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RESEARCH & DEVELOPMENT CORPORATION

Organic Agriculture in Australia

Proceedings of the National Symposium on Organic Agriculture: Research and Development
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"Organic Agriculture in Australia"

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Foreword

These proceedings present the papers and reviews given at the National Symposium on Organic Agriculture: Research and Development. The symposium was held in Canberra by the Australian National University and the Rural Industries Research and Development Corporation from 30 June to 3 July, 1996.

The symposium was attended by some 60 participants from the Australian organic agriculture industry. Participants included farmers, processors, retailers, domestic and export traders, researchers and representatives from government agencies and authorities.

The symposium was organised to provide a forum to review the state of the industry, identify key issues and areas of concern, and to develop strategies for its future development.

The papers and panel discussions presented here review the state of the industry in the areas of farming practice, the production and processing of organic products, product certification schemes, market development, government initiatives and research and development.

The symposium went on to identify key issues, goals and targets, and developed a national strategy for the industry. The RIRDC report of the symposium's outcomes and the national strategy is published as a separate volume to these proceedings, entitled *From Farmer to Consumer. The Future for Organic Agriculture in Australia.*

These proceedings and the companion report are part of RIRDC's Sustainable Agricultural Systems and Structures R & D Program, which aims to facilitate the development of profitable and ecologically sustainable agricultural systems.

Peter Core
Managing Director
RIRDC

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Acknowledgments

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- all the contributors from the industry who have made it possible;
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- staff and colleagues at the Geography Department of the Australian National University for much help and support; especially Mr Jim Derrick for his work throughout the project, and Mrs Renee Gavin for her transcribing of tapes and processing of words.

Abbreviations

ACA	Australian Consumers' Association
ACF	Australian Conservation Foundation
ANU	Australian National University
ANZFA	Australia and New Zealand Food Authority,
AQIS	Australian Quarantine and Inspection Service
ARMCANZ	Agricultural and Resource Council of Australia and New Zealand
BDAA	Bio-dynamic Association of Australia
BFA	Biological Farmers of Australia
CEC	cation exchange capacity
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPIE	Department of Primary Industries and Energy
FAO	Food and Agriculture Organisation
GATT	General Agreement on Tariffs and Trade
IFOAM	International Federation of Organic Agriculture Movements
IPM	Integrated Pest Management
NASAA	National Association for Sustainable Agriculture Australia
NSW	New South Wales
NT	Northern Territory
OECD	Organisation for Economic Cooperation and Development
OHGA	Organic Herb Growers Association
OPAC	Organic Produce Advisory Committee
OVAA	Organic Vignerons Association of Australia
RIRDC	Rural Industries Research and Development Corporation
SA	South Australia
TAFE	Technical and Further Education
TOP	Tasmanian Organic and Bio-dynamic Producers Cooperative
VAM	vesicular-arbuscular mycorrhizal fungi
WA	Western Australia

Introduction

The development of the organic agricultural industry in Australia is at a critical stage. With its total value at less than $100 million (1996 figures), it is only worth 0.25% of the same industry in the USA. The reasons for this low status of the industry are easy to distinguish: fragmentation, no national co-ordination, a multitude of certification agencies, no common logo and the lack of an assured supply of quality produce.

Global markets for organic commodities are growing rapidly with major trading opportunities available. These opportunities are available for Australian producers, particularly in Asian markets. Australia is also very fortunate due to its relatively low levels of soil, water and air pollution (compared with Europe and North. America). To take advantage of these opportunities, the organic industry needs to overcome its current difficulties and create new research .and development strategies.

The ANU and RIRDC, recognising the critical needs of the industry, staged a four day symposium on Organic Agriculture in Australia: Research and Development. This symposium, held at Eaglehawk on the outskirts of Canberra (June 30-July 3 1996), brought together the key players in the industry to review the industry and develop initiatives for the future.

To provide all the necessary background information on the industry, a series of reports from all key sectors of the industry plus research posters and major review papers were presented over the first day of the symposium. To further facilitate the process of review and the development of initiatives, various workshops were then held during the symposium in several key areas of the industry. Two keynote addresses were also presented at the Public Forum on 3 July 1996.

These proceedings contain an edited account of these reports, poster sessions, major review papers and keynote addresses. The compilation of these reports and reviews, besides facilitating the outcomes of the symposium, also represent a comprehensive overview of the current state of the organic industry in Australia and will therefore provide a crucial resource to all in the industry including farmers, politicians and researchers.

Part A:

Symposium Panel Reviews

1. Industry Summary

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As an introduction to the proceedings a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis for the industry is provided to promote debate. The SWOT order has been rearranged to present the opportunities at the end so that while recognising the difficulties facing the industry, we do not become focussed on them alone.

Strengths

There are five readily recognisable strengths of organic agriculture in Australia.

1. The industry is established.
Unlike many other emerging sectors in primary industries, organic agriculture is already established. The industry has a very well established set of core participants from farmers through processors and marketers, to consumers. Many of the core participants have been operating for decades, in the case of some farmers, for over 40 years.
A correlated feature of the industry is that it is viable in its present form. Its viability does not seem to be dependent on having reached a certain size, or on its reaching a certain size in the future.

2. The industry is committed
Another major strength of the industry is the commitment of the people involved. They are very committed. Unlike many other new and emerging industries where there are large influxes of opportunistic entrants, the organic industry has its established core. This is not to say that there not plenty of opportunities for others to enter the industry, but that the industry does not depend on new operations starting for it to work.

3. Its clean image
The organic agriculture is viewed by many in the Australia and in the world community as the cleanest form of agriculture. As Australian agriculture generally is also seen by many as one of the cleanest in the world, Australian organic agriculture has the potential to sell itself as 'the cleanest'. Whether or not this image is deserved, it is an enormous strength with which to develop larger markets

4. Wealth of existing knowledge
The industry has a wealth of knowledge on how to successfully operate organic agriculture. While much of this knowledge is practitioner based and not generally available, it has been highly developed over a long time. There are plenty of long term successful organic farmers who are exemplars of best farming practice. There are processors, wholesalers and retailers who already know how to operate in the industry.

5 The industry is international
And finally, I think the other great strength of the industry is that it is international. This internationalism has two sides. Firstly, the organic agriculture is already recognised world wide. It is a part of global agriculture. While organic products may not be as well know as the organic industry would like, they are still recognised in most countries already. Secondly, Australian organic products are already established in some parts of this international trade, especially in Europe and in east Asia. The development of the export trade in Australian organic products does not have to start from the beginning.

Weaknesses

There are four major weaknesses of organic agriculture in Australia.

1. Size
The greatest weaknesses the industry has is that it is still very, very small. Organic farming probably accounts for less than half of one percent (0.5%) of Australian farmers and farm output. The Hassall and Associates report indicates it accounts for about point two percent (0.2%) of the value of retail sales in Australia. This smallness makes the industry vulnerable to trade and seasonal cycles. There are simply too few producers of any one commodity for the industry to be able to provide the constancy of supply and quality that the market requires. The small volumes of produce and often irregular supply make it very difficult for processors and others to make serious investment commitments to the industry.

2. Fragmentation
Another major weakness, is the fragmentation of the industry.

It is fragmented at all levels, within the farming sector, in the processing sector, within marketing. There are competing domestic and international certification agencies, competing logos and trade marks. There are different levels of certification. There is biodynamic versus organic. There are individual farmers protecting particular niche markets they have created. There are anti-agribusiness movements within the industry and there are advocates of a more business-like, professional approach. There are barter only, local markets only, farmer first , and consumer first advocates all competing for the label 'organic'. This fragmentation is worsened by the lack of any level of industry coordination.

3. Exclusive
I think the industry has another serious weakness. It is perceived to be somewhat exclusive by many of those wanting to join. While the industry needs to maintain organic standards, the way in which these standards are protected is important. If farmers, processing companies, and traders feel that they are joining a trade and certification process backed by legislation, rather than a private club or even a religion, then industry development will take place much more rapidly.

4. Lack of government support
There has been little government support for organic agriculture in Australia to date. The industry in Australia has not yet established itself as a serious part of agriculture.

Threats

There are five major threats to the industry.

1. Industry Fragmentation
This is probably the largest threat that the industry faces. As has been indicated in the opening remarks to this symposium, without coordination the industry is unlikely to be able to effectively represent itself to government and to participate in its full market potential.

2. Government indifference
Government indifference is closely allied to the other weaknesses and threats to the industry. Until the industry can present a united and representative front, government action is unlikely. As has been indicated in this forum, government is likely to withdraw from any involvement in the industry until a united representative body is formed.

3. Industry frustration
Industry frustration is operating at many levels, but particularly there is strong frustration at farmer level. Farmers wanting to enter the industry find great difficulty in getting good information about virtually all aspects of the industry, from farming advice through to market reports. Many new entrants to the industry leave again quite quickly. Again there is a coordination problem. There is also great frustration at the processor and market levels of the industry. There are major problems with adequacy of supply and quality, and with pricing. Part of this frustration is in the lack of agreement as to who should control the industry. Is it farmers, certification agencies, or marketers who should control operations? This problem has been resolved in other countries by the creation of peak industry councils that represent all sectors of the industry.

4. Consumer frustration
Market research both here in Australia and elsewhere in the developed world indicates considerable consumer support for organic produce. This consumer demand is constantly frustrated by poor quality, intermittent supply, large price premiums and a confusing range of logos and certification marks. In 1996 there are fewer organic products regularly available in major Australian supermarkets than there were five years ago.

5. Competition
A final threat to the Australian industry is outside competition. We have to ask ourselves: Why is a company about to put fresh frozen organic vegetables into Australia from New Zealand? Why are these vegetables not coming from Australia? Many other organic products sold in Australia are imported. Other countries will supply our domestic market if we do not. The Australian organic industry faces similar threats in any export trade particularly into east Asia.

Opportunities

I think these are enormous.

1. Market demand
There is large untapped market demand, both domestic and international.

2. Industry co-ordination
The opportunity exists now to create some industry unity and coordination at all levels of operation from farm certification through to domestic and export marketing.

3. Research, extension and development
The opportunity exists now to achieve appropriate links with government and non-government agencies to establish the appropriate research, extension and development programs the industry requires.

2. Federal Government Initiatives

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The Federal Government through its primary industries portfolio became involved with the organic produce industry in the late 1980s. At that time market opportunities were opening up to Australia particularly within countries of the European Union.

Since government officials first met with the industry and other state governments, the Australian Quarantine and Inspection Service (AQIS) has worked in partnership with the industry to ensure that Australian organic produce is able to capitalise on the market opportunities around the world.

There have also been a number of other areas where Department of Primary Industries and Energy (DPIE) programs have focused resources on the organic produce industry and relates issues. Five identifiable areas summarise along the following lines.

Export facilitation

With the agreement of ARMCANZ, the Organic Produce Advisory Committee (OPAC) was established in 1990 to develop a national standard, to assist AQIS in facilitating trade and to provide policy advice to the Minister for Primary Industries and Energy and to DPIE. AQIS provides the chair and secretariat for OPAC.

The nationally agreed *Standard for Organic and Biodynamic Produce* was introduced on 10 February 1992 for all exports. This is underpinned by administrative arrangements for applicants seeking AQIS accreditation for export purposes, and is in accord with national approaches to apply quality systems to agricultural production.

AQIS has now audited six industry organisations. Once the *Export Control Orders* for organic certification are in place, this program will also extend to individuals who, for whatever reason, do not wish to belong to an industry organisation.

Federal resources have also been provided for Australia to lead the program of work by the Codex Alimentarius Commission to develop guidelines for governments on organic foods moving in international trade. Ruth Lovisolo from AQIS chairs the Codex working group. It is anticipated that this work will be completed by mid 1997.

Domestic regulation

On behalf of the organic industry, AQIS has pursued a request to the National Food Authority (now the Australia and New Zealand Food Authority, ANZFA) for controls on the labelling of organic foods on the domestic market. A second application is presently being finalised with consultant lawyers and will be submitted shortly to ANZFA.

Policy Issues

DPIE is committed to ensuring the sustainability of production, processing and delivery of Australia's natural resources and to improving access to markets. Organic production is one form of agriculture recognised within the portfolio policies on sustainable agriculture.

It is generally accepted that the organic produce industry has much to offer mainstream agriculture in terms of alternative systems, innovative management and landcare, and has been recognised in policy statements on sustainable agriculture. The industry has also been a leader in introducing applied quality management systems across the whole of the food chain.

Grants for Research and Development

Through programs such as Agribusiness Grants and the now superseded Innovative Agricultural Marketing Program, substantial research funds have been awarded to projects which focus on the marketing of organic produce. Successful applications have not been selected necessarily because of their relationship to organic produce, but rather competed on their own merits along with a range of applications each year covering a wide range of commodities.

The Rural Industries Research and Development Corporation, of which you will hear more during the course of these two days, has also provided funding for major studies and research projects.

Research Activities

The Bureau of Rural Sciences has for several years been monitoring international trends in pesticide risk and use reduction as part of a broader program entitled “Pesticides, Pollutants, Trade and the Environment”.

Their major activities have involved attempts to raise the level of debate in Australia on pesticide issues, recognising the increased scrutiny of residues in agricultural commodities in the post-GATT period and concerns about pesticide impacts on health and the environment. The interaction between agriculture and trade and the environment is highlighted by growing moves towards the adoption of ‘green labelling’, with obvious ramifications for the organic movements.

Relevant activities include:

- the move to develop a National Strategy for Agriculture and Veterinary Chemicals. This program is in response to the recommendations of the OECD/FAO Pesticide Risk Reduction Workshop held in Uppsala, in October 1995;
- RIRDC funding to hold a national workshop on the benefits of developing a national pesticide reduction strategy to be held in March 1997; and
- the National Cadmium Minimisation Strategy which relates largely to phosphate fertilisers.

3. Certification Agencies

DON MACFARLANE

Biological Farmers of Australia

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Introduction

A group of perceptive organic farmers met in Dubbo on February 1, 1987. Biological Farmers of Australia (BFA) was born, with the election of seven directors, viz. Gavin Dunn as chairman; Arthur Dakin; David Williams; Bernie Von Pien; Graham McNally; John Greenwood; and Robin Curtis. At Graham McNally's property "Kialla", near Toowoomba, a field day was held mid-year in 1988. The attendance by 1500 people was an encouraging expression of public interest in Biological Farming. At the AGM in September, 1988, it was decided to register BFA under the Co-operative Act of NSW.

Enthused by the great success of the field day, the new organisation established quickly and has continued to grow to a current membership approaching 700, with 600 associates. Progressively as the new organisation grew, so has the professionalism in administration. Strategies are in place to enable all practices to meet the International Standards Organisation standards in the near future. Certification procedures are modelled on AQIS and IFOAM standards. BFA increasingly presents appropriate submissions on matters of public or national interest that relate to it’s aims and objectives. Eight government departments responded to our objection to "Cotton on the Cooper".

