a pile that will not compost adequately. Too much moisture and an anaerobic pile will result, which tends to emit putrid odours.

Optimal moisture content is 50-60 per cent. A handful of organic matter should feel damp but not be able to have water squeezed from it.

The other important factor is oxygen. Micro-organisms require oxygen to grow. If they do not grow the pile will again stagnate due to a lack of biological activity. Compost piles are aerated by either thorough mixing or by air holes driven into the pile at regular intervals.

**The carbon-nitrogen ratio**

Probably the most important aspect of a successful compost pile is the relationship between the carbon-nitrogen ratio and the rate of organic matter decomposition. Micro-organisms use carbon for growth (energy source), and nitrogen for the synthesis of protein. As they utilise 30 parts of carbon per 1 part of nitrogen a carbon-nitrogen ratio of 30 : 1 is the aim in composting.

Grass clippings as an example have a lower ratio of about 20:1, which would tend to balance out the higher ratio of leaves 40-80:1.

Grass clippings composted by themselves smell of ammonia due to the volatilization of nitrogen. They also tend to pack together and cause oxygen to be excluded from areas of the pile. Woodchips with a ratio of 700:1 would require large additions of nitrogen to bring it to the desired ratio of close to 30:1. (See table 4.5.1 for some carbon/nitrogen ratios of common organic wastes)
**Table 4.5.1:** Carbon - Nitrogen ratio of some organic wastes

<table>
<thead>
<tr>
<th>Product</th>
<th>Carbon : Nitrogen ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw</td>
<td>80-100:1</td>
</tr>
<tr>
<td>Leaf litter</td>
<td>60-100:1</td>
</tr>
<tr>
<td>Lucerne hay</td>
<td>12:1</td>
</tr>
<tr>
<td>Weeds</td>
<td>30:1</td>
</tr>
<tr>
<td>Sawdust</td>
<td>500:1</td>
</tr>
<tr>
<td>Grass clippings</td>
<td>20:1</td>
</tr>
<tr>
<td>Chicken litter</td>
<td>15:1</td>
</tr>
<tr>
<td>Compost</td>
<td>25-30:1</td>
</tr>
<tr>
<td>Cattle manure</td>
<td>12:1</td>
</tr>
</tbody>
</table>

**Building a commercial compost pile**

Compost can be manufactured by two aerobic methods in the pile system, which are either a layered pile or a well mixed pile.

A layered pile consisting of 200mm layers of carbonaceous material and a 100mm layer of nitrogenous material will provide the balanced carbon-nitrogen ratio required. The carbonaceous material could be leaves, pine needles, hay, straw, sawdust, woodchips or shredded paper.

The nitrogenous material used could be grass clippings, weeds, vegetable wastes, garbage and manure. This pile once aerated by forcing holes at two metre intervals and with the correct moisture levels, will take about 6-8 months to decompose. This pile is not shredded or turned.

**The pre-mixed pile**

By turning the pile several times and by shredding a mixture of organic wastes in the ratio of two to three parts carbonaceous material to one part nitrogenous material, compost should be produced in about three weeks.

Assuming directions have been followed closely, only outside temperature variations will affect the actual completion date for the finished compost.

Both methods operate most efficiently when the piles are about 1650mm high and 2700mm wide. Figure 4.5.2 illustrates the difference between a layered pile and a pre-mixed pile.

![Figure 4.5.2](image-url) The difference between a layered pile and a pre-mixed pile.
**Materials for the compost pile**
It would be preferable to have the supply of raw materials for the composting pile on the farm. Some farmers grow crops especially for this exercise. A grass crop like oats grown with a legume crop would supply much of the bulk required for the pile. Cattle manure, sludge from dairy operations, fruit wastes, can all be used as long as careful attention is paid to adjusting the carbon-nitrogen ratio.
If off farm wastes are used, it is even more important that an efficient composting process is employed to ensure destruction of any possible contaminants.

**Equipment required**
The simplest method of windrow composting involves a dump truck to deliver the wastes and a front-end loader to mix and turn the piles. Rotary hoes and grader blades can be used to mix and form a compost pile.

A continuous input of raw materials would require several composting piles running concurrently. As one pile is completed another might be in the process of being built. As a rough guide 100 tonnes of organic wastes would reduce to about 50 tonnes of compost depending on the ingredients and the efficiency of the composting process.

**Site preparation**
The site should be leveled or slightly raised and clear of grass and provision made for water runoff and leaching. A concrete sump or shallow trenches filled with sawdust could be used to absorb the liquid and prevent contamination of any nearby watercourse or aquifer. The windrow piles should not stand in water but be prepared on raised ground.

**Successful compost manufacture**
- A balance between carbon-nitrogen materials must be maintained.
- The finer the material the more successful the decomposition.
- The better the mixing the better the decomposition.
- Adequate moisture is required.
- Provision of an activator such as animal or poultry manure will help to stimulate biological activity.
- A high temperature in the pile is needed.
- A well-made pile of correct dimensions is required.

**Table 4.5.2: Troubleshooting**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smell of ammonia emanating from pile</td>
<td>Materials packed too tightly, or too wet (reform pile)</td>
</tr>
<tr>
<td>Compost soggy, black and putrid</td>
<td>Too much moisture and lack of air</td>
</tr>
<tr>
<td>Excessive leaching of nutrients from base</td>
<td>Too much water during preparation</td>
</tr>
<tr>
<td>Pile does not decompose</td>
<td>Poor aeration, lack of moisture, not enough nitrogen</td>
</tr>
</tbody>
</table>

**When is compost ready?**
When the material in the pile possesses an earthy structure, and the original constituents are difficult to identify then the compost is in a state ready for use. It will also possess a pleasant smell indicating that proper decomposition has taken place.

**Controlling plant disease with compost**
The biological control of plant diseases depends on the establishment of a balanced soil microflora that exhibits antagonistic biological activities towards phytopathogens.
Chemical and physical factors can affect the disease suppressive nature of the compost. Particle size, nitrogen content, cellulose and lignin content, soluble salt content, pH and organic compounds released by composts are all known to affect the incidence of disease caused by pathogens residing in the soil.

The more varied and numerous the soil microorganisms, the greater the chance of biological control of a pathogen.

Examples of disease controlled by suppressive soils include:
- Fusarium wilt
- Streptomyces (potato scab)
- Phytophtora root rot
- Sclerotinia rot
- Pythium dampening-off,
- Aphanomyces root rot
- Gaeumannomyces (fungul rot, take-all in wheat)

Nematode diseases are also suppressed by composts and beneficial, saprophagous nematodes are increased by compost amendments.
The use of sound rotations with compost amended soils provides a powerful biological control of many plant diseases.

**Phytotoxicity of compost**
At various times injuries to plants or to germinating crops has been noted after the application of organic matter.

The use of crop residues, green manuring, compost applications have all been associated with plant damage.

Toxins released from decomposing organic matter often represents a temporary state. The toxins are produced in certain stages of composition and tend to be quickly activated. Any damage to plants on most occasions is not permanent and recovery tends to be rapid.

But it is wise to remember immature compost does have high levels of acetic acid and other minor acids such as propionic acid and butyric acid, which can be phytotoxic at the levels represented at this stage of decomposition.

Studies show that mature compost does not contain these high levels of organic acids.

**Analysis and application rate**
The analysis of the compost heap will depend on the components of the pile and the state of decomposition.

Although the analysis will dictate the actual quantities of nutrients supplied to plants, it is worth remembering that even more important, is the supply to the soil of millions of micro-organisms that are contained in the compost. Research has often demonstrated that there is very little difference in plant growth from the use of high analysis compost and low analysis compost. See Table 3 for an analysis and application rate of two types of compost.

**Table 5.4.3:** Analysis and application rate of two types of compost

<table>
<thead>
<tr>
<th>Compost materials</th>
<th>Percentage N</th>
<th>Percentage P</th>
<th>Percentage K</th>
<th>kg of plant food per ton of compost</th>
<th>Application rate (t/ha)</th>
<th>kg of plant food per ha (suggested rates)</th>
</tr>
</thead>
</table>

47
<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Waste</td>
<td>1.0</td>
<td>1.0</td>
<td>22</td>
<td>Composted</td>
<td>10</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>10</td>
<td></td>
<td>poultry manure</td>
<td>25</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>

4.6 Storing organic produce
by Pamela Horsley, Kondinin Group

According to the national standards, all organic produce must be handled and stored in a way which prevents contamination or substitution with non-organic produce. Storage areas must be separate and clearly identified if there is similar, conventional produce on the same farm or areas of the farm are still converting to organic. All equipment used to handle, store or transport organic produce must be suitably cleaned before use to avoid contamination. Different certifying agencies may have different cleaning requirements and conditions of equipment use. The national standard also requires operations on organic produce must be carried out continuously until the complete run has been dealt with and separate from similar operations on conventional produce.

Substances permitted as post harvest- storage treatments:

- Carbon dioxide, in controlled atmosphere
- Oxygen, in controlled atmosphere
- Nitrogen, in controlled atmosphere
- Ethylene gas, as a ripening agent
- Physical barriers, for pest control
- Temperature control, for pest control
- Diatomaceous earth, for pest control
- Sticky boards, for pest control
- Rodenticides, for pest control. Must be in enclosed traps outside of food processing or storage areas and only used when other pest control means have proved ineffective.


4.7 Livestock plays a vital role
by Robyn Neeson, NSW Agriculture

Livestock can produce meat and fibre for sale but they can also be useful on organic farms for weed control, pest management, nutrient cycling and crop establishment.

Nitrogen fixed by legumes and other nutrients consumed by livestock during grazing are returned to soil as manure and urine. Managed carefully, livestock and manure can play an important role in nutrient cycling on the organic farm.

Livestock can graze down weeds before sowing a crop or after crop establishment. Livestock can also selectively graze out weeds and avoid the less palatable crop.

They can also assist with paddock preparation for sowing by grazing and trampling stubble. Livestock play an obvious role in the pastures phases in crop rotations. Pastures build fertility and soil structure-building while reducing the potential for the build-up of insects and disease.

Nutrition
Organic farming aims to provide a diet which livestock are most adapted to consume. Organic husbandry does not aim to maximise weight gain at the expense of animal health and happiness.
Diet diversity is the key factor in balancing nutrition. A balanced diet helps to meet livestock’s physiological needs. Research has shown cows with a high production level due to emphasis on concentrates in their diet have a shorter productive life.

Organic systems use a variety of plant species in the pasture. A mixture of deep-rooted and shallow-rooted species increases the potential for making nutrients available and avoids nutrient deficiencies.

For example, in organic pastures, herbs such as chicory, plantain, yarrow and caraway are often added. Deep-rooted native species can recycle and make available nutrients, which otherwise may be unavailable deep in the soil profile. Legumes such as lucerne can supply organic nitrogen to the grass component of pastures and help recycle deep nutrients.

The long-term aim of organic systems is to correct soil deficiencies. Under the organic standards, mineral supplements used to correct deficiencies should be from natural sources. For example, certain additives such as urea and synthetic amino-acids are not allowed but seaweed and seaweed extracts, containing a range of minerals are permitted. Nutrients can also be fed in mineral licks, fodder mixes or by drench gun (refer to Pat Coleby’s article below).

According to the national standards, 95 per cent of food for organic livestock must be produced organically (either as purchased input or preferably, produced on the farm). Up to 5% may be used as feed supplements, for example minerals, kelp, molasses, stone meal and charcoal (see National Standard). In extenuating circumstances (such as fires and drought), exemptions to this rule may be granted and feed from non-certified sources may be increased to 40% of dry matter intake. Stock fed non-organic inputs must be fed on organically sourced inputs for a period of six months before they can be marketed as ‘organic’.

**Soil management for nutritious pastures**

Slow, organic remediation of soils through improved biological activity provides healthier plants and stock.

Conventional management of pastures often involves a sledgehammer approach to correct deficiencies. The use of synthetic fertilisers has resulted in problems of soil acidity and declining soil structure. Organic management, on the other hand, provides long-term improvement in soil and crop health but requires careful long term planning to ensure crop and livestock needs are met.

**Encouraging predators to manage pests**

Providing shelter, breeding grounds and year round food sources for predators encourages their presence. Nectar producing species incorporated into pastures and windbreaks attract parasitic wasps which parasitise scarab species in pastures. On-farm wetlands encourage predatory waders and when correctly located and designed, provide a filter for nutrients in drainage before it exits the farm.

1) **Shelter**

The benefits of shade and shelter for livestock have been well documented. Organic animal husbandry requires that sufficient protection be provided against excessive sunlight, temperature, wind rain and other harsh climatic conditions. This can be achieved through the provision of windbreaks or housing for livestock.

2) **Breeding**

In conventional livestock systems, genetic emphasis is on high production. The organic farmer selects livestock for a wider range of qualities. These include pest and disease tolerance or resistance (for example Brahman’s tick tolerance) and mothering ability. Breeding for lifetime yield is more
commonly the practice in organic farming. While the aim of conventional livestock production is for high, early productivity (early maturity), the aim with organic livestock is to increase their productive life and this is often associated with resistance to disease.

**Longevity advantages:**
- Long growth period means long youth, and a long immature stage has been shown to be a precondition for a longer life.
- The farmer has the opportunity to get to know herds which makes handling easier and provides thorough knowledge of the herd’s disease history.
- The herd establishes a stable social order and stable health state.
- Stress factors become adapted to the conditions over a longer period.
- The quality and quantity of colostrum in older cows is greater.

Breeding should be within the genetic capacity of the species concerned. For example, breeding for high feed conversion can lead to arthritis, whilst large hind quarters can lead to birthing difficulties.

**Organic standards and breeding**
During conversion to organic production, livestock bought in must be organic or, if conventional, placed in a quarantine area for three weeks. Once fully organic, external purchases are confined to breeding stock only - all other livestock should be bred on the property. Replacement breeders may be introduced at an annual rate of 10 – 20 per cent (depending on certification organisation) of existing breeding stock.

Livestock produced by A.I. are allowed by some certification organisations when natural behaviour is not practical. It is unlikely embryo transplant would be permitted since this technique usually requires hormone injection to synchronise breeding cycles. Livestock produced using genetic modification techniques (genetic engineering) are not permitted under the organic standards.

**Livestock welfare**
Organic farmers aim to minimise physical or psychological stress in livestock in order to promote well-being and reduce the incidence of disease. Non-stressed livestock also has implications for maintaining meat tenderness.

The national standards require that “maintenance of livestock must be guided by an attitude of care, responsibility and respect for living creatures.....Living conditions must consider the natural needs of the animal for free movement, food, water shelter and shade. Consideration must be given to their specific natural behaviour patterns.”

In respect to specific stress, “pain inflicted by treatments such as castrating, marking and mulesing must be kept to a minimum.” For example, NASAA prohibits certain practices such as the docking of cows’ tails. Dehorning and castration are allowed when carried out in as humane a fashion as possible. The national standard states that the use of anaesthetics will not result in loss of organic status.

Management aims to minimise stress during potentially stressful periods. For example, after shearing, stress can be reduced by providing good pasture with low or no parasitic burden. Eliminating noise such as noisy motor bikes and not rushing stock through gateways can also help to minimise stress during handling.

Animals experience further stress during transport to market and during slaughter. The standards aim to minimise stress during this period. For example, NASAA standards state: “slaughter will be carried out quickly and without undue stress, and......animals may not be held or herded in an area where the killing of other livestock is visible.”
Health

Prevention of disease through diet, shelter, breeding and husbandry practices, rather than treatment is the organic approach to animal health care. While it is not possible to extinguish all animal disease, when disease does occur, a healthy animal is in a better position to cope with it.

Many organic farmers regard good observation as an important part of disease management. Keeping daily or frequent records assists the producer in assessing possible origins of the disease or injury.

The routine use of any veterinary drugs such as antibiotics and vaccinations is not permitted by organic standards. Organic farmers rely on treatments such as herbs, vitamin and minerals, homoeopathy, acupuncture and dietary additives such as probiotics. But there is not always a satisfactory ‘organic treatment’ to health problems which may occur and when an organic treatment is not effective, there is no doubt that conventional treatment has to be used since the welfare of the animal is the primary objective.

Where an animal is treated with a non-permitted substance it must be identified and quarantined from other stock from the time of treatment for at least three times the withholding period specified. The quarantine area of the farm may not be used for organic production for a period of at least 12 months after it has been used for such purposes. Treated animals may not thereafter be sold as organic. Where law requires the treatment of diseases or pests, this will overrule the organic standards.

Selection of stock based on disease tolerance and resistance is a primary tool of the organic farmer. Re-occurring health problems indicate that something in the system may be wrong. If individual stock exhibit recurring problems they are culled.

Internal parasites

Organic farmers are not permitted to use anthelmintics for the control of internal parasites. Drenching is carried out on a needs basis only, as routine use is not permitted and could lead to resistance developing. But if permitted substances or practices do not satisfactorily treat an animal their welfare is the first priority over organic status.

Organic treatments include a drench made from a mixture of garlic, molasses vegetable oil and cider vinegar. Others have used aloe vera. Homoeopathic remedies and some other substances listed as permissible are not registered as veterinary treatments. Authorities have been asked to explore the legality of using these unregistered substances.

Alternative management practices aim to disrupt the lifecycle of the parasite. Temperature and moisture favour the development of internal parasites, so after rainfall or irrigation livestock are moved to a clean pasture, or pastures can be harrowed following grazing to expose the eggs and larvae to sunlight and heat. New Zealand’s agroecology program found certain pastures (such as chicory and lucerne) to be least conducive to parasite larvae intake.

Resistance to internal parasites increases with age because immunity develops through previous exposure. Sheep reach a higher level of resistance to internal parasites around nine months whereas cattle reach this stage around 18 months. Late pregnancy, lambing and weaning are critical periods of infection as resistance drops with increased stress and as feed intake increases, so it is critical to provide clean pastures at these times. Good nutrition assists in developing and maintaining resistance.

Grazing management is very important in managing parasites. Spelling can control worm populations as can alternate grazing. This system can have older, less susceptible stock grazing pasture before young stock, or have a higher number of less susceptible stock together with young stock. Another form of grazing is to graze alternately with different species (cattle before sheep as cross-infection does not occur to any great extent).
This has additional benefits as different grazing habits do not allow domination of any one weed species. Strip grazing involves back-fencing stock to match larvae development so that stock do not contaminate their pastures.

Some organic farmers prefer low stocking rates, although more recently there is a trend towards cell grazing where a large number of animals are grazed for a shorter period and then moved on. This requires smaller grazing units and results in greater fencing costs.

Cultivation and intermediate cropping provide a break in the build-up of insects, parasites or disease and therefore a clean pasture. Sowing mustard and ploughing it in as a green manure has been shown to clean a pasture.

In summary, maintaining good health and reducing the risk of parasites involves:

- Maintaining a high plane of nutrition and minimum stress
- Grazing management which reduces exposure to parasites
- Eliminating herd drenching and only drenching individual stock when infection is sighted. Close observation is a crucial factor.
- After the system is established, cull animals which show signs of heavy infestations.

Liverfluke (Fasciola hepatica) control can be achieved through control of the intermediate host, the freshwater snail. In organic farming systems this is achieved by excluding livestock from water sources where the snail inhabits and by the use of birds such as ducks. Snails prefer damp, slightly acid conditions so addition of lime may reduce snails. Copper sulphate is approved under the national standards but its use is subject to review.

Clostridial diseases are caused by spore forming anaerobic bacteria which cause a wide range of disease. At present the conventional control of these diseases is through vaccination. In organic farming the use of vaccines is restricted and is only permitted with approval from certification organisations and only when a specific disease is known to exist on the organic farm or on neighbouring farms which cannot effectively be controlled by other management practices.

To deal effectively with clostridial disease the first goal is to avoid predisposing factors. For example, in blackleg or malignant oedema (Cl. Chauvoei) a significant predisposing factor is injury. Management strategies include, avoiding and treating injuries, avoiding using the same site for operations such as mulesing and lamb marking, and burning dead stock where they lie.

Some practices emphasised in organic farming reduce the likelihood of injury. For example, dipping and drenching are avoided (stress and rough handling is minimised), and birth complications are minimised through appropriate breed selection.

Where a serious disease is endemic and cannot be otherwise controlled then vaccination is appropriate and an important management strategy.

External parasites are managed through a range of practices. These include:

- Observation of livestock
- Selection of resistant or tolerant stock (genetic selection and culling of susceptible stock)
- Monitoring the presence of pests eg. traps
- Cleanliness, for example in yards, burn crutchings
- Biological controls, for example, the use of dung beetles to remove faeces and hence the eggs of buffalo fly (Siphona exigua).
- Organic treatments - derris and rotenone can be used for lice, lime sulphur for itch mite, zinc sulphate for lumpy wool and neem and eucalyptus (*E. globulus*) oil for fly strike.

Homoeopathy works on the principle that if substances are given to individuals in extreme dilutions, they produce a therapeutic effect. Therefore, the whole organism can be treated in an attempt to raise its levels of resistance and stimulate its ability to throw off disease. Homoeopathy embodies the law of similars to stimulate the body’s natural defence mechanisms. There is little scientific evidence of the effectiveness of homoeopathy. But only a few trials have been conducted with some trials showing effects, while others fail to do so.

**Marketing**

In 1995, combined organic livestock products consisting of dairy, meat, poultry and fibres were valued at $7.5 million at the national retail level.

Consultants Hassall and Associates made the following comments regarding markets for organic and bio-dynamic livestock products:

For dairy products, opportunities include whole milk, butter, yoghurt and cheese from cows and sheep-goat dairy products.

The shortage of suitable feed grains appears to have curtailed development of an organic poultry industry in Australia. Growth potential for eggs was recorded in South Australia.

Overseas interest in Australian organic wool is high and enquires have been made from both Japan and Western Europe. If this interest can be converted into sales the potential for organic wool as a product is impressive. The main limitation appears to be the availability of an organic scouring facility.

**Meat marketing**

Livestock to be sold as certified organic must be processed through a certified abattoir. Currently (December, 1999) there are six certified abattoirs:

**BFA Certified:**
- Pittsworth Abattoir, Pittsworth QLD.
- Cudgegong CC TA Mudgee Regional Abattoir, Mudgee, NSW
- DA Holdings, Moruya, NSW
- Q Meat Ipswich, Churchill, QLD.

**NASAA Certified**
- Loxton Abattoirs, Loxton, SA.
- Thomas Borthwick & Sons, Mackay, QLD.

Meat opportunities include certified lamb and beef. The potential for pork products may be limited by the availability of certified feed grains.

A number of factors impact on the marketing of meat and meat products. One significant factor is the requirement for certified slaughtering and processing facilities. Continuity of supply is an issue with most producers. This has led to producer’s pooling resources, but this in turn creates difficulties with providing consistent quality and grade.
Meat and Livestock Australia (MLA) is interested in assisting organic producers with the formation of a vertical alliance for marketing bio-dynamic or organic meat products because from the consumers perspective it is safe, clean, green and promises taste.

Some of the problems envisaged by MLA include those of quality consistency and continuity of supply and packaging (retaining integrity of product). Product consistency could be improved by designating a number of finishing-off properties located near processors and by developing a common genetic base. Continuity of supply can be overcome to a large extent by the diverse geographic distribution of producers. Integrity would be retained (and substitution minimised) by pre-packing (vacuum packed and branded) all the cuts for retail or food service applications. A number of organic livestock marketing consortiums now exist.

4.8 Animal health – the natural approach
by Pat Coleby, Organic Consultant

Many farmers throughout the world are now finding stock do much better if drugs and chemicals are not used. Animals rely on the land to provide them with the right balance of major minerals to maintain them in a disease free state.

But Australia's soils are not strong enough to hold the amounts of minerals needed to achieve this, no matter how well balanced the soils are. Therefore, with few exceptions, animals farmed for products like milk and wool have to have other assistance, in the form of mineral supplements.

Correcting mineral deficiencies

Even beef cattle may need licks to ensure they do not run short of copper, sulphur, dolomite and seaweed, or minerals such as cobalt or boron that the soil is deficient in.

Just as weeds in paddocks can denote a poor unbalanced soil so can worms and diseases denote a poor deficient beast. Nature creates resistant strains of bacteria, worms or other pests almost as fast as the new chemicals can be made. But the use of basic minerals and vitamins will not produce a resistant strain of any of these organisms.

Perhaps the biggest worry nowadays is the fact that on any farm where artificial fertilisers are used, either in phosphatic or nitrogenous form, the natural copper in the soil becomes unavailable for use by plants and animals. This is old information and may account for the huge number of diseases, including Johne's, worms and footrot, currently rampant in stock because they are copper deficient. They are of course usually deficient in other minerals as well, but I have found that unless the copper was in the correct balance, diseases like Johne's, tuberculosis and brucellosis have a habit of becoming endemic. Research has drawn some very interesting conclusions and often places the high incidence of cancer in the same bracket.

Acidic soils have a low pH (from 3.5 to 5.5) and in these circumstances all trace minerals and iodine will be virtually unobtainable. No stock of any kind can stay healthy in those conditions. Feeding the required minerals in bail feed, licks or hand feeding of any kind is a very short-term solution. Until the health of the land is addressed, they will not be in full health. Acidic soil lacks gypsum, lime or dolomite. Some or all of these minerals will have to be applied, according to the soil analysis results.

In the meantime all stock should have unlimited access to a balanced lick which includes urea free seaweed meal and 25kg of dolomite, 4kg each of copper sulphate and yellow dusting sulphur.

Even on the saltbush country, sheep farmers claim the above lick makes a considerable difference to their productivity and cuts out the need for drenching and dipping. Saltbush in theory has more minerals in it than seaweed but the extra minerals in the lick have still allowed a big improvement in performance.
Getting the soil right first

We bought a farm in Gippsland where the pH was 4.1 and the previous owner had spread super and potash for many years. The analysis showed iron 1600 times too high and salt 600 times too high. The first topdressing with the lime minerals leveled out the salt and brought the iron down to about 300 times too high. The stock on the farm then became susceptible to anaemia and fluke within two months. I was already feeding a maintenance ration of dolomite, sulphur and copper but obviously far to little of the latter. I raised it to double what I had been feeding. The fluke were gone in three weeks and the eye membranes of all the stock became a good pink colour within ten days. Iron cannot be absorbed without the right amount of copper.

Cobalt inhibition was also a serious problem and I had to bail feed it for the first 18 months. At the end of that time (17 months after remineralisation) cobalt was back in the food chain and from then on things started to go well. As the pH comes up the trace minerals become available again. Trace minerals cannot be spread under any circumstances until the pH is 5.5 or above, or the acidity of the soil will sulphate them out and they will be lost. This can be very expensive.

On farms in northern Victoria, a copper bearing weed called heliotrope claimed the lives of many stock each spring. Heliotrope likes a soil low in lime minerals so straight dolomite was put out to neutralise the copper. The mayhem stopped in one year, and after that, remineralisation did the rest.

Pest control

Lice and ticks only attack sulphur deficient stock and ticks are only a problem on sour, out-of-balance soils. More importantly, without sulphur the amino acids, particularly methioine and cysteine, cannot attend to their job of synthesising selenium in the gut.