Grassroots Networking

Funding constraints preclude high cost conventional public relations and advertising initiatives, and BFA will ever require innovative strategies to achieve established goals. Because of intrinsic philosophical differences, many enterprises will feel threatened by our presence, our beliefs, and all we do—for example, the low key but effective methods used by the multi-national chemical cartels and agribusiness groups to denigrate the achievements and worth of any move that does not add to their bottom line. The obvious available option is no cost or low cost networking. A steadfastly dedicated membership with encouragement and advice from adequate leadership working on wide range of initiatives can be remarkably effective in changing agriculture and society itself from an industrial to an ecological base.

Societal Challenge

Industrial society is reductionist and mechanistic with many of its actions and interactions being overly destructive. It takes the wealth from the many and gives it to the few. It depopulates rural areas, destroying the social and economic fabric of established functional communities, and creates urbations even conurbations, that are gluttonously consumptive in their use of resources, particularly non-renewable resources. Even greater is the human cost.

Food is nothing more than a resource. Ecological society is holistic, where all actions and interactions support and enhance the outcome. John Muir said "When I take hold of anything in nature I find it is hooked to most everything else." Unless farming is the preferred industry, then that society will not survive for long. A stable, sustainable society can only be one that is based on viable, dynamic rural communities. Australia's greatest problem is urban depopulation. Remember that we are discussing the survival of *homo sapiens* on planet earth, not the continuance of the humanly degrading current practice of handing over most of our hard- and honestly-earned money to powerful commercial interests, and grossly oversized governments and government institutions.

Marketing

Imaginative marketing strategies need to be put in place, where personal encouragement and the dynamic of customers interacting more directly with producers makes collecting and eating organic food a living experience, rather than an exercise in mechanical necessity. Some of the available proven options are CMA, direct selling, basket delivery and, probably the best option in much of Australia, local buying groups comprising ten to twenty households. Like many of you, I am familiar with all the above methods, in place and working well.

A New Dimension in Human Relations

Two ingredients essential to the rapid development of the organic industry are unity and trust, both of which have too often been absent in the past.

Organisational Cooperation

Many organisations and groups of people have a real, even vested interest in what we are endeavouring to achieve. Because of our relatively low numbers, we need to establish an appropriate, co-operative working relationship with all these organisations to maximise our effectiveness. Most people I speak with are interested in natural farming systems or a health program geared to the needs of the people rather than the bottom line of the pharmaceutical companies.

The Engine that Drives OPAC?

"Nothing is as powerful as an idea whose time has arrived." At no time can this meeting degenerate into just another academic talk-fest. It must be the launch-pad for the greatest community-based movement this country has ever seen. Now is the time and this is the place to ditch parochialism, empire building, ivory-tower tinkering and for each of us to humbly fill our own appropriate and essential role. As we formulate our vision, we could well note Einstein's advice "You cannot solve a problem by using the same methods that caused the problem."

Research

A high percentage of the thrust in research is misdirected. Most of the agricultural researchers, in spite of their academic brilliance and profound technical and practical skills, are employed to structure products that can be manipulated through a grossly flawed screening process or design strategies to prop up an ailing agriculture. A great need in the interests of the purchaser and the environment is to establish adequate testing procedures in totally independent laboratories.

Grasping Opportunities

Dr Theo Colborn and her large team of prominent research scientists point out that it is grossly inadequate to test the thousand new chemicals released each year for immediate toxicity and carcinogenicity on male mature rats, while neglecting to test for long term toxicity, mutagenicity, and hormone disruption. The foetus of the female rats is infinitely more vulnerable. Hormone disruption caused by synthesized chemicals is quickly becoming recognised as a major cause of health disorders. "Silent Spring" has had a profound influence on the world over the last 24 years. It is likely that "Our Stolen Future" will reshape societal expectations in a profound way for the next generation. Released in March, its reading is a must. Along with many pertinent reasons, Colborn's book provides the catalyst to focus public attention on the need to move away from heavy dependence on synthesized industrial, domestic and agricultural chemicals. Besides being a carcinogen, DDT has been known to be a hormone disrupter for 50 years. It mimics testosterone and can substantially masculinise the female foetus. Prominent people have reminded us that health is 85 to 90 percent dependent on lifestyle, rather than supplementing a junk food diet with prescribed pharmaceutical therapy.

HOWARD RUBIN

The Organic Herb Growers of Australia Inc.

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The Organic Herb Growers of Australia (OHGA) Inc. was founded in 1987 by a small group of dedicated herb enthusiasts. The Association was originally called the Northern Rivers Herb Growers and Marketers Association. However, in 1990 the association decided to change its name to reflect its true status as a national body dedicated to organic growing. With a unanimous vote the association name was changed to OHGA.

At that time, there were no national standards for organic produce and OHGA developed their own set of standards and began a certification program. The first farm was certified in 1990. Today, OHGA has a fully paid-up membership of 352 members nationwide, with members in every state, and 96 certified farms.

OHGA's primary aim is to foster the development of an Australian organic herb growing industry. We do this by distributing information via our bi-monthly magazine "Herb Grower", monthly field days, and our soon-to-be-constructed Internet web-site.

Besides freely offering grower information, our association operates a fully accredited organic certification system; we are full members of OPAC and actively contribute towards the establishment of an Australian organic industry.

Our association follows the model rules set down by the NSW Association Act. We have a seven member executive committee, elected annually at our AGM, who are responsible for the decision making of the association. An executive officer who is an employee of the association maintains the office and conducts our day to day affairs. Our certification system is operated by a three member sub-committee which reports directly to our executive committee. We have a paid employee who performs the function of our inspector and organises the daily operation of the certification system.

OHGA believe that the greatest problem confronting the organic industry is the lack of domestic standards with uniform organic labelling systems utilising a common logo.

JAN DENHAM

National Association for Sustainable Agriculture Australia

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For those who don’t know me, I’m Jan Denham, the Chairperson of the National Association for Sustainable Agriculture Australia (NASAA), and an organic citrus grower. I’m going to give you an overview of NASAA, then look at some administrative issues that the industry has to address and also examine some of the areas of research and development that we see as important.

NASAA has now operated for 10 years as a certification program. It was established by a group of dedicated people who saw a need for the promotion and education of organic agriculture, as well as lobbying governments. It later took on the role of certification. One of the founders, Tim Marsh, is present here today. Over those years we have seen NASAA grow; it has been a part of OPAC, and has certified all types of operations, including farms, fertilisers, processing and input products. It now certifies both nationally (across Australia), and internationally, with large growth in our international certifications. In 1994 IFOAM established an accreditation program for certification organisations, and NASAA was one of the first organisations to receive this accreditation. This has given our certification program international recognition and to date we are the only Australian certification organisation to have this endorsement.

NASAA sees several industry issues that need to be addressed, with the most important one, I believe, to be industry unification. The past 12 to 18 months have seen a much closer relationship between the industry and NASAA, and I think the development of this relationship is an important part of the development of our industry as a whole.

We see the uniform application of certification as a major issue in promoting and increasing the credibility of organic production. Promotion of organic agriculture to both the consumer and to farmers is a very important role for organic agriculture organisations. The organic agriculture industry, I think probably like most industries, is starved for funds and it is very difficult to target where the promotion is going to be the most effective. We have the arduous role of promoting organic farming to farmers; we have the role of promoting organics and its range of benefits that flow from this system of farming to the consumer; we must also promote our certification organisation. The restriction of funds means that at times you have to target a limited area to achieve any results at all. Recently NASAA has tended to focus on the promotion of the certification program, both locally and on the international scene.

One of the other issues I think organic agriculture needs to look at is where it fits in with mainstream agriculture, and what is the relationship between organic and conventional agriculture. Research and development is also an important part of our industry, something that everyone is saying there needs to be more of. Research and development needs to be very relevant and it needs to be industry focused. It needs to have the support of the farmers so that they see it as being of importance.

We are in a very diverse industry that makes it difficult to address all the relevant issues. How are we going to identify the priorities needs to be addressed? For example, we need to survey our organic farmers; we have a lot of farmers who are already doing research and development in their own ways; and we need to see what other information is required. We need to undertake a very comprehensive survey of what is happening out there, to determine what is needed, and what people see should be the priorities of research. Also we need to be aware of all the on-farm research that is being done, which is a very important aspect of the research and development of this industry.

If this Symposium can examine some of those issues and come up with a synopsis of how we are going to address them, we will have a very successful outcome.

GRAEME STEVENSON

Tasmanian Organic-Dynamic Producers Co-operative

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The Tasmanian Organic-Dynamic Producers Co-operative (TOP) was established in September, 1993. It's current membership stands at 41 full members, with 46 friends.

TOP is involved in the certification of organic and bio-dynamic producers. To date we have 13 producers fully certified, with 4 in conversion and 5 being assessed. We are also undertaking the publication of manufacturing certification standards.

Given the existence of several other, larger certification agencies, yet another may be considered unnecessary. We went ahead with TOP for three main reasons. First, we wanted to capitalise on the uniqueness and opportunities presented by being an island state. We also believed that a regional body would be closer to the growers and better able to identify and respond to their needs. Finally, we considered there was a need for a more pro-active state representation in the organics field.

So, what does TOP do? Our main mandates and strategies are (in priority order):

1. **certification**: implement manufacturing and processing standards, promote producer certification, skillshare trainee program.
2. **grower assistance (extension)**: farm monitoring program, field days
3. **marketing**: promotion of TOP, promotion of produce, co-ordination of production and delivery (through the establishment of a produce database)
4. **administration**: professional presentation of TOP activities.

As far as markets go, our major goal is the development of domestic markets for organic produce. Having said that, we do not believe that markets alone should be the driving force in the promotion of organics; the basic organic philosophies such as reduced inputs and preventative landcare are of equal importance to the product.

One of the problems facing TOP is its smallness. We are one of four producer groups in Tasmania—the price we pay for individuality! Also, Tasmania's isolation means that we are working in a geographically small corner of a small industry. One of the effects of this is that we have insufficient funds to cover certification costs, generate user-pays grower assistance, pay for consumer education and fund market rationalisation. As such, we rely heavily on voluntary input, running the risk of personal and financial burnout.

Recommendations from the perspective of TOP are that we need to establish clear priorities, linking development with extension and research. There needs to be improved documentation of what producers are already achieving and what they have learnt. State-wide bodies (such as State-based Agricultural Departments) should be linked to a National oversight body. The Australian Quarantine and Inspection Service is not necessarily the best Federal Department to fulfil this role as not all production is export-oriented, and emphasising exports may not be the most appropriate goal for the organic industry at this stage. Efforts need to be made to overcome the intransigence of conservative professionals, including gaining the confidence of lending institutions. Finally, the concern that the organic industry will remain input-dependent (merely replacing a dependence on chemical fertilisers with other forms of soil nutrient inputs) needs to be addressed. Investigation of the validity of the closed-system farming philosophy for modern organic farming needs to be carried out, and a clear stance adopted by the industry on this issue.

KERRY WARD

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History

The Organic Vignerons Association of Australia (OVAA) was established in 1992 following an increasing demand for organic wine, particularly from overseas. It was felt that Australia was ideally suited to fill this niche in the export market, given that we were already producing wines of very low residues and our wines were internationally recognised as "green and clean".

It was felt, however, that the three existing organic bodies operating in Australia at that time were inappropriate in terms of handling the specific requirements of wine, particularly as it is an alcoholic beverage and attracts additional regulations. Also, Australian standards for wine were already strictly enforced by the Winemakers' Federation of Australia and dovetailed into export standards for both the European and US markets. It was deemed more appropriate then to develop guidelines based on the current wine industry standards, whilst ensuring that these were in keeping with the standards and practices already embraced by the three organic bodies operating in Australia.

Consequently a set of standards was developed in consultation with OPAC, with a view to becoming an approved certification agency for grapes and wine. The support of the Winemakers' Federation was sought and work instigated on the preparation of an organic winemaking standard that could form part of the P4 winemaking regulations.

Philosophy

The OVAA was formed specifically to promote the growing of grapes organically and the production of wine from those grapes.

When applied to grapegrowing and winemaking, the term organic refers to the production of grapes of high quality, with an emphasis on nurturing and maintaining the land for future generations without the use of synthetic chemicals. There is an emphasis on the use of renewable resources, pest control through integrated pest management techniques, the need for conservation of energy, soil and water resources, and the maintenance of environmental quality, with the utmost restrictions on external inputs, especially fertilisers and chemicals. The production cycle is as closed as possible.

The OVAA embraces the philosophy of organic produce as set out in the "National Standard for Organic and Biodynamic Produce" published and administered on behalf of OPAC by the Australian Quarantine Inspection Service.

Objectives

The broad objectives of the OVAA are:

- To promote and supervise the production of organic grapes and wine in Australia;
- To ensure that all produce labelled as organic wine is correctly inspected, analysed and certified;
- To work towards adopting uniform standards worldwide;
- To support research, development and extension activities with respect to organic and sustainable viticulture and oenology; and
- To act in conjunction with any association, person or body in advertising or public relations for promoting the interests of the organic wine producing industry of Australia.

Current Demand

There is still a strong demand for organic wine both on the domestic and overseas markets. Unfortunately the demand continues to outweigh the supply, and the OVAA has been reluctant to extend its marketing activities until additional supplies are available.

However, the Association is confident that in time many more grape growers will move away from traditional viticultural practices and adopt organic methods. With the introduction of strictly controlled spraying programs, environmental audits, and a general move to sustainable management practices, those growers who have already adopted organic methods will be well placed in the industry.

It is widely known that the wine industry is enjoying buoyant times, with sales continuing to increase both domestically and overseas. This is excellent news for the industry, but also means that there is a strong demand for wine grapes. The OVAA sees this as an impediment to attracting more grape growers to look seriously at organic viticulture practices. While this trend continues it does not provide the incentive people need to consider other options for their produce, even though there is nothing to prevent current winemakers from using organic grapes.

We believe that those growers who are already practising organic methods, or who are making a move in this direction, will have a substantial advantage in the marketplace should there be a downturn in wine sales from their current level, as they can offer a dual purpose product.

The OVAA also believes that consumer pressure will eventually lead to more wine companies becoming aware of the potential that organic wines offer, and will add these products to their range. Again, while there remains strong demand for premium wines and only adequate production to service this demand, winemakers also have no incentive to explore alternatives.

Organic viticulture and winemaking are well established in Australia, but only on a small scale. The OVAA strongly believes there is a very promising and viable future for organic wines and will continue to promote this vision to the industry and aim to increase the current level of production to satisfy the ever increasing demand.

Research

The viticulture and wine industry is well serviced in terms of research coordination through the Grape and Wine Research and Development Corporation, and the OVAA sees itself as being a co-beneficiary of any research activities carried out under their auspices. For many years the grape and wine industry in Australia has been at the forefront of technological advances, and we need to continue to support our research programs to ensure we maintain this edge. We would therefore be concerned if funds for research on grapes and wine were directed elsewhere.

The OVAA is aware of many areas of research that would assist organic grape and wine production. This research would also benefit the industry generally. Therefore, we would suggest that research be continued to be directed through the Grape and Wine Research and Development Corporation, but with a greater level of support and stronger emphasis on organics and sustainable management practices.

Listed below are a few of the research projects which are either being considered or need to be undertaken, and which would be of benefit to the grape and wine industry generally, but with specific application in organic production.