Seaweed as a supplement is far superior to made up mixtures as the minerals in it are in full balance and it contains every trace mineral so far mapped. Seaweed has been known in Europe for about 50 years, but its use is only just becoming more widespread in Australia. The previously mentioned lick has maintained a great many and a broad range of cattle herds as well as being much used in the dairy industry. Many farmers prefer stock to be able to help themselves but this is not always possible in dairying in which case 40 -60grams per day per head seems to work well. English farmers find 80 grams is good, but most of them have a long history of super and ammonium nitrate spreading so once the soils are rectified the cows should not need so much.

Permitted materials for animal pest and disease control


- Pyrethrum extracted from *Chrysanthemum cinerariafolium*, without piperonyl butoxide
- Rotenone extracted from *Derris elliptica*
- Quassia extracted from *Quassia armara*
- Neem oil and extracts
- Garlic oil, garlic extracts or crushed garlic
- Seaweed, seaweed meal, seaweed extracts, sea salts and salty water
- Sulphur
- Potassium permanganate
- Homeopathic preparations
- Natural plant extracts obtained by infusion, excluding tobacco
- Essential oils
- Methylated spirits
- Tallow
- Cider vinegar, certified organic
- Nettle
- Diatomaceous earth, in non-heat treated form
• Selenium and other trace elements, to correct identified deficiencies only
• Zinc sulphate
• Copper sulphate
• Vitamins
• Biological controls
• Charcoal
• Clay
• Vaccines, only for specific disease known to exist on the organic or neighbouring farms, which threatens livestock health and which cannot be effectively controlled by other management practices

Wetting agents, plant products and some seaweed products. Some commercial formulations may contain unacceptable products.
5. Certification

5.1 Certification of organic products in Australia.
by Liz Clay, Certification Inspector

For many farmers entering the organic industry, the paperwork required for certification is daunting. But the rewards through quality assurance and having a product consumers easily recognise as being organic make it worth the effort.

In Australia the production and manufacturing of organic products is regulated by the National Standard for Organic and Bio-Dynamic Produce. This commonly agreed to definition of organic agriculture and processing is the guideline for Australian certification agencies to develop their own more specific standards.

An industry organisation must be accredited by the Australian Quarantine and Inspection Service (AQIS) before it can certify organic operations. The organisation must show that its certification program will meet all the requirements of the national standard. All production, processing, handling, transport, storage and sale of organic products must be certified through an accredited certifying organisation.

International certification

In 1992 the International Federation of Organic Agriculture Movements (IFOAM) set up its own accreditation program to co-ordinate and standardise organic accreditation programs worldwide. This provides an international guarantee of organic quality for accredited producers, processors, manufacturers and retailers. IFOAM has recently developed a seal for use by IFOAM accredited certifiers and the parties they certify. The seal will provide consumers with a clear, worldwide, common recognition of genuine organic products certified to IFOAM standards.

The organic standards in Australia and throughout the world do not make claims that organic farming produces better or cleaner food. But they do describe the method of agricultural production and outline the inputs that may be used in an organic farming system.

Organic agriculture also requires that all possible preventative measures are in place to ensure that the production system is not exposed to prohibited chemical, physical or microbial contaminants. More recently the risk of genetic pollution from genetic engineering is also considered a potential source of contamination that must be avoided.

The standards define organic farming and the processing of organic products. They detail how both should be monitored by documentation and annual, objective, third party inspection. The intention of labelling of certified organic products is to send a clear message to consumers, - that when you buy organic products you are assured that you are not contributing to the contamination of the soils, the water and the air by synthetic agro-chemicals.

Organic farmers are contributing to the sustainable use of the earth’s natural resources. The growing numbers of consumers who believe in this ethic demand production assurance.

Certification of organic farming and manufacturing systems allows Australian producers and manufactures access to the lucrative international organic market place. Our major markets are Europe, Japan and North America where organic products fetch premium prices.
All organic products exported from Australia must be accompanied by an Export Control Order. It is illegal to export without one. These certificates provide verification that the product is certified organic and are only issued by the AQIS accredited organic certification organizations.

**What is the conversion period**

Conversion of a farming system to organic requires a long term perspective. It therefore requires a plan to accommodate the impacts of the change of management practices regarding soil fertility, plant nutrition, animal health and pest, disease and weed control. For this reason certifiers recognise a conversion period that may take some three years or more years to achieve.

The national standard states that a farming enterprise must undergo a twelve month period of supervision by an accredited certifying agency to ensure a workable conversion plan is in place. The period of supervision occurs after the first inspection and before entering the ‘organic in conversion period’ when produce can be sold in the organic market place labelled accordingly.

A property in conversion is defined in the national standard as ‘…a production system that has adhered to the standard for at least one year, and has been certified as such, but has not qualified as organic for various reasons. These include reasons such as the conversion system has not been operated within the requirements for the specified period (usually three years); the farm does not meet quality standards, ie soil structure considered appropriate and necessary for organic farms; or the organic management plan has not been sufficiently developed.’

**What paper work**

Certification is granted upon inspection by an approved inspector who reports to the certification body. Before the inspection the farmer must complete a farm conversion plan questionnaire provided by the certification body. Information required includes a background to the operation, the management plan, maps detailing production areas, irrigation system, storage facilities, and surrounding land use. The dates of application of the last prohibited inputs are also required. The farmer is expected to work closely with the inspection body and must complete legal documents that pledge to abide by the regulations of the organization.

Certified farmers are licensed to use the certification agency’s organic label on their produce. To ensure their production methods are in compliance to the standard, certified farmers are subject to an annual inspection by the certification agency. The inspection includes a review of the farmer’s performance and ability to comply with the standard.

Records must be kept of all inputs used on the farm and all outputs including sales, wastage and any produce that might be withheld from sale such as for seed and feed. Dates, volumes, destination, unit description and application rates, must be recorded. Farmers are expected to keep a diary of day to day farming activities and must report any changes to the site or to the nature of the enterprise.

Farms may be converted to organic gradually. If the farm is only partially certified meticulous records must be maintained of both the organic and conventional enterprises. Farming of the same variety of species on a farm that is partially certified is called parallel production and is not allowed because of the opportunity for mixing.

The national standard now requires every organic farmer to have in place a quality management program that is compatible with Hazard Analysis and Critical Control Points (HACCP) principles. A range of industry sectors have already developed quality management programs for their industries and organic farmers are encouraged to tap into these systems.
What is HACCP
HACCP is an internationally recognised basic tool used to develop food safety and quality management systems. The main focus of a HACCP food safety program is to put in place measures that prevent microbiological, chemical or physical contamination, rather waiting for the hazard to occur before taking action to correct it.

The process of HACCP is to analyse every part of the businesses’ production, harvest, and handling to identify the major hazards with respect to food safety and quality. The identified hazards are then monitored and preventative measures are put in place to prevent the hazards from occurring.

Some important food safety hazards to consider on an organic farm might include the manufacturing of compost, water quality for processing or washing produce, pest control and contamination from outside sources and clean down procedures.

Record keeping is vital
The national standard describes the definition for organic production in Australia with a guarantee to the consumer that these production methods are monitored. The inspection body relies on the accuracy of records maintained by the farmer as the essential elements for providing credibility and transparency. Insufficient record keeping is not only an infringement of the standards but effectively prevents an inspection from being carried out. If an organic farmer does not keep proper records, a warning is usually given. If this is not corrected certification will be withdrawn.

What is the cost of certification
There are currently seven AQIS accreditation agencies in Australia which are audited by AQIS to ensure they are maintaining the required level of supervision over their licensees. In turn AQIS themselves may be monitored by other organisation such as the European Union. These levels of scrutiny come at a cost.

The certification agencies generally operate as not-for-profit organizations with a range of structures from co-operatives to private companies. Each has a different fee and membership structure which may change from time to time. Some agencies offer certification for a wide range of products while others are industry sector specific. Some agencies may only certify organic or bio-dynamic production systems. Growers are advised to shop around to ensure that the certification agency of their choice provides the service they are looking for not only for now but in the future.

Most agencies charge an initial joining fee that may include membership to the organization, inspection costs, soil and tissue testing, administration and review fees. New growers, depending on their size of operation could expect to pay around $500.00 to join. Each year thereafter, annual inspection, administration, and membership costs are required. Some certification bodies charge a levy based on the percentage of product sold into the organic market place, others a flat fee with inspection costs billed separately. Once again potential organic farmers should shop around to find the agency that best suits their situation.

Certification bodies in Australia
There are seven organisations currently certified with AQIS.

National Association for Sustainable Agriculture, Australia (NASAA)
PO Box 768
Stirling SA 5152
Ph: (08) 8370 8455
Fax: (08) 8370 8381
E-mail: enquiries@nasaa.com.au
NASAA certifies producers from small to intermediate and extremely large operations throughout Australia and extensively in South-East Asia. NASAA covers some 9 million hectares and about 500 operators involved in horticulture, broadacre, livestock and mixed farms. NASAA is one of the few certification agencies worldwide to achieve IFOAM accreditation and is currently the only one in Australia to do so.

**Biological Farmers of Australia (BFA)**
PO Box 3404
Toowoomba Village Fair Queensland 4350
Ph: (07) 4639 3299
Fax: (07) 4639 3755
E-mail:bfa@icr.com.au

The BFA was formed in 1987 at a meeting of interested parties held in Dubbo, NSW. The objective of BFA is to bring together farmers, processors and the like who have a common interest in organic and bio-dynamic production and systems as a means of conserving resources and processing food without the use of synthesised chemicals.

**Bio-Dynamic Research Institute (BDRI)**
Main Road
Powelltown Victoria 3797
Ph: (03) 5966 7333
Fax: (03) 5966 7433

The Demeter trademark has been used in Australia since 1953 to symbolise produce produced using the Bio-dynamic agricultural method. The symbol was registered in 1967 by the Bio-Dynamic Research Institute. When a certain standard of bio-dynamic development has been established, farmers may apply to the Bio-Dynamic Research Institute to become certified users of the Demeter trademark.

**Organic Herb Growers of Australia (OHGA)**
PO Box 6171
South Lismore NSW 2480
Ph (02) 6622 0100
Fax (02) 6622 0900
E-mail:ohga@nrg.com.au

OHGA was established in 1986 to promote the growing and processing of herbs and herbal products. OHGA members include fruit and vegetable growers, organic manufacturers, wild harvesters and mixed farmers.

**Organic Vignerons Association of Australia (OVAA)**
1 Gawler Street
PO Box 503
Nuriootpa SA 5355
Ph: (08) 8562 2122
Fax: (08) 8562 3034
E-mail: boss@dove.net.au

The OVAA was established in 1992 following an increasing demand for organic wine, particularly from overseas. The OVAA was formed specifically to promote the growing of grapes organically and the production of wine from those grapes.

**Organic Food Chain (OFC)**
PO Box 2390
Toowoomba Queensland 4350
Ph: (07) 4637 2600
Fax: (07) 4696 7689
E-mail: organicfoodchain@hotmail.com

The OFC began through the co-operation of five commercial organic farmers who wanted an organised, highly accountable system of organic accreditation and product differentiation. Now the OFC acts as a producer, agent buyer and consolidator of a wide range of organic products and members include organic farmers, processors, wholesalers, brokers and retailers.

**Tasmanian Organic-Dynamic Producers (TOP)**
PO Box 434
Mowbray Heights Tasmania 7248
Ph: (03) 6383 4039
Mobile: 0408 171 473
E-mail: chottsy@bigpond.com

The TOP Co-operative was formed in the early 1990s in response to calls from Tasmania’s rural sector for a body to represent and support organic growers. Current grower members include producers of dairy products, grains, vegetables, herbs, fruit and wine. TOP is also involved in Skillshare and Landcare projects.

The following organisation is not currently AQIS accredited but does offer an organic advisory service and voluntary retail certification:

**Organic Retailers and Growers Association of Australia (ORGAA)**
PO Box 12852
Melbourne Victoria 3000
Ph: (03) 9737 9799
Fax: (03) 9737 9499
Toll free: 1800 356 299

Further information can be obtained from:

**Organic Federation of Australia (OFA)**
452 Lygon St
East Brunswick Victoria 3057
Ph: (03) 9386 6600
Fax: (03) 9384 1322
E-mail: ofa@netspace.net.au

This is the peak industry body for organic farming in Australia.

**Organic Produce Export Committee (OPEC)**
Australian Quarantine Inspection Service
GPO Box 858
Canberra ACT 2601
Ph: (02) 6272 4783
Fax: (02) 6272 3682
E-mail: organic@aqis.gov.au
Website: www.aqis.gov.au

This committee was responsible for developing national standards and certification procedures for organic produce for the domestic and international markets.
6. Marketing

6.1 Demand based marketing is the key
by Andrew Monk, organic consultant

Sustainable farming ventures in the next century will be based on active marketing by the primary producer. The days of supply led marketing are dying and being replaced by demand led marketing. This is marketing based on what is in demand, rather than what you might have in supply. With demand for organic products far outstripping supply capability, there is a need to consider markets and the feasibility of supplying them.

Demand can also be created by the appropriate marketing, but efforts must be constantly refocused to ensure that the product is satisfying demand, rather than simply relieving supplies. To achieve this effectively, suppliers must know their markets, their product, and the culture that produces that product.

A diverse industry
There is significant diversity within both the existing and future potential organic industry, in terms of industry sectors, regions and types of markets. Diversification of both production and markets is an accepted means of helping ensure long-term economic survival for primary producers. Markets of any kind go through periods of flood and drought – it is important to treat such occurrences as natural disasters and best to prepare for them.

Diversification often means that the organic producer may need to consider the possibility of having to market some of their produce on the conventional market at times. Indeed, for many larger producers, this back up is often essential in smaller markets where there is a propensity for flooding.