- The use of rootstocks to reduce chloride and potassium residues in export wines;
- Development of methods for the control of vine vigour and water use optimisation based on the concept of heterogenous rootzone hydration;
- Sustainable viticultural production optimising soil resources;
- The role of inter-row ground covers to improve the management and sustainability of Australian vineyard soils;
- Integrated management of Botrytis bunch rot and Light Brown Apple Moth;
- Screening of crucifer crops for glucosinolate (nematicide) levels by HPLC chemical analysis and field assessment in Semillon plantings;
- Non-conventional control of powdery mildew;

- Optimisation of vineyard spray application technology through integrated testing. and evaluation;
- Review of Integrated Pest Management (IPM) adoption;
- Biological and chemical control of Eutypa
- IPM - from Research to Practice;
- Restricted Deficit Irrigation demonstration project

Conclusion

The OVAA maintains it philosophy that there is a need for a separate body to handle the specific requirements of the grape and wine industry. It does, however, support the concept that this should be done in close consultation with those recognised organic industry bodies who set the standards and regulate the organic industry in Australia generally.

The OVAA is committed to promoting and overseeing the production of wine grapes and wine in Australia because it firmly believes that we must adopt sustainable management practices for the long term viability of our industry, as well as promoting the health aspects of our products.

The organic viticulture and winemaking base is only small in Australia at present, but the demand is growing and we need to have realistic and enforceable policies in place before major expansion occurs. In time it will not be possible for one organisation to regulate all sectors of the organic industry, but we need to work towards establishing and maintaining national guidelines which can be embraced by all organic producers.

We cannot predict the future, but we can prepare for it. Organic agriculture is our future, and we must prepare now for its greater impact on our various industries. Even though we may each elect to remain independent in our activities, we must be united in our policies.

C.J. ALENSON

Organic Retailers & Growers Association of Australia

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Introduction

ORGAA is a unique association consisting of a wide cross-industry representation of over 200 growers, retailers, wholesalers, processors, distributors, input manufacturers, consumers and associated environmentally-aware individuals. Many regional groups around Australia have affiliated with ORGAA and see it playing a pivotal role in the development of the organic industry in Australia. It therefore has affiliation with over 2,000 individuals/firms with an interest in the organic industry in Australia.

ORGAA's broad mission has been *to develop and promote the organic/biodynamic industry in Australia.* It is not involved in farm certification but has rather seen itself as a developer and promoter of the entire industry.

ORGAA Business Plan

Vision: We will be one of Australia's key organic and biodynamic farming industry associations.
Mission: Our mission is to encourage and promote the organic and biodynamic industry in Australia.
Objectives: We will achieve Australia's best practice in:

- increasing public awareness of the organic/biodynamic industry;
- providing assistance and support to farmers, retailers and consumers;
- lobbying government for the support of organic/biodynamic agriculture;
- maintaining a scheme to ensure the authentication of organic/biodynamic produce at a retail level; and
- unification of the organic/biodynamic industry in Australia.

Values: Our values are partnership with our retailer, farmer and consumer membership and integrity and honesty in all our dealings with people.

ORGAA is actively involved in:

1. supporting its membership;
2. operating a Retail Trading Scheme
3. operating an Organic Advisory Service accessed particularly by its grower membership;
4. promoting the industry at field days seminars, *et cetera*;
5. extensive educational work with consumers, such as where to get organic food, what is organic food, fact sheets, *et cetera*;
6. providing educational packages to secondary schools;
7. media work, print and radio.

Because of its wide membership representation ORGAA is in a position to see the strengths and weaknesses in the industry from the actual production through to the sale of produce at a retail level.

The strengths of the organic industry

1. The commitment of the accredited organisations to the certification process;
2. The AQIS certification process in Australia authenticating organic production, & the IFOAM accreditation of NASAA;
3. The developing range of organic produce and the improvement of quality over a ten year period;
4. The potential for exponential growth given our geographical location in relation to our Asian neighbours and our 'clean and green' image.

The weaknesses in the industry

1. the lack of one identifiable and promotable certification logo;
2. the division which has existed between the major organic industry associations;
3. the lack of government support and acceptance of organic agriculture;
4. the absence of legislation protecting genuine organic produce;

5. the lack of initiatives on the part of major value added processors to do research and development to get industry sectors off the ground (apart from Uncle Toby's & Sandhurst Farms). An example of an aggressive approach to development of the industry is Watties in NZ.
6. lack of grower assistance, consistent demand and good price for products;
7. lack of organic representation at a tertiary academic level including an absence of courses for students (with the exception of ANU and Orange Agricultural College);
8. lack of research, and often wasted, ill-directed effort when it is pursued.

The Organic Advisory Service

ORGAA decided in 1986 that an Organic Advisory Service was necessary to provide information on all aspects of organic agriculture to growers and potential growers. With an extensive library including a computer-data base of over 1800 references many growers, students and others in the industry have accessed this information.

On-farm consultancies have also been performed.

Common inquiries relate to interpretation of soil test results, pasture improvement, conversion to organic farming, what fertilisers to use, planning of rotations and specific pest and disease control information.

Research Required

It is reasonably obvious that in Australia researchers have struggled to come to grips with what is required in the area of organic research.

Comparative studies attempting to demonstrate if organic farming is a viable system are outdated and a waste of time and money, particularly given that farmers are out there achieving this method of production.

'Re-invent the wheel' research involving such things as compost manufacture, demonstrating whether worms are beneficial to a farming system, *et cetera*, clearly illustrate a lack of vision and a failure to carry out adequate literature research.

It also must be realised that research station trials may be of limited value given the artificial situation in which they are carried out, far removed from the actuality of a farming situation with the vagaries of climate and the pressures of other farming commitments.

Instead of trying to demonstrate if organic farming works we must move towards research that looks at trying to *improve* organic systems of management, i.e.:

- how can we increase the benefit of mineral fertilisers?
- is a 3/4 year ley sufficient to restore soil nitrogen levels and soil structure?
- how can we maximise nitrogen fixation in an organic system?
- how can we maximise phosphorus availability from given inputs?
- evaluation of various green manure crops on the incidence of potato diseases;
- evaluation of different cover crops on weed control and soil health;
- use of ploughed in cover crops to increase protein content in cereals;
- optimising resources in organic farming;
- evaluation of different wheat varieties to optimise competition against weeds.

Recent Research by the Organic Advisory Service

Certified organic/biodynamic farmers farm according to their given philosophies and standards, in the belief that their systems are sustainable over time. A recent action research project by the Organic Advisory Service examined sustainability indicators on a certified farm and found that this farm qualified well in all aspects of an agreed definition of agricultural sustainability.

It is the author's belief therefore that in farming according to a strict set of guidelines (which concentrate on the regenerative aspects of agriculture and minimise the threat of environmental disruption) organic/biodynamic farmers' quest for sustainability is well ahead of the more conventional agricultural industry in Australia.

Importantly, therefore, examination of sustainable agriculture indicators on other farms may well illustrate the benefit that certified organic growers can provide to the whole agricultural and social system. The implications here are that the certifiers should also be aware that their standards are consistent in their management directives on what constitutes sustainability.

On-farm research that works with the organic farmer in an action research project must be the research of the future in Australia.

A Membership/Industry Perspective

At a seminar held last year a quick survey of 40 key industry people from growers to retailers & consumers were asked "If your fairy godmother gave you three wishes how would you spend them in relation to the organic industry?" The main responses were:

1. Industry unification;
2. Better and increased promotion; and
3. Education of the public.

4. Non-Government Organisations

LIZ CLAY

Australian Conservation Foundation

Powelltown Road, Piedmont, via Noojee, Victoria, 3833

I represent the Australian Conservation Foundation (ACF), and in particular Jason Alexandra who has been working as the Rural Liaison Officer for ACF for a number of years now. Some of the issues that relate to agriculture of particular interest to ACF include water quality, land degradation, and land care. For example, we have done a lot of work for the Murray-Darling Basin Commission, but we are mainly concerned with ensuring that the ecosystems integrity is maintained throughout Australia.

Australia spends something like nine hundred million dollars on agricultural research and development each year, and ACF's view is that this funding needs to be more strategically focused towards sustainable agriculture. In particular, it needs to be focused on ecologically sustainable agriculture to fit in with the ecologically sustainable development commitment that the federal government has made.

The organic farming community is a group of farmers following a farming methodology that claims to be sustainable, and claims to be environmentally friendly. ACF take particular interest in organic farming because its principles fit in very well with how we believe our ecosystems can maintain their integrity; but we don't stop there. We are interested in seeing how the whole agricultural industry can move towards a better way in which we look after our natural resources.

ACF also believes that ecologically sustainable agriculture is very much a farmer issue; farmers are central to this notion. If there is a claim that these organic farmers are undertaking or developing sustainable systems, then it makes sense that we look to see what those farmers are actually doing. We might need to go and have a look over the fence and make an assessment of it so that we can identify some methods that could be transferred to other industry sectors.

ACF has, in conjunction with a number of organic growers, constructed a strategy for research and development to see which practices the organic farming community reports to have developed may be transferred to other sectors of the industry, to facilitate the wider adoption of sustainable practice. In effect, this means using organic farms as a model for the wider adoption of sustainable agricultural techniques.

The ACF has proposed a systematic approach to research, development and extension undertaken in cooperation with progressive organic or sustainable farmers (Alexandra, undated). We don't want to exclude anyone from that; if any conventional farmers claim to be ecologically sustainable then they may also submit a research and development proposal under this scheme. The most important aspect of ACF's strategy is taking research and development out of the research farms, out of laboratories and into a new era of collaboration with the farmers to whom the results must be relevant.

As some of this research is taking place on farms already, our interest would be to focus resources on farmers that are actually doing research and development. This may involve a re-definition of the objectives of some existing research programs, as they are evaluated against their contribution toward the clearly defined objectives of ecologically sustainable development. There would also be a need for remuneration and recognition of the farmers who are doing this work and perhaps researchers assigned to work with them. There is a wide range of successful and innovative farmers, however, ACF intends to support those who have developed innovative organic farming systems. This is not only because they have low use of synthetic compounds and fertilisers, and have lacked the support of official farm management advice, but because there is an explicit inclusion of environmental values in their farming systems.

If we continue to ignore what our successful and innovative ecological farmers are doing, what we're doing as a community is being irresponsible, wasteful and foolish. There are a few things we need to do. We need to overcome the barriers to the adoption of low input farming, and the traditional bias against research into low input techniques must be reversed. Successful organic farms are operating in a wide range of conditions throughout Australia, producing a full range of agriculture commodities.

So what are these progressive farmers doing? We need to understand and describe the agroecological processes that are occurring on these farms, and identify how agriculture in Australia generally can benefit from them. We need to characterise these farms measure and compare production relationships, soil crop processes, nutrient and disease relationships, energy and carbon budgets, water sufficiency, and runoff characteristics.

The next question is how can that knowledge be transferred to mainstream agriculture? As Els Wynen pointed out in her paper, we may first need to make a shift in our thinking that includes the concept of holism. That is not to throw out the reductionists, but we need to start thinking about whole farming systems on a wider scale.
ACF's proposal provides a number of recommendations on research and development into organic systems that could be applicable to the general farming and agricultural community (Alexandra, undated). These include starting up a research and development extension program that looks at organic farming systems and finds out what they're doing, and does this in collaboration with the farmers who are actually doing it. This may involve looking at funding from the millions of dollars that other industry sectors are using for their own research and development.

References

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ELS WYNEN

Australian Consumers' Association

3 Ramage Pl, Flynn, ACT, 2615

I am speaking on behalf of the Australian Consumers' Association which is committed to the protection of the consumers interests. In connection with organic farming they were interested to be on OPAC from the beginning of 1990, in order to protect the interests of the consumers who purchase or would like to purchase organic products.

In connection with that there are three major issues which are of interest to the ACA. One is to know what organic products are. When consumers buy an organic product in the first place they want to know what it actually is. OPAC also look at the standards for organic products as you probably saw in the background paper, so if consumers want to find out what they're buying they can look at this.

The second issue is of course how they can be sure that the food said to be organic is actually organic. And all of this comes back to what we were talking about this morning with the certification schemes. Somebody will check the farmer to see whether the product which has come off their farm is produced according to the standards which were set. OPAC went on to see whether the certification schemes are doing a good job, and that is part of the system for the market, at least for the export market. The ACA is glad that we can guarantee overseas consumers that that is what comes out of Australia as organic is organic, but I have to say that it has taken such a long time—and is still taking a long time—to guarantee Australian consumers that organic really is organic. The ACA is very interested in trying to get this issue resolved for the domestic market.

The third major issue the ACA is concerned with is the ability to reach consumers. We can have standards, we can have the certification scheme, but unless the consumer knows what the logo on the products actually means, it isn't very useful. In connection with that the ACA would prefer only one logo rather than the current six different logos, because that only makes life very difficult for consumers.

Those three issues are the ACA's main concerns.

5. Statutory Authorities

JOHN HALL

Australia New Zealand Food Authority - The Labelling of Organic Foods

Box 7186, Canberra MC, ACT, 2610

In 1993 AQIS applied to the then National Food Authority develop a domestic food standard for organically grown food. The application sought to have included in the Food Standards Code a requirement that all foods labelled as 'organic' or similar, also to be labelled with the name, the registration number of the organic producer, processor or importer and the identification of the accredited organic certifying organisation.

The AQIS application sought to ensure that 'organic' only be used in labelling food produced by growers or manufacturers who are certified under a certification scheme operated by AQIS and peak organic organisations. The standard against which authenticity was to be tested was the standard developed by OPAC.

In seeking to give effect to the application, the Authority became concerned about the legality of a provision in the Food Standards Code which made certification of a grower (by AQIS/OPAC) a precondition for selling food as 'organic'. Subsequent advice from the Attorney General's Department confirmed that the Authority would be outside its powers if it were to include a provision in the Food Standards Code requiring food to be labelled with a certification mark issued under licence by a third party (AQIS or OPAC members). AQIS chose to withdraw the application rather than press the Authority to regulate the use of the term 'organic' (and similar terms) through the Food Standards Code.

The Authority remains concerned that food legislation is an inappropriate place for provisions governing both the production and labelling of organic food. It holds the view that the production of organic food cannot be enforced by those with responsibility for enforcing food regulations because a specialised understanding of organic production systems is required.

The Authority would probably have no legal difficulties accepting for assessment an application which sought organic labelling provisions as long as there was a clear and agreed definition of 'organic' and there was no condition for the grower or manufacturer to be certified by only prescribed organisations. The Authority is assisting AQIS to develop a revised application which incorporates these important elements.

It is also the Authority's view that the organic industry may need to increase its efforts aimed at addressing the problems of consumer deception and retail fraud which it claims is taking place rather than seeking strictly regulatory/enforcement based solutions to these concerns. Consumers generally appear to have a poor understanding of what constitutes organic food and while this situation remains the scope for fraud and deception exists.

The Authority remains committed to working with the organic food industry, OPAC and AQIS in developing a regulatory framework for protecting the interests of genuine organic operators and the growing number of consumers of organic food.

MATTHEW MORROW

Murray Rural and Business Advice Service Inc.

Deniliquin, NSW, 2710

The Murray Rural and Business Advice Service is a Statutory Authority that provides information on both farming and agribusiness.