The other key reason for diversification is that in developing new markets, such ventures can be risky, and such risk needs to be managed by a balanced approach to market outlets. Diversity means lowered vulnerability, both on-farm and in market. Diversity may also allow for bargaining power over buyers. A product you have which is more in demand might be linked with mandatory sales of your other products which may be over supplied in the market. Larger suppliers call this “key hole marketing”.

Marking out your product in the market place is also essential to protect the work you do to get that product to market. Differentiation by means of labelling and packaging may be part of this. Some producers in livestock and commodity based markets have tried to become certified under the organic system in order to differentiate their produce from the general market place.

Successful marketing cannot of course be discovered in a book. Marketing is an active process of individual work and research. It is about contacts, and it is about taking calculated risks and learning lessons as you go. Essentially it is about assessing future demand potential and building supply capability. To achieve this in the organic market, you will need to know both the specialised contacts for marketing, as well as the type of culture that many of these marketeers operate within.

There are three essential rules to marketing organic products. Know the market culture and its regulatory requirements, know the specifications and demands of your customer and know your products’ performance and nature.

Know thy product
For those moving into organic production, a working knowledge of the performance of the products to be marketed is essential. Some organic produce has a shorter shelf life than its conventional
counterpart. Other products can have longer shelf life when stored and transported effectively and this also should be capitalised on where relevant.

Using the apparent weakness of a product to a market benefit is essential. For example, softer, sweeter tasting berries may need to be marketed very differently than their harder bodied equivalents. Local markets, pick your own, or similar market outlets may be the most appropriate here. Poorer quality product – from pest or disease damage may also require different approaches to marketing. The “ugly apple” has been used as a marketing campaign by some to capitalise on an inherent weakness of the product in terms of aesthetics. Juicing and processing of damaged produce may also be a possibility.

Sweeter tasting meat products, higher protein grains and other natural characteristics your own produce may exhibit, need to be taken into consideration when planning your marketing campaign.

The message is: “know thy product”. Know its inherent limitations as well as its potential for differentiation in the market place. Use this knowledge to enhance the marketing.

There may be unique requirements for the organic product to be processed, packaged and stored in accordance with the National Standard for Organic and Bio-dynamic Produce. Aspects such as labelling, packaging materials and transport and retailing arrangements require consideration and careful planning to ensure that there is compliance with all regulatory requirements, while maintaining the unique marketability of the product you have for sale.

Research is required to ensure requirements all along the production chain are maintained. For instance, there may be mandatory fruit fly control requirements across state borders, containers for export may require fumigation, and there may be food safety requirements to be met which have the potential to eliminate certain products from the organic market without alternative treatments or technologies in place.

There are technical and management means of dealing with these issues, but this entails direct involvement of the producer in the entire supply chain. Some excellent ventures have failed to reach market success due to some of these regulatory barriers. Rather than ignoring them, the savvy operator needs to seek them out, understand them and the people who maintain them.

Knowing and understanding the role that all regulators play in the supply chain is essential. For exporters, there are international as well as importer country regulations which may require extra documentation, testing or quality specifications which go beyond the requirements of the national standard.

A joint venture mentality is required between regulators, certifiers, inputs suppliers and transporters, to ensure that the chain of production – and hence marketing – is not jeopardised. The strength of this chain is always dictated by its weakest point. Knowing these weak points and working to ensure they are strengthened is essential to the successful marketing campaign.

For those not yet certified, selecting the right certifier may also be an essential aspect of marketing – which includes supply chain aspects (see Chapter 5). Some certifiers only allow for ‘organic’ to appear on labelling, even if the produce is in fact bio-dynamic. Others only allow ‘bio-dynamic’, while some allow both ‘organic’ and ‘bio-dynamic’ to appear on the label of a bio-dynamically produced good. It should be noted that while there is no domestic legislation in place for organic produce, all the major supermarkets and processors in this country demand that produce they source be only from certified operators – certified by AQIS.
Know thy market, know thy consumer

The market for organic produce is diverse, not only across sectors but also across regions of production and population. We trade involving all sorts of niches, local and direct, international, supermarket and large processors. Local markets or niche restaurant markets can be large depending on the approach taken.

The key aspect to any effective and sustainable marketing system must be based on demand rather than supply led principles. Ongoing research, possibly entailing direct buyer or consumer contact, is vital to remaining on the path of demand rather than supply led marketing.

Market intelligence can come from many sources. Most certifiers send out regular newsletters which contain market reports from wholesalers and their contact numbers. Visiting markets, speaking directly with buyers, regularly staying in touch with the end consumer – asking their views on the product you market – are all part of maintaining markets as they change and grow.

The internet is also an increasingly effective means of remaining informed. The Department of Primary Industries in Queensland has a site called Farmlink – where buyers and sellers can advertise their goods – across Australia and the world. Other web sites are available for the same purpose, while your certifier can assist in providing a list of all certified exporters, wholesalers and processors. Go to organic certification on the search engine to find some useful links.

The internet should not be underestimated as to its future potential power. The web is now available at local libraries or home computers, and it provides an up to the minute marketing tool. Many buyers for major processors and supermarkets increasingly prefer communication via email.

Market research is often carried out by government as well as private agencies. Staying in contact with your state’s department of agriculture, business development units and related service providers will keep you in contact with market intelligence regarding emerging markets as well as over-supplied markets.

Advertising is all about finding the right place. Many producers do not advertise simply due to the under-supply of produce. In the current environment of growth of market outlets for organic produce, there may be a need to consider advertising outlets which capture new potential buyers.

Co-operate to compete

Effective marketing increasingly is based upon the principles of co-operating to effectively compete. With changes to once regulated markets and in the face of stiffening competition both nationally and internationally, going it alone is often a high risk option for many producers. A quantum leap is often required for the opening of new markets. Such leaps in the ability to supply often require a collective approach to enable sufficient volume and consistency of supply. Lack of consistent supply is one of the key aspects holding back growth in organic markets for some sectors.

Such an approach is still foreign to many producers. But co-operative marketing, consortia or companies are proving their worth as new markets are being developed and maintained. Only other like co-operative ventures can usually compete with such market supply chains. Establishing such links can be costly and time consuming, requiring building of trust within and between producers and buyers, processors and retailers. Such co-operative development can also require start-up costs which often cannot be borne by a single operator.

In the existing organic market there is a significant degree of co-operation between wholesalers and their dedicated growers. There is direct communication and a support system to deal with product supply ebbs and flows. This style of wholesaling may be important – rather than constantly seeking the highest bidder for produce.
Worthwhile investment
Government assistance is available for some sectors and regions to establish co-operative networks. The benefits are that the producer maintains market intelligence, has access to more assured markets and maintains contact with the end consumer, and therefore the demand, by remaining within the co-operative supply chain.

Maintaining supply chains is about maintaining the production chain. Production chains are becoming longer and more complex as the food industry evolves. Such chains require open communication and trust between operators at both ends of the chain.

Sustaining an effective market for organic produce is often based on longer term commitment with investment in time, energy and finance. For those who continue to treat marketing as their own responsibility and as an ongoing commitment to their sustainable farming future, there are rewards and advantages not enjoyed by others who expect that a supply-led mentality will continue to get them by.

Marketing the organic product poses challenges mostly common to other specialised market niches. Knowing the exact nature of the industry, its regulatory requirements and the types of consumers now demanding organic produce will help steer a steady marketing course for the willing adventurer.

6.2 Adding value to organic produce
by Michael Burlace, Organic Advisor

Australian farmers have faced a situation of increasing costs and reduction in income since the 1950s.

Figure 6.2.1: The Passing Years

If farmers sell for less than it costs to grow produce, they subsidise the consumer. Even if the consumer meets visible costs, what about repairing acidity, salinity and erosion? There will be no sustainable farming until there is sustainable marketing.

According to figures from the Australian Bureau of Statistics, real farm income has barely risen since 1952. But costs have risen steadily and strongly except in 1991.
Niche markets
Once there was a bulk market. This is changing but there is some demand for bulk farm produce. Farmers can't make much from these bulk markets. The rest of the market is niches within niches.

The egg market used to be graded only on size but since deregulation, consumers choose from ordinary (cage) eggs, vegetarian eggs (fed no animal products), organic eggs, free-range eggs, 'heart safe' eggs (higher omega-3 fatty acids), brown eggs, barn eggs and so on. There is a mass egg market and many niches. Often cage eggs retail for less than the cost of production. Those farmers are at the wrong end of the graph.

Factors influencing what people buy today:
• Smaller families and more women working mean demand for small serves of convenience foods.
• More people diet and generally eat less.
• Convenience products (citrus, which peels easily, seedless grapes) are more attractive.
• Many people graze continuously instead of having three meals.
• People want value for money but many will pay extra for quality.
• Taste and texture sell organic tomatoes and other fruit.
• Many people eat in a healthy way to prevent heart and cancer problems.
• Some people have high incomes and high commitment to work, children, interests or friends.
  These cash-rich and time-poor people pay for convenience.

Why add value?
Most farm produce is almost valueless unless it has value added to it. Processed goods give greater flexibility in marketing and storing and adding value gives more chances to set price instead of being given it. By processing, the selling season and shelf life can be extended. Adding value can also make a product more attractive.

Organic farmers have four main ways to increase profit:
1) The produce is different (organic not ordinary) and can attract a premium.
2) The produce can be processed to increase the return significantly.
3) The cost of production is sometimes lower, therefore there is room for more profit above that cost.
4) Because the produce is different it can be sold more directly to the consumer.

Processing generally adds more value than the fact that the product is organic. An organic jam maker is not competing with conglomerates but in a niche. A conventional farmer trying to sell jam would find it difficult to establish a niche and may be up against big-name brands.

Selling direct to the customer can be more profitable, particularly if the other factors are working well.

Where the value goes
The consumer pays $100 and the farmer nets between $4 and $10 in many industries. There are many costs between farmer and consumer and a rise in price from farm to retail is the reality. But very little of the final price goes on raw materials. And even in a pure wool jumper there will be non-farm "raw materials", such as the label and the thread for assembling and embroidering the jumper. In a suit there are many raw materials including labour (see graph 2).
Figure 6.2.2: Percentage of retail dollar to each layer.

A $100 item of clothing typically returns $40 to the retailer, $30 to the manufacturer, $20 to the fabric maker and $10 for the raw materials. The farmer doesn't get all the $10. There will be buttons, sewing threads, transport and other items to come out of the $10. What is left may pay for shearing, breeding, pasture, fences, wool levies, commissions and so on.

The closer you get to the consumer, the bigger the slice you can get. There will be costs, mainly administrative and processing costs but these are generally more than covered by the returns. Closer means fewer people between you and the consumer, and that your price rises as each is removed from the chain.

The value of processing
Few commodities can be stored raw, but once processed may store for years. So processing gives more control of when to market. Flour, jam, wine and juices are more easily marketed and sales can be spread through the year.

Much of the increase in price for processed commodities compared with raw ingredients is from the processing and presentation. If this can be done for a reasonable cost, you're ahead. The ingredients are often the cheapest part.
Many ways to add value
There are more ways than processing to add value. By taking people on farm tours, for example, value can be added to the enterprise.

- Growing a super-sweet variety of corn or a rare variety of vegetables. Medicinal instead of kitchen herbs is another area;
- Providing greater convenience, by making ready-made salads or pre-cut vegetables for a busy cook. Add a dressing or sauce to increase the appeal and value;
- Increasing the value of your animals by using stud genes. Instead of a bull being worth hundreds of dollars as meat, it could be worth thousands as a breeding prospect. Obviously not all animals in a stud get that sort of money, but the average in a stud is higher than in almost any commercial mob. And you don't have to be a registered stud. If your animals are worth more because they are resistant to pest problems, you can get a higher price. Producing seed to be sown rather than seed that is eaten is similar to being a stud;
- Food which is low fat or suits people with diabetes or allergies can attract a premium;
- Finding different ways to pack can be worthwhile. Garlic in plaits gets a better price than garlic sold loose;
- Using people's nurturing tendencies can add appeal to products. People will often do more for a baby than they will for themselves and they may be prepared to buy organic lambskins, baby clothes, baby foods.

Investing in processing
Sensible investments in processing usually give a greater return on capital, labour and time than the same investment in farming. Setting up a processing plant can cost less than $50,000. That wouldn't buy much land or farm machinery. So value adding plant can mean a relatively small investment. Depending on what you process and what machinery you use, no labour may be required. Often there is no need for your own equipment, the work can be contracted out.

An example: Milling wheat into flour
Most organic producers who mill grain actually make more from milling than from farming. The following gives an idea of the returns from milling wheat. While the figures are approximations they are based on real farmers' real figures. It is based on high interest and conventional wheat prices of ($250/t for 13.5+% protein) and a normal organic premium (20% or $50/t).

A stone mill to handle 1t/day (365t a year) costs $10,000. Allow $30,000 to put it in a shed with a small cool room and meet health regulations. This gives a capital investment of $40,000.

This family enterprise mills 100t/year and sells to a wholesaler in 5 kg bags at $4.20 which is equivalent to $840/t. One of the two adults checks the mill once an hour so they and the other can do other work. So labour was not costed in. Because it is wholemeal flour, there are no losses, 1t in gives 1t out. If we subtract what the family could get for the unmilled wheat, $300/t ($250+50), this leaves an increased return of $540/t for the flour compared with wheat. So the family has increased the income by 100 tonnes times $540/t which is $54,000.

Running and power cost $150/t, bags cost $90/t to give a total of $240/t or $24,000. The interest cost (at 15% on $40,000) to establish the mill is $6,000 for the first year. Add them for a total cost for the first year of $30,000, not including the $40,000 setup or capital.