Our program is to create in the Murray region a greater diversity of agricultural produce and value-adding. This is carried out with a view to servicing export markets and achieving import replacement, as well as improving marketing and developing niche markets.

To do this, we work with several target groups. In encouraging the development of new industries, we work with those people developing new industries and expanding existing ones. We carry out 'enterprise facilitation' by connecting these entrepreneurs with farmers. We also deal with agribusiness through organising agricultural marketing systems, marketing alternatives for agricultural products and developing branded products. We also encourage the formation of new Associations. This allows a group of producers to be recognised, attract funding, develop best practices, promote their produce and manage risk. We also work with individual producers.

There are several problems we see facing producers. The first is that there are no back-up services available when things go wrong. The second is the question of where to go to find information, including information about the market being supplied, such as how large they are and of what value. And there is a lack of financial data available generally, such as gross margins on production.

To overcome these problems we can work to a series of objectives. The first is to increase public awareness of the issues surrounding agricultural production. This involves generating support and lobbying for greater recognition.

Some of our other activities focus on aquaculture, including the establishment of education programs on aquaculture, with the aim of establishing the aquaculture industry and facilitating the commercialisation of activities such as carp processing.

Our suggestions regarding what is needed in the organic agriculture industry include better quality control; a produce grading system; and improved reliability of supply. Organic producers already excel at producing a commercial product, but do not yet excel at producing a high premium product. These points should be a focus for the future.

Other points of interest in the wider agricultural industry picture should also be considered. There are many structural changes going on that may help or hinder organics. The government is now wanting to work with farming bodies and there is a greater awareness of 'grass roots' problems facing farmers and primary production more generally. Partnerships with marketers are becoming more common, while agents are becoming less and less rural in area.

Finally, we should remember that successful development of small industry takes time and proper management. Essential to this is the ability to turn a perceived negative into a positive.

6. State Government Representatives

GERRY PARLEVLIET

Agriculture Western Australia

3 Baron-Hay Court, South Perth, WA, 6151

There has been a substantial increase in organic agriculture activity over the late eighties and early nineties, with both NASAA and the Bio-dynamic Association of Australia (BDAA) actively promoting the benefits of organic production techniques to farmers.

There was also effective lobbying of government agencies for action and support of the organic agriculture industry. In Western Australia, this resulted in the establishment of the Organic Council; Agriculture Western Australia introduced three organic agriculture contacts within the department, myself included; some trials were conducted to examine techniques for weed control in potato crops, but the results were inconclusive; farmer-initiated trials were funded under the National Landcare Program at Morowa, and there has been long-term monitoring of the effects of cultural practices on earthworm populations in trial plots.

However, the documented research has not all been in favour of organics. Richard Bell, of Murdoch University, has shown that 'phosphate' under an organic system does become depleted in comparison to conventional systems.

In Western Australia we have a reasonable number of organic sheep, cattle and wheat producers, and a few small producers of organic vegetables, fruit, wine and milk. Organic wheat growers formed a cooperative which established a mill and marketed organic flour.

Despite this progress, some changes in the organic industry have been noticeable in the last few years. In the WA zone, NASAA went quiet in 1994-5, and BDAA also became less public. This is despite receiving indications from overseas buyers that there is a very large market out there. We have heard figures to the value of 40 billion Yen, although Grant Vinning suggests that it may be worth as much as US$40 billion. Already we are exporting some organic noodles to Japan, but it is clear there is scope for expansion.

To facilitate the growth of organic production, Agriculture WA has produced several information booklets, including John Burt's *Organic Vegetable Production* (1996). We have also contributed to a large number of field days and seminars on organic farming and related topics. There is now an organic training course being accredited by WA authorities (same as NSW) run by 'Green Skills'. In addition, WA TAFE are introducing a Study Guide on organic farming.

This symposium is important to help us focus activities in the future. Some of the local concerns that have been identified by farmers include nutrient supply, weed control, and uniform labelling procedures. The high-tech information systems being established in WA could also be used to supply information to organic farmers. These options need to be fully explored.

JASON K. OLSEN

Queensland Department of Primary Industries

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There are a range of factors which, from my experience, can favour or impede the adoption of organic farming techniques. I'll discuss a few of these, then give some examples of 'organic type' projects being undertaken by the Queensland Department of Primary Industries (DPI).

There are several factors which may favour the adoption of organic farming practices. The first is actual dollar votes: consumers are willing to pay a premium for organic produce. Secondly, organics is being increasingly seen as a credible alternative to conventional practice. This is particularly so as the extension of organic techniques to growers expands. Thirdly, international legislation now favours limiting the use of chemical inputs. For example, the European Union has placed restrictions on the application of nitrogen-based fertilisers, while the Montreal Protocol restricts the use of MBr. These conditions clearly favour the development of low-chemical farming practices in food exporting countries such as Australia.

Conversely, there are also several impediments to the adoption of organic farming techniques. Each of these are, in different ways, economic issues. The first is simply the cost of organic inputs in high-value commodities. This includes both the physical costs and the application costs. The second is the importance of marketable yield as a determinant of economic outcomes, and the competition resulting from the comparatively low cost of synthetic fertilisers containing nitrogen (these are 6%-7% of the total variable cost of growing a bean or capsicum crop). The third is uncertainty over whether the average consumer can be persuaded to pay the premium for organic produce. In other words, does the community *generally* place a higher value on organic produce, or only a small section of the broader food market consumers? Finally, the farmer must confront the consequences of the yield shortfall that may result from pest and disease pressure and less than optimal nutrition.

As a result of these factors both for and against the adoption of organic farming practices, there is a lot of uncertainty surrounding the decision to convert from conventional farming. However, there are several emerging issues that may favour the change to organics into the future. One is the likely removal of many biocides from the market due to environmental concerns, for example MBr due to ozone depletion. Also, the presence of nitrates and pesticides in groundwater, chemical residues in meat products and 'persistent' chemicals finding their way into the environment are all likely to result in further restrictions on the use of chemicals in agriculture. Similarly, water shortages and algal blooms may increase public pressure for restrictions.

Other agricultural issues that can also favour the development of organic agriculture, such as the problems of disposing of stockpiles of used plastic mulch, as well as greater awareness of the impact of conventional farming techniques on soil structure leading to soil degradation, the build up of 'yield-decline' organisms and pathogens in the soil, and elevated levels of cadmium and other heavy metals in soils from the use of fertilisers and soil ameliorants.

Finally, as these issues gain greater publicity, community perceptions of organic agriculture as a clean and healthy alternative to conventional produce are likely to be enhanced.

Queensland DPI is contributing to the greater adoption of organic-type practice in several different ways, many of which can be illustrated by the projects it is running or assisting with.

1. Queensland Fruit and Vegetable Growers are currently undertaking a "Farmcare" project, to help growers put together guidelines for growing their produce with minimal impact on the environment. Industries which will be covered include tomatoes, bananas, deciduous fruit, pineapples, heavy produce, strawberries, vegetables, avocados, citrus, lychees, mangos, papaws, grapes, melons and stonefruit. This project has been created in response to new Queensland Government legislation which outlines the 'duty of care' farmers have to the environment. These guidelines will be designed to meet that duty of care.
2. Queensland DPI itself is carrying out a project called "Development of Sustainable Intensive Crop Production Systems". It is a multi-disciplinary project dealing with groundwater, VAM, root-knot nematodes and subclinical levels of root rot (yield-decline) organisms.
3. The DPI is also running a project for the "Development and Evaluation of Sustainable Production Systems for Steeplands". It aims to develop improved production systems for steepland bean and banana cropping industries, for example minimum tillage and fallow-management options.

Each of these and other similar projects are designed to reduce the amount of chemicals entering the environment through the agricultural industry.

DUNCAN FARQUHAR

Department of Primary Industries and Fisheries Tasmania

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Total Tasmanian agricultural production has a farm gate value of over $600 million per annum. Certified organic agricultural production has never been appropriately valued by the Department of Primary Industries and Fisheries (DPIF) but would certainly be below $2 million.

Many of Tasmania's products rely, at least to some extent, on the state's 'Clean Green' image in the national and international marketplace. This is supported by the state's relative freedom from pests and diseases, which allows its industries to produce high quality production with relatively low chemical inputs.

Much of Tasmanian agriculture is based on export. With markets in many of our export destinations showing organic agriculture as a significant growth sector, developing organics is seen as taking advantage of this substantial opportunity. Organic production is neither a current priority of either the DPIF or major processors in Tasmania, beyond our commitment to sustainability. However, if a clear path to export success was evident using fully certified organic production techniques, and the systems "scored" better for sustainability, then change could be possible. Tasmania has an adaptable and innovative primary industries sector with a well established export infrastructure, a long growing season, and a cool, clean climate.

For these reasons DPIF keeps a watching brief on organic and biodynamic production in Tasmania.

Tasmania is understandably keen to ensure the integrity of the Australian and Interstate Quarantine barrier. The state is also keen to ensure it's producers adopt the cleanest production systems that are practical. At this point, organic agriculture is a source of inspiration for people trying to improve conventional production systems.

An example of such a development is the low input fungicide program DPIF developed for apples using Limil® for the control of black spot. This material stops the development of black spot by establishing a high pH which prevents the germination of black spot spores. The National Registration Authority has exempted Limil® from registration under the

Agricultural and Veterinary Chemical Code. Limil® is a physical control for black spot, helping the Tasmanian apple industry reduce its use of pesticides. Another example is that prominent Tasmanian wine producers "Piper's Brook Vineyard" are members of the Organic Vignerons Association and are keen to adopt the cleanest production systems that are practical.

The DPIF assists in networking of new growers with industry groups involved in organic production, particularly the herb industry through the Tasmanian Herb Growers Association. The DPIF new crops group, supported by the Rural Industries Research and Development Corporation, is investigating the commercial potential of four medicinal herbs in conjunction with organic herb growers throughout the state.

Two certification agencies currently dominate Tasmanian organic agriculture. They are NASAA and the local Tasmanian Organic-Dynamic Producers (TOP). There is an active organic herb growers movement in Tasmania, and there are many vineyards with an interest in organic production.

DPIF is not aware of proposals for major processing companies or large investors in Tasmanian agriculture to specifically target organic agriculture or to take advantage of opportunities presented by certified organic agriculture. There is an interest from some larger conventional producers and many smaller scale producers in this market.

Organic products feature on many supermarket shelves in Tasmania.
Retailers of organic agricultural inputs have a presence in Tasmania. Fertilisers are, however, rarely comparable in price per unit of input for macronutrients. Other "growth enhancing" products are sold with little information as to efficacy, rates and timing of application for particular crops. The pest and disease control agent range is small. Pest control would include some home remedy products that may not comply with the efficacy or safety requirements of the National Registration Authority were they to be registered. Other safe and efficient pest and disease control methods and materials may never be registered nor their use extended as effectively as conventional chemical controls under current systems. As in most countries and all Australian states, the testing, production and extension of safe and efficient conventional chemical controls is financed by the sale of chemical products. Many organic pest and disease control methods may not be suitable to the testing, production, extension and sales system of conventional agriculture. However, the suppliers of organic agricultural inputs in Tasmania as in other areas do attempt to provide a few answers toward safe, sustainable and efficient certified organic agricultural production.

The collection and collation of information about organic agriculture is not routinely undertaken by DPIF Tasmania. The Tasmanian certification agency TOP has supported a project to document aspects of the production system of it's members. (See Dr Graeme Stevenson for details of this project).

Organic agriculture is not an area where clear gains attract major government or private resources. DPIF Tasmania welcomes moves towards national coordination and systematic approaches to taking advantage of the opportunities presented by the organic agriculture movement. DPIF looks forward to a time when exports of Tasmanian organic produce contribute to the prosperity of our state.

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ROBYN NEESON

New South Wales Agriculture

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New South Wales Agriculture plays several roles in facilitating the development of the organic agriculture industry. We assist the Commonwealth government's development of standards through working with OPAC. We conduct and encourage research and development. This is largely industry driven. There is an agriculture extension network throughout the State which provides information to assist growers, and we work in cooperation with the TAFE system to facilitate education, including home study courses, and with short courses in organic techniques offered at the Murrumbidgee, Yanco and Tocal Agricultural Colleges.

NSW Agriculture also has an Organic Waste Recycling Unit, which examines composting methods for food plant waste to use on crops instead of landfill. We are also carrying out research into Integrated Pest Management and biological control systems. Shortly the Internet ill be utilised to provide information on organic techniques and research results to NSW Agriculture Officers and directly to growers.

The NSW Agriculture is currently restructuring it's research and development program. It is developing Cooperative Research Centres and centres of excellence, which will increase research into organic farming systems. The Department has a mandate to facilitate self-reliant industry groups and linkages between sectors.

Overall, NSW Agriculture places great importance on encouraging the adoption of sustainable, resource efficient systems that are profitable and have minimal off-site effects. I believe that organic systems, in general, fit this description. As such, the more farmers adopting organic techniques, the better.

This outcome is being facilitated by the Department's extensive research and development program, supported by a comprehensive advisory network to ensure that the information reaches the growers. This research and development needs to be strongly industry driven to ensure it is relevant.

Two areas where NSW Agriculture can assist with the greater adoption of organic farming techniques I believe to be financial management planning through the conversion phase, and the development of a clear marketing strategy for organic produce. Industries are encouraged and supported by NSW Agriculture to develop market focused plans.

ROSS CLARKE

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The Department of Natural Resources and Environment (previously known as the Department of Agriculture, Victoria) acknowledged the growth of the organic industry in 1988. A survey of organic retail outlets in Melbourne and Geelong (Clarke, 1988) found that:

i. there were 24 specialist organic retailers representing 1.5% of specialist fruit and vegetable stores in Victoria and turning over $2.5 million annually
ii. Supermarket chains were likely to sell organic produce
iii. there was an undersupply of some fruits and vegetables, and
iv. there was a need to introduce consistent labelling practices.

One of the key recommendations of the report was to introduce a national certification scheme which would reduce the number of 'grades' presented to customers, provide uniform labelling and be backed by an industry trademark or logo.

Under the Department's Clean Agriculture Program, a Manager (Organic Farming) was appointed in 1989 to identify and conduct relevant research, assist industry to develop standards for organic produce, promote better understanding of organic farming practices and assist the industry to develop market opportunities. The Department released a Directory of businesses and services to the organic industry (Morgan, 1989).

To ensure that programs were relevant to industry needs, the Minister for Agriculture and Rural Affairs established the Organic Produce Consultative Committee which consisted of representatives of the members of the major organic associations, including farmers, distributors of organic produce, members of the major organic associations and Department staff. The Committee identified strategies and projects to develop the industry, barriers to development, and provided effective communication between government and industry. A key part of the Committee's work was to develop uniform standards for organic produce. The initial work was built upon by OPAC which in 1992 released the National Standard for Organic and Biodynamic Produce.

A survey of consumer attitudes, perceptions and behaviour with respect to chemicals in fresh food production (Parigi and Clarke, 1994) was undertaken in Melbourne in 1989 and repeated in 1992. The survey identifies that the "clean food issue is a universal and growing one, fuelled largely by a fear of the unknown." The report found that although the amount of organic food purchased had increased from 1989 to 1992, current non-purchasers are less likely to buy organic produce in the near future because of "lack of availability", "quality" and "price". The survey was again repeated in 1995, and provided evidence that consumer perceptions regarding chemicals in food had improved for fresh fruit and vegetables, but not for meat and dairy produce.