After one year and after repaying all capital and running costs, the family is $16,000 worse off than at the start. This includes paying interest on the setup costs, less the first year's return.
First year's milling returns

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased income</td>
<td>$54,000</td>
</tr>
<tr>
<td>Total capital investment</td>
<td>$40,000</td>
</tr>
<tr>
<td>Mill running costs</td>
<td>$24,000</td>
</tr>
<tr>
<td>Interest</td>
<td>$6,000</td>
</tr>
<tr>
<td>Total cost, including capital</td>
<td>$70,000</td>
</tr>
<tr>
<td>First year loss</td>
<td>$(16,000)</td>
</tr>
</tbody>
</table>

Second year's milling returns

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased income</td>
<td>$54,000</td>
</tr>
<tr>
<td>Mill running costs</td>
<td>$24,000</td>
</tr>
<tr>
<td>Net profit in second year</td>
<td>$30,000</td>
</tr>
<tr>
<td>Year 1 loss, plus $2,400 interest</td>
<td>$18,400</td>
</tr>
<tr>
<td>Profit after second year</td>
<td>$11,600</td>
</tr>
</tbody>
</table>

In the second year, the family pays $2400 interest on the loss from the first year. By the end of the second year the family has paid all capital and running costs and is $11,600 ahead overall.

After that there are no more interest bills, so each year the family has an increased income of $54,000 and running costs of $24,000, leaving them a $30,000 profit.

Third and following years' milling return

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased income</td>
<td>$54,000</td>
</tr>
<tr>
<td>Running costs, no interest any more</td>
<td>$24,000</td>
</tr>
<tr>
<td>Net each year after first two</td>
<td>$30,000</td>
</tr>
</tbody>
</table>

Even if the economics change a lot, this family will probably still have an excellent investment.
Adding value without big costs

- Renting facilities to freeze fruit to thaw later to make jams and sauces.
- Using home equipment to run trials to find out the potential.
- Contracting out all or part of the processing operation to avoid the need to invest in plant (for example a butcher cuts and packs your beef or lamb).
- Having food processing or marketing students do some work: developing recipes to meet organic standards and commercial needs, designing packaging, locating equipment, students can also help with promoting, researching markets and legal research.
- Renting a shop approved for food use.
- Buying industrial equipment second-hand.

Resources

- ABC rural radio and rural TV are excellent.
- Rural papers and magazines.
- Ask local agriculture department officer or consultant to connect you with specialists.
- Look at the value adding section of The Organic Exchange website: www.organicexchange.com.au

Why people don't add value

Most farmers just want to farm and so marketing, processing and such may not suit them. Most people don't like a negative response which happens with many sales calls. Many farmers don't believe they have access to the capital they would need and there is a risk of losing money just like in farming.
All in all, you need initiative and a lot of push to get through the maze of rules, market demands and processing needs, let alone the economics. But those who persist and get through can do very well.

6.3 Exporting organic and bio-dynamic products
by Australian Quarantine Inspection Service (AQIS)

The stimulus to introduce an export facilitation program in Australia was created by the increasing world demand for organic produce and the need to provide assurances about the integrity of the product.

Export demand
By 1990 Australia had achieved a niche market in the European Union for organic produce. While this market has continued to grow other markets have also opened up for organic produce. These include Switzerland, Japan, the United States, Singapore, and Hong Kong. In was estimated in 1996, that the organic sector in Australia was $90 million, with exports adding an additional $30 million. The current estimated total value of organic produce is more than $200 million.

As most people would be aware, the Australian Quarantine and Inspection Service (AQIS) regulates the majority of agricultural produce and food commodity exports from Australia. In addition, AQIS also regulates the export of organic produce to ensure that it conforms to the National Standard for Organic and Bio-dynamic Produce (national standard). The national standard defines the minimum requirements for the preparation, production, transportation and labeling of organic produce.

Governing the certifying agencies
Apart from the national standard, approved certifying organisations must be able to demonstrate an awareness of both the Export Control (Organic Produce Certification) Orders 1997 and importing country requirements. This ensures that all consignments exported from Australia comply with relevant importing country requirements.

AQIS achieves this co-regulatory approach by auditing approved certifying organisations and selected certified members annually. In addition to this auditing process, approved certifying organisations will regularly inspect their certified members to determine their compliance in relation to the relevant standards for organic produce.

Once approved by AQIS, approved certifying organisations can provide government-to-government certification (Organic Produce Certificate) for all export consignments of organic produce. Exporters of organic produce must obtain an Organic Produce Certificate from an approved certifying organisation before the export of any agricultural product or food commodity which has on its label, or in its merchandise that it is organic, bio-dynamic, biological, ecological or any similar word.

AQIS supports the organic certification program by randomly checking consignments to determine their compliance to export legislation and importing country authority requirements.

Further information relating to the export of organic produce can be obtained by contacting the Manager AQIS Food Programs ph: (02) 6272 4783, fax (02) 6272 3682, e-mail organic@aqis.gov.au or please visit the AQIS Organic Home Page at http://www.aqis.gov.au/docs/approg/orgfront.htm
7. Economics

7.1 Economics stack up for organic farming
by Dr. Els Wynen, Eco Landuse Systems.

Evidence available from several studies implies that organic cereal-livestock farming can be financially as rewarding as conventional farming, both for individual farmers and for the sector as a whole.

This would be the case even if a considerable number of farmers move towards that type of agriculture, although the situation may be less positive during the conversion period. Individual farmers contemplating converting to organic methods would need to consider the sustainability of their current systems, their ability to withstand possible diminished returns in the conversion period and their preference to farm in a way that requires more attention to rotations and a greater use of livestock.

Organic farmers are also more likely to be involved in the marketing of their products. While these methods won't suit everyone, there is mounting evidence that more and more farmers find a switch to organic methods worth contemplating.

Established organic agriculture
The only comprehensive survey of the financial and physical characteristics of broadacre organic farmers was undertaken in 1985-86. Although dated, the results nonetheless provide useful insights into the differences between organic and conventional cereal-livestock farming in Australia.

A survey of 13 organic farmers, located in the five mainland south-eastern states was undertaken. Of those, eight were 'fully organic', and five 'semi-organic'. All had farmed under the new management methods for at least five years. The results of the study presented here are mainly those of the eight 'fully' organic farmers. The exception is the data on farmers' opinions, for which all 13 farmers are included.

Why organic farming
Given the low numbers of organic farmers, the question can be asked why farmers use that kind of management anyway. About three quarters of the answers given by cereal-livestock farmers in the survey related to issues of health (farmer, the farming family, soil, crops and livestock) and off-farm environmental problems.

Of the rest, the largest part of the answers indicated a preference for that lifestyle (13 %). A decrease in input prices and increase in output prices was mentioned in only 8% and 3% of the answers, respectively. A total of 5% indicated conventional farming system was not working. In short, the most important reasons for conventional farmers to move towards organic broadacre farming were problems they experienced while applying conventional farm management methods. Overseas studies showed similar reasons for conversion.

Comparisons
In comparing different production processes, it is often tempting to conclude that any apparent difference in success may be due to more favourable climate, soils or perhaps managerial ability in one group or another. To minimise the effect of these factors the organic farmers were each compared with one neighbour who also was a broadacre cereal grower. To find an appropriate comparison, local agriculture department officers were asked to nominate a conventional farmer who, in their opinion, was at least as good a manager as the organic farmer. Other factors had to be similar, such as soil type, local climate, and farm size.
Because the management skill of farmers is a major influence on farm profitability, it is important, when comparing farm profitability, to find farmers with similar management skills. In the survey, every pair of farmers was asked to grade themselves and their neighbour as managers. Of the group of organic farmers, two of the 10 respondents thought that they were better managers than their neighbour, six that they were similar, and two that they were worse managers.

Of the 11 conventional farmers, six considered themselves better managers than their neighbour, and five similar to their neighbours. None thought they were worse. In other words, more conventional farmers thought that they were better than, or similar to, their organic neighbours in management skills than the other way round. For most pairs of farmers the grading was similar. The exception was two pairs, where both farmers thought that the conventional farmer was a considerably better manager.

**Input costs**

For years conventional farmers have talked about the cost-price squeeze, with rising input costs and stagnant or falling output prices. Such talk is more likely to be heard in times of high inflation. In such times farmers’ attention is more directed towards methods to avoid these trends. It is tempting to look at a system where less inputs are needed and premium prices exist, as is generally believed to be the case in organic agriculture.

From the survey it is clear that input costs on Australian cereal-livestock farms are, on average, indeed lower than on conventional farms. The first column in Table 1 shows the costs on organic farms, the second those on conventional farms, and the third and fourth show the difference between the two, in dollars per hectare and percentage respectively. The fifth column tells us whether that difference is 'statistically significant'.

If the measure is significantly different (indicated by one or more asterisks we can be confident that, if we were to survey all organic farmers we would come up with the same result. If there is no statistical difference (indicated by 'n.s.') then we can't be sure that the difference found in this sample is caused by a difference in farm system.

In Table 7.1.1 input costs are shown both for area cropped and for area operated. The reason for showing both these measures is that the costs per hectare cropped show how the management of soil fertility and pest problems compare under each management system. But that does not provide an overall picture of the returns of the total farm. Some costs, such as interest and labour, are difficult to apportion to parts of the farm, and are shown only on the basis of the total farm.
Table 7.1.1: Input use on organic and conventional farms in south-eastern Australia

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Per hectare cropped</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilisers</td>
<td>9</td>
<td>27</td>
<td>-18</td>
<td>33</td>
<td>**</td>
</tr>
<tr>
<td>Pesticies</td>
<td>1</td>
<td>18</td>
<td>-17</td>
<td>1</td>
<td>***</td>
</tr>
<tr>
<td>Fuel</td>
<td>35</td>
<td>33</td>
<td>2</td>
<td>107</td>
<td>n.s</td>
</tr>
<tr>
<td>Machinery</td>
<td>89</td>
<td>101</td>
<td>-12</td>
<td>88</td>
<td>n.s</td>
</tr>
<tr>
<td>Per hectare operated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilisers</td>
<td>3</td>
<td>19</td>
<td>-16</td>
<td>16</td>
<td>**</td>
</tr>
<tr>
<td>Pesticies</td>
<td>0</td>
<td>14</td>
<td>-14</td>
<td>0</td>
<td>***</td>
</tr>
<tr>
<td>Interest</td>
<td>5</td>
<td>16</td>
<td>-11</td>
<td>31</td>
<td>n.s.</td>
</tr>
<tr>
<td>Fuel</td>
<td>12</td>
<td>21</td>
<td>-10</td>
<td>57</td>
<td>**</td>
</tr>
<tr>
<td>Mach. &amp; Equipment</td>
<td>3</td>
<td>74</td>
<td>-42</td>
<td>42</td>
<td>*</td>
</tr>
<tr>
<td>Labor</td>
<td>35</td>
<td>41</td>
<td>-6</td>
<td>85</td>
<td>n.s</td>
</tr>
</tbody>
</table>

Note: statistically significant difference calculated with the paired Wilcoxon test:
- n.s. = not significant at 90 % confidence level
- *** = significant at 99 % confidence level
- ** = significant at 95 % confidence level
- * = significant at 90 % confidence level

The two measures give a different picture. Taking area cropped, only the expenditure on use in nutrients (including materials allowed under organic management such as rock phosphate) and pesticides are significantly lower on organic farms than on conventional farms. But per hectare operated, all costs are lower on organic farms with the exception of interest and labour costs. Note that, although labour costs is often thought to be relatively high on organic farms, this survey shows that, in the cereal-livestock sector in Australia at least, that is not the case.

In an Australian study in 1995, Hassall and Associates (HA) reported that 70% of the 50 responses to their survey of farmers classified as ‘grain/cereal’ farmers, mentioned that they estimated their input costs to be lower than on conventional farms. One quarter of this group reported higher labour costs, and 10% lower costs, with two-thirds similar costs.

The difference in costs per hectare cropped in nutrient and pest management (here taken as including all forms of pests, such as insects, weeds, fungi, etc.) between the system will not surprise anybody.

Part of the way in which organic farmers cope with soil fertility and pests is by trying to avoid problems in the first place, through a shift in management. For example, where conventional farmers use herbicides, organic farmers may rotate their crops, or use livestock in smaller paddocks. This may affect requirements for capital goods, such as machinery and equipment. Where under conventional management the emphasis is on growing the most profitable crop as much as possible, a shift in rotations under organic management to avoid fertility and pest problems means inclusion of less profitable enterprises. This affects the mix of total production on the farm, and leads to lower returns to farming. So in a sense, the decrease in some of the farm costs on organic farms is offset by a decrease in returns.

Another aspect of input costs on organic farms is the price per unit of input. In general, prices per unit of input in organic and conventional farming can differ greatly.

Those inputs which are not used by most conventional farmers, for example rock phosphate, may well cost more per tonne than super phosphate. The higher costs are partly due to the low total volume
used in a particular area, which means that economies of scale in the production and marketing don't apply. For example, transport of the input may be much more costly if backloading of the one truck with the input is difficult to find. Of course, if and when more farmers use this input, opportunities for cost saving, for example through sharing transport costs, occur.

This picture of lower input costs on organic farms also emerges overseas. In a publication in which economic studies on organic farming from all over the world were combined, variable input costs are reported to be typically 50-60% lower on organic farms with cereals and grain legumes. Fixed costs (depreciation and fixed labour) on organic farms were generally similar to those on conventional farms, with the exception of some studies from the United States. In a more recent study in Denmark, input costs on 38 dairy farms (with extensive cash cropping) were found to be 17% lower than on average conventional farms.

**Yield comparison**

It is often assumed that yields (production per hectare) suffer under organic management as compared with conventional farming. But the Australian survey did not show any difference in wheat yields on organic and conventional farms in 1985-86, where they were on average 2.4 t/ha and 2.5 t/ha on organic and conventional farms respectively.

Overseas, the relative yields when farms changed to organic practices where found to directly relate to the intensity of the conventional farming system. Switching from the intensive conventional systems of Europe would lead to greater losses than in countries such as Canada, the United States and Australia, were agriculture is less intensive. Furthermore, relative yields were not the same for all crops. For example, differences in wheat yields were greater than in yields for crops such as oats and field beans.

In Australia in particular, where droughts or dry conditions are not uncommon, yield variability between years is of interest to farmers. In the survey, many of the organic farmers mentioned that in dry years, their crop seemed to suffer less from lack of water than their neighbours'. Tests carried out on the limited data available suggest that yields indeed tended to decrease less on organic farms than on conventional farms in years with dry weather conditions.

In wet years (such as in 1992-93) this trend may well be reversed, as nutrient availability may then become the limiting factor on organic farms. This was not necessarily the pattern overseas, where droughts are less common.

**Output prices**

Many people think that organic produce always fetches a premium. But, in 1995, almost 25% of organic farmers interviewed who sold grain, mentioned that they did not receive any premium for their products at all. Less than half mentioned a premium of 10 - 20%, and just under one third mentioned a premium of between 20 - 50%.

Marketing products as organic does incur costs. In order to be allowed to sell the produce as 'certified organic', a farmer has to pay for the cost of inspection of the farm and certification. Inspection cost of up to $600 and a cost of 1% of the gross income of organic produce, is typical.

In addition, marketing of organic produce might be more costly as no established markets might be available. Just over one third of respondents to the HA questionnaire reported higher marketing costs as compared with conventional farms. Some (7%) mentioned lower costs, while almost 60% reported no change in costs.
Returns to farming

The measures of returns to farming are different for the two management systems (see Table 2). Organic farms could not be shown to be any more or less profitable than conventional farms in terms of cash returns. Only the total cash cost can be shown to be statistically lower on organic farms.

But cash measures do not show where the farm is headed over time. A better measure is 'returns to capital and management', which includes depreciation costs and family labour. At $37 per hectare operated (3.0 % of capital) for organic farms and $21 (1.2 %) for conventional farms, no significant difference could be shown. In other words net returns to farming could not be shown to differ between the two systems.

Table 7.2.2: Financial aspects of organic and conventional farms in south-eastern Australia ($ per hectare operated), 1985-86

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash Returns and Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cash Receipts</td>
<td>181</td>
<td>262</td>
<td>-81</td>
<td>n.s.</td>
</tr>
<tr>
<td>Total Cash Costs</td>
<td>76</td>
<td>128</td>
<td>-52</td>
<td>**</td>
</tr>
<tr>
<td>Farm Cash</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Surplus</td>
<td>105</td>
<td>134</td>
<td>-28</td>
<td>n.s.</td>
</tr>
<tr>
<td>Returns to Capital and Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ per ha operated</td>
<td>37</td>
<td>21</td>
<td>16</td>
<td>n.s.</td>
</tr>
<tr>
<td>% of cap. Invested</td>
<td>3.0</td>
<td>1.2</td>
<td>1.7</td>
<td>n.s.</td>
</tr>
<tr>
<td>Adjusted Returns to Capital and Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ per ha operated</td>
<td>42</td>
<td>37</td>
<td>5</td>
<td>n.s.</td>
</tr>
<tr>
<td>% of cap. Invested</td>
<td>3.4</td>
<td>2.2</td>
<td>1.2</td>
<td>n.s.</td>
</tr>
<tr>
<td>Adjusted Return to Capital and Management Assuming Conventional Wheat Prices</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ per ha operated</td>
<td>31</td>
<td>35</td>
<td>-4</td>
<td>n.s.</td>
</tr>
<tr>
<td>% of cap. Invested</td>
<td>2.5</td>
<td>2.2</td>
<td>0.3</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Note: statistically significant difference calculated with the paired Wilcoxon test:

n.s. = not significant at 90 % confidence level

*** = significant at 99 % confidence level

** = significant at 95 % confidence level

* = significant at 90 % confidence level

The return to capital and management, as reported above, includes interest costs and rent for the farm. In order to be able to compare the financial aspects of farming itself, the cost of interest and rent should be deducted from the total cost of farming, which gives the 'adjusted' returns. Also those figures ($42 for organic and $37 for conventional) showed no difference between the groups of organic and conventional farmers. Whichever way we looked at it, we are not able to conclude that there is a difference between the two systems in terms of profitability.

Changing relative conventional prices

The production mix on organic farms is often different from that on conventional farms. The relative profitability of organic and conventional is therefore influenced by relative crop and livestock prices. For example, when grain prices increase relative to livestock prices as they have done in the 1990s, organic farming will become less profitable as compared with conventional farming as studied in the survey.
Changing relative prices will, of course, also change the enterprise mix on farms over the longer term, as witnessed more recently when crop prices increased with low livestock and livestock product prices. This rotation change is true for both farm types, although organic farms may be somewhat more limited in their ability to change by their need to prevent pests through this tool.

**The cost of conversion**

Even if established organic farmers have similar returns to conventional farmers, that does not necessarily mean that it is easy to get to that stage. There are quite a number of hurdles to overcome. Work defining the transition period and its impact on cereal-livestock farming in Australia was done in the early 1990s.

Costs identified as conversion costs can include:

- Gathering information about aspects of production and marketing:
  - It may take some time before micro-organisms in the soil essential for organic management are established. For example, fungi which break down straw may not be present in the first years after conversion, causing the farmer problems with planting and germination of seed. This may also be part of the cause of yield reductions in early years. In the survey mentioned above, four of the 10 farmers did not notice a difference in yield levels in the early years, compared with what they would have expected under conventional management. Three farmers thought the yield levels had increased, and three believed they had decreased. In the 1995 HA study, two thirds of farmers in the category of 'seed, grain and livestock' reported decreases in yields in the early years (for an average of five years), and one quarter mentioned an increase (for three years, on average).
- Increased capital outlay could include fencing material, for subdividing large paddocks, separate farm storage space for organic produce and additional livestock.
- Generally, a farmer in the first two years of organic management can only be certified as being in conversion. This means that premiums are less certain.

The above-mentioned factors affect returns to farming. In Australia, this has been estimated for a 400 hectare cereal-livestock farm in the Tatiara area in South Australia. The study was based on assumptions regarding the actual changes in area farmed including crops grown; yields; use of fertilisers, pesticides, machinery and labour.

In the example, with input and output prices (no premiums) for 1990-91, decreases in gross returns to farming reached a maximum of $15,000 in year two and went down over the years to $6000 in year 12. With premiums for organic products, the losses were much lower. A maximum loss in the second year at $12,000, was changed into a profit after the fourth year. This reached a maximum in year 12 of $7400. But the results are totally dependent on the assumptions for the particular farm. As all farms are different, farm specific estimates are required if guidance is needed.

Respondents to the HA survey (1995) in the 'seed, grains and cereals' group were divided on the issue of how their annual income changed. Just over half said it decreased and the rest mentioned an increase during the conversion process.
7.2 Trial shows concerns at bottom line
by Chris Penfold, University of Adelaide

Organic and bio-dynamic farming in Australia has achieved an ever increasing level of awareness and acceptance by producers over the last decade.

Some of the main reasons for the adoption of organic farming practices are the detrimental affects of synthetic chemicals, declining soil fertility, changing consumer sentiment and the general decline in terms of trade for agricultural production.

But research during the 1980’s did not keep pace with the level of interest in alternative farming practices. A dearth of knowledge was evident with regard to soil fertility and weed management, the economic viability and the ecological sustainability of organic farming.

The Roseworthy Trial
To help address this issue, the long-term Biological Farming Systems Comparative Trial was established at the University of Adelaide’s Roseworthy Campus in 1989 to compare the sustainability of organic, bio-dynamic, integrated and conventional farming systems.

The trial compliments other long -term programs established in the United States. In Australia, trials investigating broadacre organic farming practices have also been established at Morowa, Western Australia and the Rutherglen Research Institute, Victoria.

In the Roseworthy trial, only inputs allowed by the National Association for Sustainable Agriculture Australia (NASAA) and the Biological Farmers of Australia (BFA) were used on the organic and bio-dynamic sites. On the integrated site, a combination of minimum tillage/direct drilling was carried out with municipal sludge used as the principal fertiliser.

Synthetic pesticides were used for weed, insect and disease control, but absolute control was not essential. The conventional site used ‘best practice’ minimum tillage/direct drilling, synthetic fertilisers and pesticides as required and rotations which included a pasture phase when necessary to control herbicide resistant weeds.

Trial results
Under the conditions imposed in this trial, it was found that organic and bio-dynamic farming produced sustainable productivity at a lower level of output and lower financial reward than the integrated and conventional systems.

Soil fertility
Soil fertility declined on both the bio-dynamic and organic sites. On the bio-dynamic treatment both nitrogen and phosphorus declined. Phosphorus levels were maintained under the organic regime but nitrogen declined.

The non-conventional fertilizers are expensive sources of both nitrogen and phosphorus which made farmers reluctant to apply them at replacement rates or higher.

Ideally, organic farming requires a ready source of composted manure to supply nutrients as required by todays farming systems. The use of rock phosphate, as required by the certification standards, is of limited use, particularly in alkaline soils. The availability of phosphorus is a major limitation to organic farming productivity in southern Australia.
**Weed control**

Weed control was the major constraint to production on the organic and bio-dynamic treatments. The trial inherited a large seed (ryegrass, wild oats, three cornered jack, (capeweed) and bulb (soursob) bank which created problems on all treatments.

Through minimal, well-timed tillage, delayed sowing, hay production and high seeding rates, most weeds were contained at acceptable levels except soursob.

Seeding was delayed to gain some suppression of the weed, resulting in significant yield reductions.

Two major complimentary trials investigating non-chemical alternatives for weed management were carried out over the past five years of the trial. The capacity for sheep to selectively graze weeds from within crops was apparent as lupins, faba beans, coriander, chick pea and mustard were all shown to be unpalatable.

Commercial weeders were also investigated for their capacity to control weeds in emerged crops. Finger tine weeders were more aggressive than rotary hoe weeders, removing harder to kill weeds but also causing more crop damage.

Given ideal conditions, which entail a dry soil surface, minimal surface residue and a crop considerably more advanced and therefore better anchored than the newly emerging weeds, the finger tine weeder performed very well. Such conditions occur only rarely, making these implements more an option for summer rainfall districts.

**Financial returns**

Financial returns, as measured through long term gross margins analysis, were an important measure of the systems sustainability. A major impediment to the productivity and financial viability of the alternative systems was the low economic returns available to sheep grazing pastures over the period of the trial.

Pastures therefore were only used in the early stages of the trial. If, through improved wool prices, pastures could have become a major component of the rotation mix, it would have been possible to sustain grain production levels experienced at the start of the trial. This would have only been possible if soursob had been removed before the initiation of the trial. By using pastures, weeds would have been more readily managed and soil nutrition would have been maintained through the use of rock phosphate and biologically fixed nitrogen.

Other important findings were:

- Ryegrass on the conventional and integrated treatments was resistant to ‘fop’ and ‘dim’ group herbicides after four years, but this was overcome with a change in herbicide group.
- Root colonization by the mycorrhizal fungus was considerably less on medic plants grown in soil from the conventional treatment than the organic, bio-dynamic and integrated treatments when measured in 1996. This phenomena is not unexpected, because mycorrhizal infection levels are negatively influenced by increasing levels of soil phosphorus. The conventional treatment had 125 per cent more available phosphorus than the bio-dynamic treatment.
- The loss in tensile strength of burial cloth was one tool used to measure microbial activity. The integrated treatment measured less decomposition, indicating less activity.
- The total microbial biomass is another indicator of soil health. This was shown to increase on the organic treatment with the opening rains in the year following a green manure crop. The integrated treatment had considerably less microbial carbon throughout the 1996 growing season, possibly caused by poorer soil structure.
- The organic, bio-dynamic and conventional systems had more water stable soil aggregates than the integrated system.
• Earthworm populations showed a trend to increase over the period of the trial on the integrated treatment.

This research trial has shown the main difference in sustainability was the increased productivity and profitability of the conventional system compared to the organic. But the experience gained has provided insight into improving organic systems. Ley periods are essential in organic farming systems, for both weed control and nitrogen fixation. But while the premiums for organically produced meat and wool remain elusive, pastures can be a financial liability.

To overcome this, it is suggested that green manures could take a much larger role in the rotation. Where possible, a lucerne phase would be included in the rotation to improve the water use of the whole farming system

Nutrient supply, particularly phosphorous, remains a concern for organic farming. The potential of microbial activators now commercially available, to assist in increasing the availability of soil bound phosphorus should be investigated.

Organic farming will never be adopted in Australia to the degree that is occurring overseas. There is however considerable demand in Europe and Asia for organic grains, which is presently undersupplied.

Concurrently, there are many farmers who still prefer to farm in a low input approach, who like stock within their operation and who require additional information to improve their farming system. Research into low input - organic farming systems should be expanded to cater for this substantial sector of the levy paying farmer population.

**Recommendations**

While this research has shown that lower production levels and economic returns are to be obtained from organic systems, it does not preclude organic farming as a legitimate farming system. There will always be a small proportion of farmers who will prefer to operate without or with reduced amounts of synthetic chemicals and fertilizers. These should be supported by research and development in a proportionate amount to their high input neighbours.

The global market for organic foods is currently expanding at 25% per year, providing premiums for certified product. Product quality is an issue in both organic and conventional systems and the best pasta assessed in South Australia in 1997 came from a conventional farmer who incorporates green manures into his cropping system.

A concern arising from this trial is the adverse impacts on soil structure and microbial activity evident on the integrated treatment. The reason for this has not yet been determined, but the use of sewage sludge even at low rates is a possibility. With the use of this product now being advocated at application rates up to 600% higher than used on this trial, possible deleterious effects of the product should be properly investigated.