A Sustainable Vegetable Production Systems research program was established at the Vegetable Research Station, Frankston, in 1989 supported by the Department's 'Cleaner Agriculture Program, RIRDC, the Chicken Meat and Egg Industry Research and Development Councils, and the Victorian Vegetable Growers' Association of Victoria (Morgan, 1990). The research included compost experiments, IPM approaches and a study of conventional vegetable production which monitored crop performance, soil micro-organisms and soil invertebrates.

A survey of 900 Victorian farmers was undertaken in April 1989 to:

i. determine the extent of organic production in Victoria

ii. quantify current awareness, understanding and attitudes towards organic farming practices amongst Victorian farmers
iii. develop an understanding of farmers' intentions towards adopting organic production systems in the major agricultural industries, and
iv. determine farmers attitudes to the benefits and disadvantages of adopting an organic production system.

The study found that about one third of Victorian farmers have an interest in developing organic production systems and that organic farming appears to be practiced by between 3% and 9% of respondents (Clarke, 1991). The lack of a fixed number indicates the problem of farmers having different definitions of organic farming. The study identified a pressing need for on-farm production information before farmers decide to adopt organic practices.

In 1991, a joint project was funded by the Department and Dairy Research, (Small *et al.*, 1994). The project built upon the findings of some preliminary studies of Biodynamic dairy farms in northern Victoria. The project had the broad objective of "studying methods used by alternative dairy farms in order to understand them and identify those practices that may be applicable to conventional dairy farms". Measurements taken included soil and pasture characteristics, status of herd health, chemical and sensory characteristics of milk, stocking rates, milk production and nutrition, and a financial comparison of conventional and biodynamic dairy farming in the Goulburn and Murray valleys.

To assist those interested in adopting organic farming practices or wishing to gain certification, the Department has published "Organic Farming—Getting Started" (Madge, 1995). It explains the principles of organic farming, and the steps involved in certifying an organic farm. It also includes lists of industry and Department contacts and relevant publications.

The Department is committed to continuing to assist the organic industry. It is represented through the Standing Committee on Agriculture and Resource Management on OPAC. Current research programs include a study of crop and pasture rotations for organic grain production (see Newton *et al.*, this volume).

The Department's Agribusiness Unit has identified orders for organic produce from Japan that conservatively exceed $100 million. Clearly, the organic industry has potential to grow but it is still constrained by a small supply base, under-developed distribution systems and a lack of coordination and product promotion. It is very encouraging to see the industry working towards addressing some of these issues.

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7. Post-farm Sector

GRANT VINNING

Asian Markets Research, Opal Beef

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The Opal Beef project was conceived by David Brook at Birdsville in the early 1990s. It was his opinion that beef produced in the Lake Eyre catchment was "clean", if not organic, in that it was produced without access to grain treated with chemicals, that all the pastures are naturally grown without recourse to fertilisers, that the animals were not dipped because the region is west of the tick line, and that producers in the region choose not to use Hormone Growth Promotants and/or antibiotics. The project area takes in about 400 000 square kilometres: the eastern edge of the project is managed by Scott Fraser. Some of the properties are immense: most are at least 25 000 hectares, with some greater than 15 000 square kilometres. Most members run around 400 breeders but two members have over 15 000 head each.

Asian Markets Research (AMR) undertook the market research for organic beef in Asia, provided marketing skills training and managed the group's market development mission. In 1994-95, AMR went to Singapore, Taiwan, Korea and Japan. The group concentrated on the Japanese market for reasons of market size (126 million people), spending power (Japan has the second highest per capita GDP in the world), and a history of demanding clean food.

As an adjunct, it is noted that Singapore has a organic food market. Based on the up-market Japanese-based department stores, the market is small but growing. Since 1994, AMR has observed a marked growth in the Taiwan organic market. It has moved from a tepid "we could be interested" to the existence at the June 1996 Taipei International Food Fair of several booths dedicated to organic food.

The Japanese organic market is significant. It has four main outlets:

- HAN or home delivery system where consumers undertake *sanchoku* or direct negotiation with producer groups;
- the retail sector;
- the food service sector, especially the restaurant trade; and
- food manufacturing.

Up to about five years ago the organic food market was dominated by stores in the Japan Consumer Cooperative Union (JCCU) system. Since then there has been a major move into the organic food market by conventional food outlets. With the retail sector, organic foods are now being sold by some of Japan's major retailers as part of their policy of being able to offer their consumers choice. In the food service sector some of Japan's largest restaurant chains are now offering its customers the choice of a conventional as well as an organic menu.

From this has emerged a system of importers, distributors, retailers, food service sector, and food processors who are familiar with organic products. Members of Opal Beef met representatives from each of these sectors in their March 1996 market development mission.

Legislation regulating the organic industry in Japan is vague and nebulous. The process involves six steps. The result has been confusion and some distrust of the term organic. As a result a number of the major buyers of organic food have created their own testing laboratories. This is particularly true for the JCCU. Opal Beef visited one of these stations in order to become familiar with the process. To a large extent, approval or certification from this process is currently more important than certification from an Australian certifying body.

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Introduction

The battle is not over when a crop has been grown organically and sold organically. This paper addresses the storage and transport part of the chain of production/marketing, concentrating mainly on durable foodstuffs. These are dry commodities such as cereal grains, dried fruit, and derived dry milled or as mixed products such as flour or muesli.

Durable foodstuffs are subject to a range of insect pests. If left uncontrolled, these pests can multiply and cause a variety of damage as well as simple loss of weight. Insect infested foodstuff is not tolerated by most consumers (including purchasers of organic food), and for export products there are often specific regulations and/or content specification requiring they be pest-free and inspected to show that this is so. If grain is harvested and sold or processed immediately, control of pests may become someone else's problem, but in general durable foodstuffs will require some pest control somewhere in transit from harvest to consumption.

For perishables, such as vegetables and fresh fruit, the pests found on the product are normally those which originate as field pests. While their presence may also be unacceptable to markets/consumers, they are typically controlled prior to harvest and do not multiply or damage the product post-harvest. A few semi-perishables such as potatoes and onions may be attacked by pests in store. Control is best effected by good management and store hygiene, but some of the processes used on durables may also be applicable.

Fortunately for the organic industry, there has been much research effort in developing non-chemical pest control processes for grain and other durables in storage. This has been driven by consumer and market aversion to chemical pesticide residues on foods, and has resulted in several technologies which can be classed as organic but are used by the commercial sector. It must be remembered too that grain storage used to be organic, and that the use of chemicals for pest control is only a recent introduction (since 1960 for bulk grain storage). Many of the processes used previously still have utility, though they may need adaptation and improvement to meet today's standards and commercial environment.

Disclaimer

In the summary given below there are a number of processes identified which can help control stored product pests. Different certifying agencies and markets have different requirements for a product to be organic. Additionally, there are a variety of local and national regulations, including registration and residue requirements, which may restrict application of the processes. Furthermore, some procedures have a degree of hazard associated with them. Intending users should familiarise themselves with these various restrictions and take appropriate action before attempting use of the processes set out below.

Additionally, what process is best is very situation-dependent—what is simple for a 1000t welded steel bin may be inappropriate for an unsealed farm bin or bulk muesli in a retail outlet. Professional advice should be sought in case of doubt. The effectiveness of the treatments is often also dependent on the skill of application and suitability of the storage. However, in all cases, good management is important to their success.

In general, grain and similar products should be stored cool and dry to minimise risk of pest and mould damage, and to preserve quality. A few commodities, eg dried sultanas, may lose quality in cool storage, so care is needed even in this.

Toolbox

Different processes are particularly applicable in different scale of storage and situations. Choice of process is best approached on a case-by-case basis, but the following may act as a general guide.
For small lots of up to 50 kg, as found in some specialist production, and retail and wholesale outlets, approaches include:
1. Insect proof packaging. The product is packed in a film with low oxygen permeability, and the pack may or may not be purged with an inert gas (N_2, CO_2 or a mixture). If pests are packed within the package, and it is not purged, then their respiration lowers the oxygen within the pack to insecticidal levels. The pack must be very well sealed—insects are adept at finding small imperfections in seals and laying eggs through these into the package. They may also bore through packs, though generally these are from the inside out, not vice versa.

2. Low temperatures. Stored product pests are quite tolerant of low temperatures, but treatment at -18°C, the temperature of a domestic freezer, will give control in a day or so. Additional time must be allowed for the cold to penetrate to all parts of the pack. This is quite slow.

3. High temperatures. Heating to 62°C for a few seconds or 55°C for two hours will give control, but again additional time must be allowed for heat to reach the centre of the pack. Heating in a domestic microwave oven is a possible option. With heat, in particular, experiments must be carried out to ensure that the product is unaffected and the pests are killed. With most grains and grain products there is a window of opportunity where the pests are killed but quality is maintained. It is easy to over- or under-heat.

4. Inert atmospheres. Small lots of grain or grain products can be placed in plastic dustbins or other gas-tight enclosures (with the bins the trick is to invert the lid and then tape round the seam with wide PVC tape) and then treat with CO_2 using about 3kg per tonne of product or m3 of space. CO_2 can be added from a cylinder through a probe into the bottom of the enclosure or as dry ice onto the product surface prior to sealing. Some products absorb a substantial quantity of CO_2 creating a vacuum which needs to be relieved to avoid damaging some rigid enclosures.

Larger 50 tonne silo lots, as commonly found in small farm bins:
1. Inert dusts. There are certified diatomaceous earth dusts (eg Dryacide) that can be added to dry grain to give long term protection. Magnesite and lime are also used by some growers, though these are much less effective than Dryacide in terms of quantity needed per tonne of grain. Inert dusts can be used in poorly sealed bins, but are not acceptable to many markets, because of the change in grain properties they cause.

2. Controlled atmospheres (CO_2 and nitrogen). CO_2 has been used by some organic growers for many years to disinfest bulk grain. For use, it requires a well sealed and preferably white painted bin (outside). Nitrogen has been applied with success experimentally, but, to my knowledge, is not yet used. At present, gas cost makes nitrogen unacceptable.

3. Smart aeration. CSIRO experiments have shown that carefully controlled and managed aeration may yield grain to insect free standards. A surface application of an insecticidal barrier such as Dryacide or pyrethrum appears to be needed. The process is not yet fully tested at 50t bin scale.

For large scale grain storage, typically lots of 500t or more:
1. Integrated control using controlled atmospheres and cooling. GRAINCO, in their BFA certified store at Malu, Queensland, use a combination of CO_2 treatment, to disinfest the grain bulk followed by cooling using refrigerated aeration (air is cooled and dehumidified by passage through a refrigeration system) to preserve grain quality and prevent reinfestation. Dryacide is used as a structural treatment to control pests around the storage bins and good hygiene practices are in place throughout the store.

2. Smart aeration. Well controlled aeration combined with a surface application of Dryacide are used by Uncle Toby’s for their

organic storage. This combined process is in use in Australia for canola and wheat storage at a field trial level, with results suggesting that it can be used to provide export grade insect free grain when well managed.

3. Pyrethrum. Where certifying agencies, residue restrictions, and markets permit use of synergised or unsynergised pyrethrum spray, added as a grain protectant, this is a theoretical possibility for disinfestation and long term protection of bulk grain. In the past, a combination of pyrethrum synergised with piperonyl butoxide has been used successfully, but costs are quite high.

4. Controlled atmospheres. Both CO_2- and N_2-based controlled atmospheres have been used in Australia for grain disinfestation. Nitrogen is routinely used at GrainCorp's Newcastle terminal for treatment of conventional export grain and CO_2 is in use in a small number of sites across the country.

5. Heat. Heating of grain briefly into the low 60°Cs followed by rapid cooling has been demonstrated to modern commercial prototype level in Australia using a fluid bed rig heated from a propane source. The prototype treated grain at 200 tonnes per hour. The process is not yet in commercial use for bulk grain but offers the prospect of in-line disinfestation to residue-free standards.

For export containers:

1. CO_2 disinfestation of grain in export freight containers has been used by the organic industry since the mid-1970s. The main special requirement is a well-sealed container meeting a pressure-test standard to retain the gas well for an adequate period.

Concluding remarks

The organic industry is quite well supplied with options for pest management and elimination in bulk grain, other similar commodities and derived products. There is a clear need in the organic (and conventional) industry for modern extension literature to allow potential users to choose appropriately between the options and apply them safely and effectively.

IAN DIAMOND

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I shall start with some wide, sweeping statements:

- This organic industry is alive and well and very, very healthy;
- It is strongly established and growing strongly;
- It has strong government support and acceptance and, in some areas, encouragement in the form of subsidies for organic farming and conversion; and
- The organic industry has attained market shares greater than 2% of food sales in some areas.

The organic industry I am talking about is the international organic industry. Overseas, there is great strength in organics.

My company, Organic Connection Australia Pty Ltd, specialises in exporting organic foods from Australia and has been doing so for a number of years.

One year ago I moved to Europe to assist our company develop stronger markets for Australian organic foods. We have been successful in this development and are thankful to the Australian organic certification bodies for their high quality standards. We are also thankful to people in AQIS who have helped Australia attain government to government respectability for Australian organic foods. Finally and most importantly we are very grateful for the Australian farmers that have supplied us with quality organic foods.

I have some concerns about organics in Australia:

- The domestic market is very weak and so there is a large gap between export and domestic production, leading to uncertainty for producers.
- Also of concern is whether the number of organic farms will be maintained if sufficient markets are not obtained. Will we see a reduction of organic farm numbers in the next few years?
- Value-adding in Australia tends to be internationally non-competitive, particularly in relation to organic products. This limits export potential.

Promotion and public relations for organics in this country are grossly inadequate to give the organic industry a decent profit, which leads me to the point about fragmentation and unity and the talk about an umbrella body. It is very unlikely that an umbrella body will suit everybody. Nevertheless, that should not stop it if it has the ability to represent a large portion of the organic industry, not just the certification bodies.

Dr Stevenson used the word philosophy and I would like to suggest that we extend the use of the word to include "vision". This symposium gives us the opportunity to move ahead with vision for the Australian organic industry.

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Organic Foods of Australia

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Introduction

One of the basic tenets of marketing any product is to match the supply of product with the needs of consumers. It would appear that in the marketing of organic foods in Australia, this basic principle is, in many instances, being misunderstood or forgotten. Instances of organically grown produce being sold as conventional foods through a lack of matching supply with demand are widespread. The perceived consumer need is not matched by reality.

In order for organic growers and processors to continue to invest further in the industry, a coordinated approach to match supply with demand, and promote the benefits of organic food to the general public, must be adopted. In addition, other growers and processors need to be recruited into the industry to develop the economies of scale necessary to make production more cost competitive. The general consumer is ready to purchase organic foods on a regular basis, but only when the premium for such a purchase is within reasonable limits.

Building a Viable Organic Industry

From a marketing perspective, the authors perceive four major impediments to the growth of the Australian organic industry at the present time.

These are:

1. A fragmented approach to matching the growing of organic produce with end markets which often results in an unsatisfactory return on investment for those involved.
2. Processors and consumers are frustrated by fluctuations in the supply of organic produce. Markets that have been established can be lost overnight because there is no coordination of growers to ensure markets are protected by spreading the risk against crop failure.
3. In many instances, organic farmers are placed at a price disadvantage against their conventional counterparts because of the requirements of being an organic grower. In order for the grower to maintain a reasonable return, unrealistic premiums are being asked for organic foods at store level which the majority of consumers are not prepared to pay.

4. The general consumer has little appreciation of the benefits of organic produce, resulting in general apathy and an unwillingness to pay a premium for such produce with the end result being lack of demand.

In the paper 'Overview of the Organic Industry in Australia' (Dumaresq and Greene, this volume) the authors summarise the limitations of the future development of a sustainable Australian Organic Industry with the following comments:

1. The level of production is small and, starting from such a small base, is likely to remain small for the immediate future.
2. The development of larger markets requires a greater level of organic production and any increase in production requires the development of larger assured markets.
3. Considerable local and regional planning for increased production of the organic product and its post-farm handling will be needed to achieve market development.

It is the authors contention that until these key issues are addressed as a priority, the growth of an internationally competitive Australian organic industry is unlikely. Under scrutiny these issues appear to present a "chicken and egg" paradox. Essentially, without a reliable market, the risks of increasing production of organic food is considered too great, but without a reliable source of organic produce capable of growing quickly to match demand, post farm activities (processing, marketing, distribution) are highly speculative.

The consequences for the Australian organic industry are serious.

In marketing terms, the Australian organic industry must identify its 'Sustainable Competitive Advantage' (SCA), that is, an attribute that is unique to Australia. In product terms this is also referred to as a 'Unique Selling Proposition'. From an international perspective the most obvious SCA is Australia's reputation for having a pristine environment - clean air, clean water, uncontaminated soil, *et cetera*. This is further supported by Australia's enviable position as a regional 'Bread Basket' with a strong agrarian identity.

In order to capitalise on this image the Australian organic industry must be given a higher profile in our potential export markets. The first stage is to present a unified, internationally recognised 'peak' body with widely understood accreditation requirements and definitions.

Stage two is to begin to build 'Brand Identity', under which a broad range of products can be marketed and into which investment can be made. Having unified the approach, both administratively and by brand, the fragmentation of the industry is addressed, however the 'Supply versus Demand' issue remains.

A solution proposed in this paper is to effectively 'reverse engineer' the conventional marketing approach. In this approach potential markets are identified and researched to determine the specific product requirements. Having identified the potential and the niche, the establishment of a chain of distribution is required (if only on the basis of an expression of interest at this stage). Finally, with estimates of demand from market research, the product is selected. This is the critical stage of the exercise as the control of demand is only possible through the broadening or narrowing of the target niche, i.e. positioning of the product through price and distribution (limited availability).

Having established a bridgehead with an initially limited range of uniformly branded products, growth will be dictated on the basis of product availability. As availability increases, so the distribution is broadened.

This strategy is most successful where multiple markets are targeted as it provides a hedge or risk minimisation should one market experience a downturn.

Clearly for demand to be regulated by product (or brand) positioning, it is imperative that there is a close association between the marketer and the coordinating peak body, creating accurate forecasts of demand and availability.

In support of the statement that the consequences for the Australian organic industry are serious is the level of marketing activity being undertaken by New Zealand and the USA in particular.

In 1992 the U.S. Agricultural Trade Office commissioned research into 'The Japanese market for health food and beverages', a comprehensive appraisal of fresh and processed organic food product demand at a cost of US$400 000. Similar reports (and expenditures) have been commissioned by NZ and not surprisingly both NZ and the USA in particular are enjoying the benefits of this research as the demand in Asian markets for organic food continues its steady growth. According to the USATO report in 1989, the market for organic food in Japan totalled US$268 million, 38% of which was processed. The market grew at 40% per annum during the previous 4 year period and was conservatively forecast for 20% per annum growth.

Australia runs a serious risk of failing to gain significant market presence in these rapidly growing markets. Equally, Australia needs a broadly based, successful, export orientated industry to provide revenues for the development of the small but vital Australian domestic market.

Economies of scale in production of export requirements will not only increase grower and processor returns on investment, but in doing so will reduce the need for excessive premiums currently required to make sections of the organic industry viable. Without this cost barrier, and with wide product availability combined with broad awareness of the positive attributes of organic produce (high nutritional value, philosophy of sustainable agricultural practices etc.), the market for organic produce domestically will undoubtedly grow.

Summary

- Australia requires a broad based, successful export market to stabilise product supply and ensure consistent and reliable demand.
- To be a successful exporter, a unified, international profile must be created for the Australian organic industry peak body.
- The demand for product can be regulated through selective marketing activities. ie. appropriate product or brand positioning.
- Coordination is essential between the industry peak body and marketing activities.
- A successful export initiative will provide revenues for the development of domestic markets and provide economies of scale for organic growers, thereby increasing their competitiveness against non-organic growers.
- The increased profile for organic products generated through domestic marketing initiatives (made possible through revenues from export) must promote the positive attributes of organic produce such as high nutritional value and the value to society of sustainable agricultural practices. Focusing on negative attributes of non-organic produce (pesticide/herbicide residues, additives etc.) must be considered as a secondary communication objective to avoid ‘mainstream’ backlash.
- The Australian organic industry is competing in an international market place and is currently well behind its competitors in securing and developing international market share. Greater emphasis and corresponding investment are required in the area of marketing and market research in particular.

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JOSEPH ALLAIS

Joseph's, Retail

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There are four points of interest regarding the future viability of the retail and wholesale trading sector in organics.

1. Quality of supply
2. Consumer confidence
3. Lack of information available to the public
4. Certification standards

All of these points are what we would describe as grey areas, and in some way they all tie in with one another.

We are aware, as you all are, that there are a large number of producers who are organic but do not choose to become certified, for some reason or another. It could be they are too small, too large, already have guaranteed sales in their own specific markets, or maybe it is just not worth the added aggravation. If these growers alone were all of a sudden to enter the organic market, it would create competition. Competitiveness would come in the form of quality and choice without lowering prices, as most producers fear. If quantity of supply rises so does the quality, one step in building consumer confidence.

Most consumers would love to buy organic—it tastes better and it is better, so why don't they buy it? I feel there are two reasons:

i . PRICE: They use this as an excuse not to buy; and

ii. FAITH: They have no faith in the industry of organics. This becomes evident with the lack of information available to the public of the certifying standards.

As retailers and wholesalers we would like to see an overriding council in place which accurately represents the organic industry. The certifying standard for this council would be in line with the terms and conditions that the government has set down for export. With this council in place, when a member of the public next questions the reliability that the product they are buying is truly organic, we will be able to tell them that this council follows government guidelines, ensuring that the consumer is getting what they pay for.

People understand government; they cannot comprehend an ever increasing number of acronyms pertaining to independent certifying bodies. This however, does not make the existing certification agencies redundant; it enhances them as the next step in organic farming. They would then have the time and resources to inspect farms and shops on a regular basis, and provide more scope for information to be passed on to the consumer via the wholesalers and retailers.

We envisage a more committed certifier with the ability to promote growers certified with them, adding another benefit–the benefit of becoming independently certified over what would be an ever-increasing mainstream organic industry. In doing so this would create more consumer confidence.

A stronger more dominant industry is wanted by us all, and I believe that by co-operating on a level that will benefit the consumer, through quality, confidence, information and united certification, the consumer will ultimately benefit all of us.

7. Farmers

NICHOLAS CHAMBERS

"Fernleigh Farms", RMB 5460, Bullarto, Victoria, 3461

Crops and Livestock Producer

I have been an organic producer for the last seven years. Primarily commercially motivated, we grow a range of products, including carrots for juicing, specialist potatoes, goats and pigs and summer crops.

Organic farmers set themselves away from conventional farmers. Conventional farmers have real skills in confronting the commercial reality; they have better access to research and development; and, through the Victorian Farmers' Federation, other state farmer organisations and National Farmers' Federation have the ear of government.

Having said that, however, we must concentrate on common positives and not negative differences. For example, mixed farming regimes developed and employed by conventional farmers can also have benefits for organic farmers, and these benefits should be shared. Conversely, there are also cultural practices developed in the organic industry that are applicable to mainstream agriculture.

Other problems arise in the post-farm sector. Organic wholesalers and marketers have not been as commercially driven as other conventional operators. For example, we talk about margins of 20%; in reality the margins on fresh produce are 100% - 200%. This kind of thing is stopping market development.

So it seems that it is easy to get so far, but to really move forward from where we are at the moment we must increase professionalism across the industry. This is not simply a matter of 'educating consumers', but actually doing a better job in all aspects of organic food production. For example, I sell 80% of my potatoes on the conventional market as the organic market as it stands is too small. It is still profitable to do this, but the profits are small in comparison to what they would be if they were all sold as organic.

To move ahead, then, I see that the organic agriculture industry needs several things. First, it needs to be self critical. Secondly, it needs to get away from the welfare mentality that is currently evident. Thirdly, I hate to be negative, but we need an umbrella organisation to publicise problems in conventional farming, such as the differences between the states regarding the registration of agricultural chemicals. Also people should be aware of the use of unregistered chemicals in conventional agricultural produce. Finally, we need to employ the state farmer organisations and NFF to negotiate with Simplot, McCains, Heinz and the big players on our behalf, as they do for conventional farmers. If we achieve this, then the organic agriculture industry will have a chance to move forward.

ARNE PEDERSEN

United Plantations, PO Box 733, Emerald, Queensland, 4720

Broadacre cropping

I thank you for the opportunity to be amongst the 'movers and shakers' of the Australian organic industry. It is very positive to be at this symposium with people of influence together defining common ground and future focus.

Farm Development

Our farm was purchased as a run down sheep station in 1982. Basically it was a fence around 15 000 hectares of bush country situated in the very fertile Central Highlands of Queensland. After closely examining the soils and soil profiles we commenced clearing blocks of selected areas in preparation for farming and crop production. This task was completed by 1986 when we had 12 000 hectares of prime agricultural land ready to farm. At the time of purchase and because of our Danish base, the Financial Investment Review Board gave us five years to develop the farm. Smart, but extremely risky. As soon as the progressive land clearing allowed us we commenced construction of our contour banks with the assistance of the Queensland DPI's soil conservationists in Emerald. Over the following three years we built some 300 kilometres of banks. Initially one, two or three banks were built from the top of slopes to give some protection and erosion control. Areas of inferior soils, hills, creeks and water courses were not cleared of native vegetation.

All our planning right from the start was long-term. We only ever focused on one crop per year and never jumped on the "free run" band wagon for this area. We incorporated legumes into our five year crop rotation. Sunflower is our first crop followed by a legume ploughed in at flowering, then two years of wheat, one year of peas, one year wheat and then back to sunflower. In later years, one of the wheat rotations has been replaced by sorghum as a result of the prolonged drought situation confronting us.

During our first ten years we continued to expand our on-farm grain storage. By 1992 we had a storage capacity of 18 000 tonnes, which includes 1800 tonnes of sealed CO_2 silos plus a 150 tonne per hour cleaning and drying facility. This allows us to segregate quality and varieties. Also, we do not have the pressure of marketing at harvest time. Grain buyers can come in, look at the wheat, sample it and decide what suits them, and from the point of contracting pay us storage. A road train (50 tonnes) can be loaded in 10 minutes, including weighing.

Transport is carried by both road and rail. In both instances, the carrying vehicle is steam cleaned to ensure no contamination of grain results from direct contact with the truck body. Only food containers are used for container shipment whether in bags or bulk. Trucks with curtains are not ideal for certified grain as the are difficult to keep clean.

Certification

Our first inspection after contacting NASAA took place in early 1985 by a certification officer from South Australia, who was joined by an officer from the Australian Wheat Board. This visit took place over several days during which time soil samples, plant material and water samples were collected. Subsequently we had several inspections at very short intervals.

The inspection officers without exception had great difficulties in coming to terms with the size of our operations and decided to certify us in stages. This also came about as a result of our trial of a small area of rain-grown cotton in 1985, with which we experienced little success. This area was quarantined for four seasons before it was cleared for certification by NASAA.

Compared with conventional farmers in our district, we always harvest our crops a week later. We take soil samples annually, always at basically the same time each year, and field samples are from the same area for comparison of sample results and crop yield results.

In our experience, we can count on little or no back-up from the DPI, especially in later years.

Conclusion

Central Queensland offers great opportunities for expanding broadacre organic crop production. The highly fertile soils are an ideal base, but I must add that in later seasons weather conditions have put a dent in our production.

ROSS CARTER

Rolson Grange, PO Box 40, Wolseley, SA, 5269

Various produce

Following are some thoughts on the need for increased research into organic/biological farming:

Research in this area is sadly lacking, yet it is required to enhance and promote this most beneficial art of agriculture. Despite Mr Dennis Avery being of the view that plastics and pesticides will save our world, and that organic agriculture produces carcinogens in our food and causes erosion, organic agriculture is about efficiency, balance, health and vitality. When God created this world, he made a paradise and it will not return to that state by plastics and pesticides, nor by the use of toxic residue chemistry. Nor will it by organic agriculture, but at least by working within the framework of nature and her laws, we will at least attain the balance and sensibility that can reverse the increasing trend toward more and more degenerative diseases and premature deaths. As the world becomes more chemicalised so the health of the population degenerates.

In the yield assessment trials of the growing of chick peas conducted by the Victorian Institute of Dry Land Agriculture at Horsham, some trial areas were sprayed with chemicals up to seven times between seeding and harvest. In one Adelaide, hospital, an average of two farmers a day are admitted in order to be detoxified from the effects of chemicals during the seasons of widespread chemical use. Yes, there is a very real need for research into organic/biological farming and scientific help to farmers/gardeners, who are working to provide top quality, health-promoting produce.

There are three main areas that require attention:

1. *Soils*

a) nutrition
b) pH
c) humus and structure
d) cation exchange capacity

In these areas balance is required and then many problems will be over come.