**Industry implications**

Importantly, this trial has shown well-managed conventional farming systems appear to have no deleterious impact on the soil and have higher productivity and profitability than alternative organic and bio-dynamic systems. But this analysis does not include the health risk to farmers associated with the use of farm chemicals, off-site effects of spray drift or solute pollution of waterways that may occur.
The research supports the need for pasture or green manure leys to sustain low input farming systems. Increased profitability from the livestock industries will greatly assist the farmers in this category.

7.3 Conversion process under the spotlight
by Viv Burnett, Natural Resources and Environment

Since 1994 a broadacre demonstration site at the Rutherglen Research Institute has been farmed according to organic standards. The primary aims of the site have been to show farmers how organic principles can be incorporated into farming practice, and to monitor the production of both crop, pasture and wool from the 9ha site.

The site is jointly managed by producers, researchers and industry representatives and has been featured at Rutherglen Field Days, the most recent in 1999 when over 150 producers inspected the pasture and cereal plots.

Site Management
The demonstration site has operated with a rotation of a cereal crop, followed by annual pasture, then a green manure consisting of Balansa clover before the next cereal crop. This rotation which ran from 1994-1997 provided for a cropping intensity of 30% or one crop every three years. Since 1998 the rotation has changed to incorporate a perennial pasture in one section (Table 7.3.1).

Soil fertility has been maintained through the addition of green manures either as Balansa clover or as annual pasture consisting of ryegrass and subterranean clover. Organic fertiliser was either top-dressed onto pasture or sown with the cereal crop. Cereal crops have been established using higher seeding rates to compete with weed growth.

Crop stubbles were mulched to aid decomposition and an average stocking rate of 23 DSE/ha was used. Weed management has included cultivation before cropping to kill weed growth along with grazing and slashing in the pasture phase to prevent weed seed set.

Table 7.3.1: Rotation at organic Rutherglen site 1994 - 1999

<table>
<thead>
<tr>
<th>Year</th>
<th>Block A</th>
<th>Block B</th>
<th>Block C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>Annual pasture</td>
<td>Balansa clover (GM)</td>
<td>Wheat</td>
</tr>
<tr>
<td>1995</td>
<td>Annual pasture</td>
<td>Balansa clover (GM)</td>
<td>Wheat</td>
</tr>
<tr>
<td>1996</td>
<td>Balansa clover (GM)</td>
<td>Wheat</td>
<td>Annual pasture</td>
</tr>
<tr>
<td>1997</td>
<td>Wheat</td>
<td>Annual pasture</td>
<td>Balansa clover (GM)</td>
</tr>
<tr>
<td>1998</td>
<td>Perennial pasture</td>
<td>Oats</td>
<td>Triticale</td>
</tr>
<tr>
<td>1999</td>
<td>Perennial pasture</td>
<td>Wheat, Oats, Barley</td>
<td>Annual pasture (GM)</td>
</tr>
</tbody>
</table>

Results
After six years of organic crop and pasture management the results from this site are not conclusive. The soil at the site is generally acidic with low organic matter levels, although there is a trend that suggests organic matter is increasing with organic management (Table 7.3.2). There is some evidence to suggest that soil phosphorus is being distributed more evenly through the top 20cm of the soil profile and is not declining under organic management despite the reduced input of soluble phosphorus (Table 7.3.2).

It has been shown that average cereal yields can be achieved with pre-sowing cultivation and higher seeding rates. In 1999, when a direct drilling regime was used to establish the crop, yields were shown to decline even with higher seeding rates (Table 7.3.3).
A better than average stocking rate has been maintained on the site with an average of 23 DSE/ha. Wool weights have also been maintained at conventional levels (Table 7.3.4). The number of earthworms has been higher in the pasture and green manure phases than in the cropping phases of the rotation (Table 7.3.5).

Table 7.3.2: Soil chemical data for organic 1995 - 1999.

<table>
<thead>
<tr>
<th>Analysis</th>
<th>pH (CaCl₂)</th>
<th>Avail. P (ppm)</th>
<th>Organic Matter (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block</td>
<td>Depth (cm)</td>
<td>5 8 9 5 8 9*</td>
<td>5 8 9*</td>
</tr>
<tr>
<td>A</td>
<td>0-10</td>
<td>4.5 4.7 4.4 14.4 11.0 15.7</td>
<td>2.0 3.6 3.2</td>
</tr>
<tr>
<td></td>
<td>10-20</td>
<td>4.1 4.5 4.0 4.0 7.0 13.0</td>
<td>1.6 2.0 2.3</td>
</tr>
<tr>
<td>B</td>
<td>0-10</td>
<td>4.4 5.0 4.2 14.4 11.0 15.8</td>
<td>1.5 4.5 3.5</td>
</tr>
<tr>
<td></td>
<td>10-20</td>
<td>4.2 4.3 4.2 4.8 11.2 11.6</td>
<td>0.6 3.0 2.6</td>
</tr>
<tr>
<td>C</td>
<td>0-10</td>
<td>4.4 4.6 4.1 10.4 11.7 16.8</td>
<td>3.4 3.9 3.5</td>
</tr>
<tr>
<td></td>
<td>10-20</td>
<td>4.2 4.2 3.8 1.0 10.6 11.0</td>
<td>1.4 3.3 1.8</td>
</tr>
</tbody>
</table>

* A = Pasture 95, Balansa 96, Wheat 97, Per.pasture 98
B = Balansa 95, Wheat 96, Pasture 97, Oats 98
C = Wheat 95, Pasture 96, Balansa 97, Triticale 98
*1999 Soil testing – post autumn break

Table 7.3.3: Grain production from the cereal phase of the rotation, 1995 - 1999.

<table>
<thead>
<tr>
<th>Year</th>
<th>Paddock</th>
<th>Crop</th>
<th>Yield (t/ha)</th>
<th>Sowing Rate (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>Block A</td>
<td>Wheat Katunga</td>
<td>5.3a</td>
<td>100</td>
</tr>
<tr>
<td>1996</td>
<td>Block B</td>
<td>Wheat Katunga</td>
<td>1.2</td>
<td>150</td>
</tr>
<tr>
<td>1997</td>
<td>Block C</td>
<td>Wheat Dollarbird</td>
<td>3.4</td>
<td>175</td>
</tr>
<tr>
<td>1998</td>
<td>Block C</td>
<td>Triticale Maiden</td>
<td>0.3b</td>
<td>170</td>
</tr>
<tr>
<td>1999</td>
<td>Block B</td>
<td>Oats Quoll</td>
<td>1.3</td>
<td>85</td>
</tr>
<tr>
<td>1999</td>
<td>Block B</td>
<td>Oats Quoll</td>
<td>2.1</td>
<td>170</td>
</tr>
<tr>
<td>1999</td>
<td>Block B</td>
<td>Barley Picola</td>
<td>1.0</td>
<td>85</td>
</tr>
<tr>
<td>1999</td>
<td>Block B</td>
<td>Barley Picola</td>
<td>1.4</td>
<td>170</td>
</tr>
<tr>
<td>1999</td>
<td>Block B</td>
<td>Wheat Rosella</td>
<td>0.5</td>
<td>85</td>
</tr>
<tr>
<td>1999</td>
<td>Block B</td>
<td>Wheat Rosella</td>
<td>1.1</td>
<td>170</td>
</tr>
<tr>
<td>1999</td>
<td>Block B</td>
<td>Wheat Silverstar</td>
<td>0.6c</td>
<td>85</td>
</tr>
<tr>
<td>1999</td>
<td>Block B</td>
<td>Wheat Silverstar</td>
<td>0.7c</td>
<td>170</td>
</tr>
</tbody>
</table>

a harvested as hay due to high ryegrass infestation (144 roles @110 kg/roll).
b severely affected by frost.
c affected by frost

Table 7.3.4: Wool weights and stocking rates
Table 7.3.5: Earthworm numbers 1995 - 1999.

<table>
<thead>
<tr>
<th>Year</th>
<th>Block</th>
<th>Rotation Sequence</th>
<th>Earthworm Nos. (#/m²)</th>
<th>Earthworm Mass (fresh) (g/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>A</td>
<td>Annual pasture</td>
<td>29</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Green manure</td>
<td>26</td>
<td>12.7</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Cereal crop</td>
<td>25</td>
<td>12.3</td>
</tr>
<tr>
<td>1996</td>
<td>A</td>
<td>Green manure</td>
<td>200</td>
<td>44.0</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>Cereal crop</td>
<td>19</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>Annual pasture</td>
<td>52</td>
<td>18.2</td>
</tr>
<tr>
<td>1999</td>
<td>A</td>
<td>Perennial pasture</td>
<td>86</td>
<td>16.0</td>
</tr>
</tbody>
</table>

What it all means
The conversion phase has demonstrated both positive results and highlighted some of the difficulties that producers may encounter in organic conversion.

The positive results from this site have been the sustainable production of wool with fleece yields being maintained at conventional production levels. Production of cereal grain has been achieved in three years of the six (1996, 1997, 1999). One year was lost to drought (1994) and the 1998 crop was lost to frost damage. In 1995 the crop was cut for hay.

The cereal yield results achieved from the site demonstrate that the method of crop establishment can be critical to achieving reasonable yields.

Where pre-sowing cultivation was used and there were not any other extenuating factors, for example, frost or drought, average wheat yields were obtained (1996, 1997).

In 1999, when a direct drilling regime was implemented, cereal yields were below average due to excessive weed competition (Table 7.3.3). These results suggest that management of weed populations should commence at least one year before cropping. The process should include higher seeding rates and cultivars that have early vigour so that the crop has a competitive advantage over the weeds.

The soil results from the site suggest that phosphorus may be becoming more evenly distributed through the soil profile (Table 7.3.2). There could be two reasons for this observation. The practice of green manuring on the site can work to incorporate organic matter through the top 20cm of soil and this could result in the presence of available phosphorus throughout the surface 20cm. In addition, there is some evidence to suggest that the population of earthworms is increasing generally over the site (Table 5). The incorporation of organic matter and nutrient cycling effect of earthworm activity may contribute to this result.

A significant problem at the site has been the existence of large populations of redlegged earth mite. Redlegged earth mite can extensively damage emerging pasture species such as subterranean clover or oilseeds such as canola.

Organic management of earth mite must address the issue of mite population and this directly relates to food source and habitat. Green manuring in the spring can reduce earth mite habitat and the food
source for the mites can be affected by growing unpalatable species like lupins or chickpeas. Increasing seeding rates of susceptible species also reduces the amount of damage caused by earth mites.

Farming organically is not just about stopping the use of synthetic pesticides and fertilisers and starting to use organic replacements. It involves a much deeper appreciation by the land manager of the way plant, animal and soil systems are inter-related and how change in one area can affect other systems.

The organic conversion phase is a learning phase for producers and seeking out knowledge from practising organic farmers and combining this with regular and close observation of soils, plants and animals, should provide a sound basis for farming within organic systems.

**Figure 7.3.1:** Organic Steering Committee at AV Rutherglen (2/7/99), from left, Brian Nugent (Vicmill), John Docker, Nick Taylor, Tony Reeckman and Viv Burnett.

**Figure 7.3.2:** Early emergence of wheat (Rosella) sown by direct drilling at the Organic Demonstration Site at AV Rutherglen (8/6/99).
Figure 7.3.3: Rutherglen Field Day
(8/9/99) with Viv Burnett speaking to a group of interested producers at the Demonstration Site.

Figure 7.3.4: Spreading worm casts (3/6/99) on perennial pasture block
at the Organic Demonstration Site at AV Rutherglen
8. Appendices
8.1 Wholesalers and Retailers of Organic Produce

**Australia**

Website: www.GoOrganic.com.au

**The Green Line** – Information, Marketing, Online Ordering and Home Delivery
Bio-Dynamic and Organic
Rosemary Long
PO Box 1010
HARTWELL  VIC  3125
Ph: (03) 9889 2299
Fax: (03) 9889 1399
Email: rlong@thegreenline.com.au
Website: www.thegreenline.com.au

**New South Wales/ ACT**

**Eco Farms**
Nick Maill
PO Box 71
FLEMINGTON MARKET  NSW 2129
Ph: (02) 9764 2833
Fax: (02) 9746 6174
Email: Ecofarms@ozemail.com.au
Website: www.worldwholefoods.com

**World Whole Foods**
2/35-43 Essington St
MITCHELL  ACT  2911
Ph: 1300 653 663
Fax: (02) 6242 4764
Email: info@worldwholefoods.com
Website: www.worldwholefoods.com

**Annabel’s Natural Food Store**
18 Willoughby Rd
CROWS NEST  NSW  2065
Ph: (02) 9906 6099
Website: www.annabels.com.au

**Avalon Organics**
17 Avalon Parade
AVALON  NSW  2107
Ph: (02) 9918 3387
Fax: (02) 9973 4499

**Bountiful Harvest Organics**
Unit 4
328 Windsor St
RICHMOND  NSW  2753
Ph: (02) 4588 5373
Fax: (02) 4588 5377

**Cleavers Meats**
Shop 6
The Grove Arcade
174 Military Rd
NEUTRAL BAY  NSW
Ph: (02) 9953 2129

**D & L Organics**
Megalong St
KATOOMBA  NSW
Ph: (02) 4782 4184
Fax: (02) 4782 9168

**Dewford’s Alternative**
10A Loftus St
BOWRAL  NSW  2576
Ph: (02) 4862 4848
Fax: (02) 4862 4868

**Dynamic Organics of Mosman**
Ph: (02) 9969 3332
Fax: (02) 9969 3352
Website: www.dynamicorganics.com

**Back To Eden**
Josef Leescot
Unit 2, 177 Arthur St
HOMEBUSH WEST  NSW  2140
Ph: (02) 9746 0070
Fax: (02) 9746 0040
Mobile: 0428114707 or 0411 414707
Email: eden@geko.net.au