2. *Plants*

Crops

a) pest and disease resistance
b) nutritional balance
c) sap sugar levels
d) life force and vigour

Weeds

a) troublesome weeds
b) predisposing requirements
c) non-chemical eradication/control

3. *Animals*

a) internal parasite resistance breeding
b) supplementation, garlic powder, wormwood, diatomaceous earth
c) external parasite sulphur, seaweed meal
d) mineral supplementation, emphasis on minerals showing low in soil analysis
e) scouring effect of pasture species, culling
f) drench sea minerals, apple elder vinegar, nutrimal

On our 930 acres of farmland, situated in South Australia near the Victorian Border, we are always trying different methods, rotations and products. We are not very scientific and at times not very successful, but it does certainly keep life interesting. In each of the aforementioned areas, we are currently doing the following experimentation:

Soils:

1. Soils analysis, related soil amendments
2. carbon, Nutri-carb
3. microbial activation, bio-series microbes
4. green manure
5. remineralization, para-magnetic rock dust
6. rock phosphate, North Carolina rock, reactive phosphate, calphos
7. compost, mineral mix, Mega green

Plants: crops

1. cultivating/planting according to the phases of the moon
2. seaweed treatment, Natra-kelp
3. seed applied microbes, Biologic S.C. 27
4. trace mineral seed treatments, zinc
5. calcium foliar feed
6. fish emulsion/seaweed
7. hydrogen peroxide, anti-pathogenic treatment for chickpeas
8. species that perform without artificial stimulant
9. biological ionisation

Plants: weeds
1. encourage germination pre-planting, rolling
2. cultivate dark of moon
3. reducing effect by increase in crop density
4. tickle weeder in crop cultivation
5. row crop beans
6. double-crop beans and linseed, balansa clover
7. inter-crop medic in wheat
8. treat troublesome weeds (for example, soursob) using a tea made from themselves/sea minerals (dehydrated sea water)
9. use of para-magnetic rock dust

Animals
1. internal parasite resistance breeding
2. supplementation, garlic powder, wormwood, diatomaceous earth
3. external parasite sulphur, seaweed meal
4. mineral supplementation, emphasis on minerals showing low in soil analysis
5. scouring effect of pasture species, culling
6. drench sea minerals, apple cider vinegar, nutrimal

Summary

We have been farming organically for 20 years, and we are always looking for better methods and results. Methods that consistently show better soils and production; results that are attainable and repeatable.

Our biggest concern is crop nutrition especially phosphorous, soil structure and humus levels.

Marketing is also one of the biggest challenges, that is, growing crops that are required when it comes harvest time. The ability to store with carbon dioxide protection is a requirement that needs to be addressed by both the growers and the end users. There needs to be better communication between the two.

I wish to congratulate the organisers of the symposium. We need to take the challenge of researching within the framework of organiculture and comparing and experimenting within that framework by researchers who are dedicated to the betterment of this industry.

RON AND BEV SMITH

Boys Road, Fish Creek, Victoria, 3620

Dairy

Introduction

Farming today is like driving a car - hearing the rattles and turning the radio up louder.

We need to have a better understanding of our most precious resource - the soil - it's life force and the effects our fertilisers, weather, machines and animals have on it. Too many fertiliser companies (including some organic ones) are only interested in above ground yield, ruining our soil structure. We talk of planting trees to stop erosion when nothing is said about the paramagnetism of our soil. Many conventional fertilisers are diamagnetic, which pushes the soil particles apart, thus allowing it to be washed or blown away.

The Farming System

One of the first measurements taken when soil testing should be an accurate cation exchange capacity (CEC) to show how much nutrient a particular soil can take. The other is that the construction of the pH should be entirely by nutrient balance and not just liming to correct the acidity problem.

Too many farm consultants and companies have a vested interest in certain products. Trees are a very important part of helping our soil, but only that–a part, not the whole.

The animals that graze on a balanced pasture don't have health problems such as grass tetany, bloat, mastitis, milk fever, footrot, cancer, etc. Farmers today are bombarded with vaccinations and sprays, not even considering that milk from a dairy cow is an extension of her blood thus, even in minute trace form, these substances are coming through in the milk. This results in people with allergies and other diseases. We know that a proper balanced soil will result in a healthier animal, thus the products that we eat from these animals such as milk, yoghurt, cheese and butter, are better for our health.

They have played a big part in making our family healthier. Twenty years ago Ron was an asthmatic, which we found to be caused from allergies to certain conventional fertilisers and sprays. There have been many studies to support these claims.

Research has been driven by the powerful dollar for far too long, with sponsors *et cetera*, having vested interests in the end result. Many famous scientists have spent their lifetime studying the soil for long term results–not just one or two years, but 20 to 50 years down the track.

William Albrecht studied soils and the use of fertilisers to grow animals on plots, looking at how they grow and produce. He then went on to study many generations of their offspring, and also checked them for genetic strength.

This research would be invaluable if we could use the technology that we have today to do unbiased, accurate tests on our soils, plants and animals.

There have been comparisons between conventional and organic farms researched - the conventional farms have come out in front on product and yield. The part needing consideration is the cost factor, and the bottom line, including veterinary costs, the future health of the soil, plants and animals, the life-style of the farmers and the health of all the people who eat the food grown organically.

Humans and animals don't have to eat as much balanced food to live a healthy life. After the produce leaves the farm, more emphasis should be put into the quality of the end product for human health, ensuring the best process is used to retain enzymes in the food.

One thing that concerns us is homogenising the milk. It sells better because people don't have to shake the container, but the process of homogenising is damaging to human health. Even pasteurising is killing good enzymes and bacteria as well as bad. Low temperature pasteurisation is better. Milk should be allowed to be sold in it's raw state with more stringent tests done on the end products.

Another area of concern is that departments don't know how to go about the research of organic farms, soils, produce, *et cetera*. A part that needs researching is the time that farmers put in as constructive work and corrective work.

Constructive work includes: tending the soil, for example composting, aerating and harrowing, feeding the animals with good balanced diet and a good family life style.

Corrective work includes drenching, vaccinating, treating sick animals, spraying weeds, insects, pests, using herbicides, fungicides and pesticides. These problems are all caused by an unbalanced soil.

The research results should be freely available to farmers and the public.

Conclusions

We feel that all food sold as organic should have an accreditation label on the product by one of the recognised bodies: BDAA, NASAA and BFA. These bodies are at present being brought under the umbrella of ORGAA, an organisation that is keeping in touch with the farmers, processors and distributors, supplying valuable help and information from the farm to the customer. We need an organisation like ORGAA to keep the whole movement running smoothly. Also needed is more money for constructive research such as farmer discussion groups, information groups and packages from around the country and world, to help each other.

At the moment information, research and trials are all paid for by the farmers themselves. Testing new materials available, purchasing study books and magazines, attending libraries and so forth; these costs are all born by the farmers.

In addition, the produce from areas should be manufactured and sold locally with any excess transported to other areas; thus cutting down on the massive energy wastage with trucks, ships, planes *et cetera*, travelling in opposite directions carrying the same produce.

Bev and I enjoy the very demanding and challenging lifestyle of organic dairy farming, and the interaction and almost daily phone calls, letters and magazines from other organic farmers from around Australia and the world. We are bringing up a large family of fit, healthy and intelligent children. It is an exciting life with many challenges and new ideas to be explored. Knowing that the produce from our farm is very beneficial to health gives us peace of mind.

LLOYD PIERCE

Elizabeth Valley Mangoes, Lot 11, Elizabeth Valley Road, Noonamah, NT, 0837

Orchardist (mangoes)

There appears to be a generally uninformed attitude concerning organic agriculture in areas where it should not be, that is in the government departments of Primary Industries and AQIS. Growers can receive any amount of expert advice on conventional chemical farming but there is no comparable balance of information available for organic farming. There is a need to change this situation and to correct any misleading information.

For example: "It may work down south but not up here", "You may be able to grow organic mangoes, but not bananas, papaws, melons, vegetables *et cetera*", "There are more pests in the tropics, therefore you need to spray chemicals regularly", "There are poor soils in the tropics, therefore you need to use plenty of NPK chemical fertilisers".

These uninformed attitudes do not hold true. My experience in organic horticulture is mainly limited to mango production near Darwin in the tropical climates of the NT. There are only a few commercial organic growers in this region. There are many more individual organic gardeners from the "Permaculture" association. They all encourage and support the all-over view that there is no reason to believe tropical organic growing is any more difficult to achieve than colder climate growing.

My introduction to and education in organic farming came from the many books and magazines on methods used by organic farmers in temperate climates. Basically the same principles apply in tropical regions with the same results. The life in the soil under our mango trees keeps improving year by year. There have been no pest control sprays used in over five years. I believe we have achieved a balance in the orchard between pests and predators. The non-use of high nitrogen chemical fertilisers, I believe, also discourages thrips, which are a major problem for conventional growers. Our mangoes look and taste good.

We do of course have some problems which must be overcome without the use of dangerous chemicals. In the interest of public health, the bureaucracy in authority over the use of pesticides should fast forward the approval of Neem products, as there has never been any documented evidence of Neem having a harmful effect on people.

Mastotermes Darwiniensis (large termites) are a major problem for organic growers. The conventional chemical method is to poison the soil with an organochlorin bait or liquid, with the effects lasting in the soil up to fifteen years. For the organic grower early observation is essential. The treatment I use is to remove a branch & pour citronella oil or neem or similar low toxic formula down the termite hole, directly into the offending colony. In a few days if scavenging black ants appear then it is evident that the treatment has been successful.

Another problem involves the different standards now required between chemical and hot water dips for post harvest fruit fly control in mangoes. The chemical treatment is claimed to penetrate two millimetres below the fruit skin after the fruit is immersed in the systemic chemical, "Dimethoate", at 400 parts/million of water for a period of one minute.

The organic hot water treatment now required is for fruit to be heated at forty-six degrees *down to the core* and held at that temperature for ten minutes. This can take up to two and a half hours and causes scalding of the skin in up to 85% of the fruit. Core temperature requirements are not workable or necessary.

The original hot water tests accepted mangoes being held for 10 minutes at 46 degrees. This whole process takes up to 45 minutes for the

46 degree temperature to penetrate 10 mm. below the skin. In comparison with the 2 mm penetration of the chemical dip, this is clearly a more efficient method, and also the scalding is eliminated. This same hot water treatment also controls the fungal disease Anthracnose and Stem End Rot, thus eliminating another chemical dipping process. The present core temperature requirements place the hot water process at an unfair disadvantage, preventing the way for other fruit and vegetables to be successfully treated.

The reliance on chemical post harvest control on horticultural products has been criticised by the 1991 Horticultural Advisory Committee in the Bateman Report, and suggests hot and cold treatments already available should be used. A detailed submission on hot water dipping can be seen in a separate paper. I ask the symposium committee for endorsement to table this submission at the next all-state conference of AQIS.

Every year there are numerous reports of fruit fly infestations in mangoes arriving at the markets. This may be due to poor monitoring of the Dimethoate dip whereby leaching has occurred, leaving the dip under the minimum requirement. It may also be due to post dipping storage where no protection is required to stop fruit fly entering the boxes through the vent holes. The point to be made is, should not these two possible causes of infestation be addressed first, before the impending decision is made to change from Dimethoate to Fenthion, a more systemic chemical? To ensure our hot water dip process does not receive any undue blame, in future all of the vent holes in our boxes will be screened with 1.6 mm mesh.

I do not meant to be critical of individual conventional growers, or people employed in government departments. However, I am critical of the system, where the chemical fix is well entrenched. If events such as this symposium can lead to an educational program, reaching schools, universities and appropriate government departments, future generations are going to thank us.

RAY HYNES

"Craigilea", Willow Tree, NSW, 2339

Poultry Production

Fifteen years ago, I wouldn't have thought I would have been talking at an organic gathering such as this because I wear shoes and wear deodorant and cut my hair regularly, so things have come along way since then. About 12 or 13 years ago four things happened that made us change our thinking. One was our child was born, the second thing was my wife was watching a journal show they broadcast from The Press Club in Canberra. Kate Short was talking about what was happening to a lot of our food inputs. When you have a young baby in a cot in the next room and you're listening to this, you start to become quite aware.

About 3 months later we saw Alex Podolinski's show on the ABC, on Country Wide. A few months later we were actually living in a sandstone ridge country just out of Maitland at a place called Patterson. We found that we were constantly putting nitrogen and phosphorus on to try and keep our pastures alive to feed our cattle. Being as tight as I am, I thought 'I just can't go on, I just have to do something else instead of forking this money out just to keep the feed alive'. So between Kate Short, the birth of our child, Alex Podolinski, and the fact that I was paying out money, we became aware of biodynamics. We actually didn't actually become biodynamic there at Maitland, but we soon had a change.

About eight and a half years ago we moved to the slopes on the Liverpool range, just south of Tamworth. We were determined to make a new start on the new property, and kicked straight into biodynamics. We contacted a man who came out and inspected the farm, gave us some great advice, suggested a few things we might read, and so away we went. The farm was 500 acres, 50% was farmed, 50% was native grazing country. The 50% that was farm, we felt, was very poor in soil structure and we had an ongoing erosion problem. We had a gully which was created because the Soil Conservation people had made these lovely contour banks which concentrated all the water flow onto grassed waterways. But they didn't get grassed in time because the storm came and we lost all our grass and the waterway when the contour banks broke.

As that was the situation we decided to put all the farm down to pasture and in so doing we also went straight into a rotational grazing system which is part of the organic way of thinking. So, after a couple of years when kiddy number four came along and the farm debt wasn't getting any lower, and cattle prices weren't going up, we got rid of the sheep. I took on a bit of saddlery (I used to be a saddler), and my wife went to work for a local poultry producer, Teagles. At this stage we sat down and realised that we both loved the land, we were doing the right thing by the country, by ourselves, by the family, by the community, but we were not getting ahead, we had to go intensive.

So, we started to play around with all sorts of ideas. We thought about nuts, but we were right on the edge of the farming country, on the black soil plain, and the cockatoos would have had a feast, so we gave up that idea. We looked at stone fruits but didn't really know enough about it; we looked at cash crops, but we were both too busy to go into cash crops.

Then, a friend of ours from the coast had just got out of chickens. He recommended we go into poultry, as there was a great market for table birds, but we didn't want to set up an abattoir on the farm, which would have been necessary as we were an hour and a half from the nearest poultry abattoir.

Then, a couple of years ago, we happened to go to Agquip, a big machinery display held at Gunnedah. Going through the Department of Agriculture shed we met Ian Littleton, with organic free range egg production, so after about a 10 minute talk and a $20 outlay for his book, within 2 months we had some day old chickens on the farm; we moved into eggs.

This was just before the drought, but we had a steady cash flow, and a second batch of birds on the way. We went to the bank manager, leased a flash car that could fit all the kids in, and then a month after that the drought hit ... and it hasn't gone yet. So we sold the car, but those eggs (we had to meet a grade A), got us right through that drought. There's been a constant cash flow and it's not just because they're eggs, it's because they're organic or biodynamic, because they were certified and there was a market for them.

I'm told my eggs are probably the dearest eggs in Sydney and Melbourne, but I received a letter a couple of days ago from a health food shop in Melbourne asking "can you triple your supplies because yours is the only product that I get customers ringing me up saying 'make sure you put my eggs away because I wont be in for so-and-so days'", and he said he'd never had anyone do that for a product. So we're going to write back and say that after three years of drought and nearly selling the Pajero twice, it's great to get a letter that let us know that everything that we're doing is right.

As far as other products are concerned, the beef there is very little market for, so we just sell through the traditional market. To be organic is not good enough, you have to have quality organics. Our beef is good, we just can't convince the people who want to eat organic beef that it is organic because of our distance from the markets and transport becomes a problem.

We are now in the process of planting seven hundred olive trees. We will have to process our own olives on farm, just as we pack our own eggs ready to go straight on the shelf. We have full control over the eggs that way. We also have a descriptive label on our eggs, so that when consumers pick it up there's a story on the back. So we're going into olives now, and we hope in 5 or 6 years to have our own processing plant. We've got people at us fortnightly begging us to go into meat birds, are there are no organic/biodynamic meat birds available. We have to say no, we want to get the eggs up and running to a point that we can handle, then we will take the meat birds. I'm designing a shed now that will take them.