**Prime Quality Meats and David Jones**
Craig Cook
Suit 1 Level 1 Shaw House
49-51 York Street
SYDNEY  NSW  2000
Ph: (02) 9299 7054
Fax: (02) 9299 7048

**Mary’s Organic Home Delivery**
(organic meat wholesaler)
Ken Taylor
586 Darling St
ROZELLE  NSW  2039
Ph: (02) 9555 7078
Fax: (02) 95557079
Email: ken@marysorganics.com.au
<table>
<thead>
<tr>
<th><strong>More Health Organics</strong></th>
<th><strong>The Beach Butchery</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph/Fax: (02) 9764 2805</td>
<td>Malcolm Hay</td>
</tr>
<tr>
<td>Email: <a href="mailto:morehealth@one.net.au">morehealth@one.net.au</a></td>
<td>14 Hall St</td>
</tr>
<tr>
<td></td>
<td>BONDI BEACH NSW 2026</td>
</tr>
<tr>
<td></td>
<td>Ph: (02) 9130 3236</td>
</tr>
<tr>
<td></td>
<td>Fax: (02) 9130 4683</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Nourish</strong></th>
<th><strong>Earth Food Store</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop 3C</td>
<td>81 Gould St</td>
</tr>
<tr>
<td>45 Gladesville Rd</td>
<td>BONDI BEACH NSW</td>
</tr>
<tr>
<td>HUNTERS HILL NSW 2110</td>
<td>Ph: (02) 9365 5098</td>
</tr>
<tr>
<td>Ph/Fax: (02) 9879 3353</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>One Earth Foods</strong></th>
<th><strong>Eco – Nature</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop 3, 47-49 Elanora Rd</td>
<td>Shop 17A, 15-17 Havelock Ave</td>
</tr>
<tr>
<td>ELANORA HEIGHTS NSW 2101</td>
<td>COOGEE NSW 2034</td>
</tr>
<tr>
<td>Ph: (02) 9970 6113</td>
<td>Ph: (02) 9664 6085</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Organic Action Home Delivery Service</strong></th>
<th><strong>Lettuce Deliver Organics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph: (02) 9746 3105</td>
<td>Ph: (02) 9763 7337</td>
</tr>
<tr>
<td>Mobile: 0415 286116</td>
<td>Fax: (02) 9763 7338</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Russell’s Natural Food Markets</strong></th>
<th><strong>Simply Organic Natural Health Foods</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>53-55 Glebe Point Rd</td>
<td>Woolworths complex</td>
</tr>
<tr>
<td>GLEBE NSW 2037</td>
<td>58 President Ave</td>
</tr>
<tr>
<td>Ph: (02) 9552 4055</td>
<td>CARINGBAH NSW</td>
</tr>
<tr>
<td>Fax: (02) 9552 4058</td>
<td>Ph: (02) 9524 0608</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Summer Hill Organic Fruit Market</strong></th>
<th><strong>Macro Wholefoods</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cnr Old Canterbury Rd and Carrington St</td>
<td>31-35 Oxford St</td>
</tr>
<tr>
<td>SUMMER HILL NSW 2130</td>
<td>BONDI JUNCTION NSW</td>
</tr>
<tr>
<td>Ph/Fax: (02) 9799 3258</td>
<td>Ph: (02) 9389 7611</td>
</tr>
<tr>
<td></td>
<td>Or</td>
</tr>
<tr>
<td></td>
<td>170 King St</td>
</tr>
<tr>
<td></td>
<td>NEWTOWN NSW</td>
</tr>
<tr>
<td></td>
<td>Ph: (02) 9550 5422</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>The Health Emporium</strong></th>
<th><strong>AC Butchery Pty Ltd</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>263-265 Bondi Rd</td>
<td>Shop 174 Marion St</td>
</tr>
<tr>
<td>BONDI NSW 2026</td>
<td>LEICHHARDT NSW 2040</td>
</tr>
<tr>
<td>Ph: (02) 9365 6008</td>
<td>Ph: (02) 9560 5278</td>
</tr>
<tr>
<td>Fax: (02) 9300 9330</td>
<td>Fax: (02) 9569 8687</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Spiral Foods</strong></th>
<th><strong>Riverina Organic Farmers Organisation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Jim Wilson</td>
<td>Bob Congdon</td>
</tr>
<tr>
<td>PO Box 157</td>
<td>Woodstock</td>
</tr>
<tr>
<td>Annandale NSW 2038</td>
<td>BERRIGAN NSW 2712</td>
</tr>
<tr>
<td>Ph: (02) 9571 9611</td>
<td>Ph: (02) 6035 9425</td>
</tr>
<tr>
<td>Fax: (02) 9571 9208</td>
<td>Fax/Fax: (02) 8687</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Melbourne Office:</strong></th>
<th><strong>Ron Ward – Bio-Dynamic Meat</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph: (03) 9429 8655</td>
<td>‘Bellevue’</td>
</tr>
<tr>
<td>Fax: (03) 9427 9207</td>
<td>Olympic Way</td>
</tr>
<tr>
<td></td>
<td>COOTAMUNDRA NSW 2590</td>
</tr>
<tr>
<td></td>
<td>Ph: (02) 6942 3634</td>
</tr>
</tbody>
</table>
Demeter Farm Mill
David Williams
‘Demeter’
BREEZA NSW 2381
Ph: (02) 6744 5754
Fax: (02) 6744 5780
Email: demeter@northnet.com.au

Wholegrain Milling Co Pty Ltd
PO Box 347
GUNNEDAH NSW 2380
Ph/Fax: (02) 6742 3939

Wild Bean Coffee
Ph: (02) 9438 2761
Fax: (02) 9438 4577
Email: wildbeancoffee@hotmail.com

Santos Trading P/L
Howard Wilkinson
4 Ti-Tree Place
BYRON BAY NSW 2481
Ph: (02) 6685 5685
Fax: (02) 6685 5686
Email: santos@oncs.com.au

Nature’s Fare (Lotus Organic)
Neville Brown
PO Box 170
MILPERRA NSW 2214
Ph: (02) 9792 7522
Fax: (02) 9792 7451
Email: nature@bigpond.com

Heaven And Earth Systems Pty Ltd
Catrioma Macmillan
PO Box 3335
TAMARAMA NSW 2026
Ph/Fax: (02) 9365 7668
Email: info@universalorganics.com.au
Website: www.universalorganics.com.au

Green Grove Organics
PO Box 11
ARDLETHAN NSW 2665
Ph: (02) 6924 5374
Fax: (02) 6924 2999

Heavenly Organic
Ph/Fax: (02) 6681 6555
Email: organic@smatra.com.au

Liquid Organics Pty Ltd
Ph: (02) 9516 1534
Fax: (02) 9516 1734

Nutrisoy Organic Tofu and Tempeh
15 Hannon St
BOTANY NSW 2511
Ph: (02) 9316 5171
Fax: (02) 9700 1121

Pioneer Organic Tea Tree Oil
51 Ocean Dr
EVANS HEAD NSW 2473
Ph: (02) 6682 4200
Fax: (02) 6682 5556

So Natural Foods Australia
Ph: (02) 9526 2555
Fax: (02) 9525 5406
Website: www.sonalatural.com.au

Stassen Organic Tea
Ph: (02) 9318 0824
Fax: (02) 9310 2746

The Young Roller Flour Mill Co.
133 Lovell ST
YOUNG NSW 2594
Ph: (02) 6382 1988
Fax: (02) 6382 3536

Tip Top Organic Plain and Self Raising Flour
1 Braidwood St
ENFIELD NSW 2136
Ph: 1800 649 494

Total Package
Ph: (02) 9938 5166
Fax: (02) 9938 4786
Email: sales@totalpackage.com.au

Trade Winds Tea and Coffee Pty Ltd
3/23-25 Fitzpatrick St
REVESBY NSW 2212
Ph: (02) 9792 1094
Fax: (02) 9792 1086

Victoria

Nature First Organic and Lotus Organic.
The latter is a health food stores only range.
Contact: Greg Barfoot.
PO Box 139
134 Argus Street
CHELTENHAM VIC 3192
Ph: (03) 9584 2245
Fax: (03) 9584 5821
Email: info@kadac.com.au

Kadac Pty Ltd –
Distributing over 600 organic products since 1973.
Roger Pitt, Director
PO Box 139
134 Argus Street
CHELTENHAM VIC 3192
Ph: (03) 9583 1522
Fax: (03) 9584 5821
Email: rpitt@kadac.com.au

Hakea & Gippsland Organic Range
Ph: (03) 9484 7401

Uncle Tobys Vita Brits
Reply Paid 63943
Barkly St
WAHGUNYAH VIC 3687
Ph: 1800 025 768
Website: www.uncletobys.com.au

Stoney Creek Oil Products Pty Ltd
PO Box 37
TALBOT VIC 3371
Ph: (03) 5463 2340
Fax: (03) 5463 2553
Email: admin@stoneycreekoil.com.au
Website: www.stoneycreekoil.com.au

Organic Wholesalers Pty Ltd
John Williams
Stores 386-389
542 Footscray Road
FOOTSCRAY VIC 3011
Ph: (03) 9687 6388
Fax: (03) 9689 4742
Email: sales@organicwholesalers.com.au

Earth’s Best Baby Food
Locked Bag 57
MALVERN VIC 3144
Ph: 1800 633 333

Organic Connection Australia
Organic Exports and Marketing
PO Box 573
KEW VIC 3101
Ph: 1300 303 601
Fax: 1300 303 602
Email: idiamond@organicconnection.net

Melrose Health Supplies
(Specialises in oilseeds)
Geoff Steinicke
4 Redland Drive
MITCHAM VIC 3132
Ph: (03) 9874 7800
Fax: (03) 9874 7366
E-mail: melrose@smart.net.au

Biodynamic Marketing Co.
C/o Post Office
POWELLTOWN VIC 3797
Ph: (03) 5966 7370
Fax: (03) 5966 7339

Pureharvest
15 Ardena Court
EAST BENTLEIGH VIC 3165
Ph: (03) 9579 3422
Fax: (03) 9579 3312

Timboon Farmhouse Cheese
Ph: (03) 5598 3387
Fax: (03) 5598 3504
Email: timboon@standard.net.au

South Australia

The Organic Market
Shop 5
Druids Avenue
STIRLING SA 5153
Ph/Fax: (08) 8339 4835
Email: organics@ozemail.com.au

Chiquita Brands Adelaide Pty Ltd.
Shane Collard
Store 5
Adelaide Produce Market
Diagonal Rd
POORAKA SA 5095
Ph: (08) 8349 5044
Fax: (08) 8349 5274
Email: scollard@chiquita.com

Four Leaf
Ph: (08) 8528 5330
Fax: (08) 8528 5385
Email: flmill@mail.mdt.net.au

Queensland
United Organics
Organic retailers
PO Box 117
BRISBANE MARKETS Queensland 4106
Ph: (07) 3278 5997
Fax (07) 3278 5998

Anglo Paradise Gold Coffee
6/8 Finsbury St
NEWMARKET QLD 4051
Ph: (07) 3356 6288
Fax: (07) 3356 9199

Mighty Bean Soyfoods Organic Soy Tempeh
Ph: (07) 5446 7342
Fax: (07) 5472 7026
Email: mightybean@bigpond.com.au

Naked Foods (Aust) Pty Ltd
PO box 991
BEENLEIGH QLD 4207
PH: (07) 3805 4499
Fax: (07) 3805 4622

Soland Health Food
Ph: (07) 3353 3366
Fax: (07) 3353 3331
Email: soland@soland.com.au
Website: www.soland.com.au

Tasmania

Specialist BD & Organic Wholesalers
Rick & Jo Eastern
PO Box 12
SHEFFIELD TASMANIA 7306
Ph/fax: (03) 6491 1439
Email: biodistributors@microtech.com.au
Website: www.sheffield.tco.asn.au/bio/

Further information about organic or bio-dynamic retailers and wholesalers can be obtained from the certifying agencies and contacts listed in Chapter 5 of this manual.
9. References - Further reading

National Standard for Organic and Bio-Dynamic Produce OPAC 1998

IFOAM 1998. Basic Standards for Organic Production and Processing. Contact the Manager AQIS Food Programs ph: (02) 6272 4783, fax (02) 6272 3682, e-mail organic@aqis.gov.au or NASSA.

Standards from the respective AQIS accredited certification agencies. (See chapter 5)

Acres Australia, the national newspaper of sustainable agriculture.


Government contacts

New South Wales:

Robyn Neeson
Alternative Farming Systems Officer
NSW Agriculture,
Ph: (02) 6951 2735
Fax: (02) 969557580
Email: robyn.neeson@smtpgwy.agric.nsw.gov.au

Els Wynen
Ph: (02) 62583561
Fax: (02)62583812.
Email: els.wynen@ibm.net

Queensland:

Peter Deuter
Ph: (07) 5466 2222

South Australia:

Chris Penfold
University of Adelaide
Ph: (08) 8303 7735
Fax: (08) 8303 7979
Email: oas@alphalink.com.au

Tasmania:

David O'Donnell
DPIWE
Ph: (03) 6421 4047

Victoria:

Viv Burnett
DNRE,
Ph: (02) 6030 4500
Fax: (02) 60304600
Email viv.burnett@nre.vic.gov.au

Ross Clarke
Ph: (03) 9210 9387
Fax: (03) 9800 3521
Email rossclarke@knoxy.agvic.gov.au

Sue Titcumb
NRE Ballarat
Ph: (03) 5333 6933

Western Australia:

Garry Parlevliet
Agriculture WA
Senior Development officer
Ph: (08) 9368 3219
Fax (08) 9368 3946
Email: gparlevliet@agric.wa.gov.au