We're also in the process of setting up a big agro-forestry site on our farm. We believe in diversity, biodiversity. The agroforest isn't just a plot of trees, the agroforest is an plot that we're putting on contours and it will serve a number of purposes. Amongst the species we'll have commercial timbers, short and long term; we'll also have bush tucker trees and fodder trees, so the advantages will not only be commercial but also in bio-diversity, pest management, and the protection of stock and crops due to the alley farming effect that we're going to create.

In terms of animal health, you talk about soil health and inherent health, and that a good, healthy soil produces healthy things above it. We have only had the vet on our farm a few times in the eight and a half years we've been there, once was for a horse who'd been poisoned, the second was for a borrowed bull that had an infected foot which I couldn't handle.

I'm a questioner–I think all organic farmers are questioners–I don't believe anything that any of you people tell me. I'll take it in, I'll absorb it, I'll go and do a bit more reading, go and talk to two or three more people, then go and talk to the locals and then I might adopt it, but I wont just accept what I'm told. As far as research goes, all the research we've done is on farm. You experiment on farm; you ring up the local Department of Ag. and talk about pasture establishment and they say "Right, with your Roundup …". I wont say no, I don't want to know that I'm organic, you sit there and after five or ten minutes that he's told you what rate you've got to apply it all, you say, "Well what if I wanted to try it without sprays?" You don't go straight away and say no, no, I'm organic ... because if you do they'll hang up on you anyway.

PETER RANDALL

Farm 1051, Murrami, NSW 2075

Irrigated Rice

My family and I are farming two rice farms along with my father Tom, at Murrami, Northwest of Leeton. We have 900 acres of irrigation land. Each year we grow approximately 200 acres of rice using a four year rotation on clover-based pastures producing 400-500 tonnes of rice each year. We have been certified with NASAA for eight years.

We also run 1300 sheep between the two farms. Our sheep cover just about all the breeds, Marong carpet wool, crossbreeds plus a few cashmere goats. This year we are also growing one hundred acres of wheat. We saw organic farming as a way of staying viable and healthy. We save at least $20,000 per year on exports. We saw the trend in conventional rices growing more and more chemical dependent and didn't want to go down that track. I am encouraged by this symposium, as I believe we need a single voice for our industry. Someone the media, the public, the growers can go to. Also I'm impressed by the calibre of the people here, and am assured that the industry is in good hands. What I would like to see is a peak body independent in its own right, to educate the public to the environmentally sustainable nature of organic farming. We also need greater truth in labelling and more collaboration with conservation groups. I see this as a great step toward an exciting future for organic farming and I think we came here to achieve that common goal.

ROBYN DALEY

"Pialligo Apples", 10 Beltana Road, Pialligo, ACT, 2609

Orchardist (Apples)

I'm one of the ACT's one hundred and twenty insignificant organic producers. I look after about a thousand apple trees and we're in the somewhat scary phase of converting from a conventional orchard into an organic orchard. This has been a very exciting process but it's also been very traumatic because at the same time we're trying to keep our orchard viable. At the moment we have a larger market than we can supply for organic apples in Canberra and so our major concern is to get enough apples grown organically to service that market.

Since we've become organic we've had more trouble with pests and so we're having to sort out our crop. This leaves us with not enough apples to satisfy our eating customers. We are actually having to ration supplies, especially this year which was a particularly bad year. Finding information to deal with our pest problems hasn't been easy because it seems that most apple growers that are trying to convert to organic methods are in the same situation as us, they're just feeling their way. There doesn't seem to be much research done on this. Duncan Farquhar was telling me about something that's happening in Tasmania but it seems as though their research is at about the same stage as the research that the farmers are doing on their own farms which is to try things out and see what happens. If it doesn't work then try something else next year or try different doses next year until we get it right. In the meantime we've got apple stab, we've got codling moth, we've got brown apple moth, and they're all eating up our apple crop. So we just have to keep trying.

I found that we can get some information by researching old work which was done pre-1950s. I've found some interesting old books all pre-1950s which was the time before all these magic chemicals and they just *had* to rely on organic processes, so I've found some things which I've tried and will try in the orchard and it seems other farmers are trying.

As I mentioned, we're in the lucky situation of having a good market in Canberra. We actually live in an inner-suburb of Canberra, and so it's only a very short drive to come and buy our apples from a road-side stall. This is good, because I get to talk to consumers, I get to find out exactly what they want and what they expect from organic produce and why they want to buy organic produce. So there's a lot of feed-back that way and I think it's important that we don't lose sight that we're actually aiming at the organic consumer and we need to find out exactly what they want and how we can satisfy that need. I find that to the Canberra people, the fact that it is organic or that we're trying to be organic is the thing that's important. They also say that the taste of our fruit is superior to other products and this is also seen as important.

ARTHUR DAKIN

"Wirrena", Nyngan, NSW, 2825

Broadacre cropping

Well after those eight success stories, I've got another one. First of all I'd like to thank the Committee for letting me have this opportunity to speak here today. I've got so many things written down here I don't really know what I'm going to say, but I'll first of all tell you that I'm a broadacre farmer, I've been in Nyngan for 20 years. I was a conventional farmer and followed everything I was told by the Department of Agriculture up until 1965 when I ran into great trouble on the farm I had in Victoria. I had a lot of animal sickness, and a friend of mine, Henry Stephenson, who had converted to biodynamics paid me a visit. After many phone calls and much perseverance Alex Podolinski also came. The first thing we got was a shovel. I said "What do I want a shovel for?" He said, "we've got to have a look and see what is going on underneath". Well I'd never thought to have a look underneath, so we dug down and I had a lovely top soil. I thought I'd do wonders with that, having been a dairy farmer a few years before. But anyway, when we dug down, the root zone was only about three quarters of an inch and we found one worm - and what a miserable looking worm that was! So anyway, I went in, boots and all, into biodynamics.

Within two years we had a field day on the property and I just couldn't believe the difference. I had cattle, and the whole top soil was alive with worms, with deep roots, the whole thing was vigorous, the pasture rejuvenated. Also, it had been fed a lot of super every year; because we were only a few miles from Geelong it had been fed heavily. The super had acted as sort of a drug, and the pasture was just sitting there waiting for it's annual bit of phosphorous but, of course, it didn't get it. If you read Alex Podolinski's book, you'll see the reason we did it.

When I went to biodynamics the first time, I rang Alex up and said I had a problem, the sub-clover is going purple. So what I had to do was get some super-lime mixture. I think we put forty pounds per acre on and it had to be held for six weeks to neutralise the super phosphate. We put that on once and that was the last thing we did as far as that problem was concerned; except we did do a test and we did get rock minerals from South Australia and that was fantastic. There were no problems with animal health any more.

Anyway we got to the stage when everybody around us was sub-dividing and all commuting to Geelong and one day there were five new neighbours in the yard and they were picking my brains and I couldn't put up with it. So, we sold out, sub-divided the place, got us enough cash and I did what I had always wanted to do, we decided to go into broadacre farming.

We had a look around—I believe that fate guides where you're going—the only farm we looked at was one at Nyngan, 10,000 acres, $10.00 an acre, so up we went. Fabulous soil; if you don't know where Nyngan is, our farm is about 60 kilometres from the cairn that's at the centre of NSW, so don't think we're that far away. We're not even half way across NSW, but the people in Sydney seem to think that we might as well be right over in Western Australia. It's very deep soil, it runs up to undulating ridgy country which is a big advantage, as we only get very small water on one corner from another farm. This gives us control over all our own water.

When we went there, there were nine hundred acres cleared. The history of the country is that it was originally part of the "Overflow" run, became a station and was sub-divided in 1927. It was very heavily timbered Kurrajong country, the timber was very high, enormous timber, and they ring barked it at about the turn of the century, everything except these natural zones they left every kilometre or so, and they are still there. From the turn of the century it was never touched and some of the

regrowth was a hundred feet high but it was a poorer species and the land was fairly degraded from overstocking.
Also of course the feral animals were unreal, the wild pigs when we went up there were just in mobs of hundreds, the feral goats were by the thousands, and the kangaroos were by the millions. Slight exaggeration, but it was pretty bad! Now , the pigs are under control because they've been taken for game meat in Germany thank goodness. Some of the pigs that go in, I don't know how they eat them, but they pay good money for them. The goats if you can round them up make good money, and the kangaroos are a problem and will always be a problem while we've got these greenies about. I don't know why they don't assess the problem, there are still too many kangaroos and they are causing over-grazing. They talk about de-stocking and that sort of thing, but they will never do it while the kangaroos are where they are because they've got the ability to breed up so quickly—you wouldn't believe the way they breed.
So we came up there and we decided to try biodynamics on broad acres.

We've had great success in converting it to biodynamics, despite running by the seat of our pants, and getting no help. Since I got married eleven years ago and brought my wife's biodynamics expertise into it, we've worked on peppers, we've worked on all sorts of things, we've put a thousand cow horns down, we make our own 500 and 501 on the place. I think closed systems are what we've got to go for; if we can do it we won't have any inputs. We have mucked around with rock phosphate, we have used chicken stuff. At the moment we're not using anything; we had our first soil test done, but I think the best soil test is your gut feeling and your nose. I use my nose more than anything else. If you walk onto an organic or biodynamic dairy farm you don't notice the smell, if you walk onto a conventional farm you'll notice the smell, same with the sheep. If you walk into a conventional sheep yard it stinks, if you walk into a proper organic farm it won't. I've never done any certifying, but I'll use my nose first.

When we decided to start Biological Farmers of Australia, we were 8 farmers. Now I've always been farmer orientated, farmer for the farmer, and that's why we started as a co-op. I've become absolutely paranoid in this and you all know that. But, here today, I realise, that I have got to change and I've always commended myself with the ability to change and accept the situation I've got. And I realise that the umbrella body has got to be, but I do ask that you really think about it and please make it farmer-orientated. Please don't just take over and tell the farmers what to do because that's what we've got to do. We've got to marry the farmers with the academics and the researchers; somehow we've got to marry it. Some of this research that you've been talking about, to me (and I think I'm a fairly average farmer) is beyond us. You've got to build the confidence of the farmers; you can't expect to walk on the farm and have them tell you all they've been doing because they won't. You've got to somehow build their confidence and then it will all happen.
Finally, the bottom line in everything to do with organic farming, is good food! What we have got to produce is good food because half the troubles out there are because people don't eat good food. If everybody ate good food, we wouldn't have half the tragedies that we've got today–I fully believe that and I hope you all do too. I hope you all eat organic food as much as you possibly can.

One thing that I've got left over from the BFA—I've been told that researchers like figures—and a very important figure, out of the BFA computer, is that there are four hundred and seventy six names who have dropped out of that computer in about seven years. Now that's where we've got to start. What's the good of feeding more farmers into the system if they're going to drop out the bottom? Those farmers have dropped out because they don't know what to do, they don't get the information. Now it's obvious here today, that there's information everywhere, but it's not correlated. I've known of Jonathon Banks for nearly 20 years because I was one of the early ones that did his test, but I don't know where his material is that he's been talking about, I haven't seen it. So somehow that's got to be correlated. But the people who drop out of the system have got to be stopped. We've got to stop that drift.

Briefly, one other thing is (that was mentioned before), Bill McGillfray, an ex-director of the BFA, has suggested to have a levy. It's very easy to get a levy, but I think that would be the fairest way to fund anything if we've got to put in some money towards government research.

Finally, I hope everyone involved in the organic industry can work together and get some positive direction through the proposed umbrella body.

9. Poster Paper Reviews

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Dynamics of Organic Farming in Australia: A Preliminary Analysis

Introduction and Research Objectives

In 1992, we started a national study of organic farming. Preliminary results are now available, although most of the data analyses and much of the data collection are still to be done.

Fundamental research problems of the project included:

1. a study of the prospects and problems faced by modern organic farmers;
2. a study of the process by which conventional farmers converted to organic farming; and
3. measurement of organic farmer attitudes and perspectives on general land use such as the use of chemical pesticides and fertilizers and diversity of crop production.

Related and important research objectives include examining the institutional support available for organic farming, satisfaction with farm work by organic farmers, and the role of the farm family in the conversion process.

In general, social and economic research has investigated the social and economic stability of organic farms in relation to human capital resources (values, skills and commitments of farmers and farm families) and organic farmer needs and access to institutional support (for example, capital from banks and lending. institutions, access to information). These are a few of the research objectives that are subsumed in a larger project integrating biophysical and social analyses of organic farming, an emergent and increasingly important dimension of contemporary Australian agriculture. A unique aspect of this research has been the close relationship between biophysical and social scientists in project conception, development and implementation. Organic farming is both a biophysical and socioeconomic system. The two cannot, in reality, be separated as soil characteristics, for example, depend upon the knowledge and the ability of the organic farmer to apply his or her knowledge to crop production and conservation. The ability of the farmer to do so, over time, depends on the presence and effectiveness of support systems allowing them access to information, capital and, most importantly, the personal support to undertake the risks associated with conversion to organic farming, or staying in organic farms. On the other side of the equation, prospects of sustaining crop production and soils are boosted enormously by soil scientists' understanding how organic practices enrich and conserve farm soil.

Research Methodology and Data Collection

A national sample of 200 organic farmers were drawn with the cooperation of the Biological Farmers of Australia. Using modern techniques (the Total Design Method (TDM) (Dillman, 1978)), for the construction and

[1] The senior researchers (Rickson and Saffigna) have been involved with agricultural research in the United States and Australia for most of their professional careers. Richard Sanders is a senior research assistant on the project. This project is being funded by the National Soil Conservation Program.

administration of mail questionnaires, about 80% of organic farmers who were sent questionnaires returned it completed. Properly applied, the TDM method for using mail questionnaires overcomes problems associated with collecting data from a diverse population. It also overcomes the problems of cost from collecting data by personal interview. However, non-response is usually a serious problem with mail surveys, which can be overcome with the proper application of the TDM research methodology. TDM incorporates methods for survey construction, dissemination and follow-up which are integrated in an overall package to encourage and facilitate responses.

A national sample of 600 conventional farmers has now been drawn and the research team is in the process of mailing questionnaires to each of the sample members. The questionnaire for the conventional farmers is similar in content and length to the one sent to the organic farmers and will allow systematic comparisons. Responses of organic and conventional farmers will therefore be compared on several dimensions found in present and past research to be associated with crop productivity and soil conservation.

A final stage of the project will be the examination of focus groups to measure, qualitatively, the experiences and perspectives of both organic and conventional farmers to modern farming, the changing nature of agriculture in Australia and the future of organic farming.

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Biological Farming Systems Trial

The trial aims to compare four broadacre farming systems, namely organic, biodynamic, integrated and conventional for their sustainability. It is based on a 16 hectare site, enabling the use of farm scale machinery and grazing of sheep to simulate as closely as possible the real farm conditions. Parameters being assessed to determine sustainability include soil physical, chemical and biological properties, product quality, economic outcomes and energy usage. After seven years, interesting outcomes in the areas of soil properties and economic fortunes are evident. These were available in a handout at the workshop, and will be readily sent to anyone interested.

As a researcher, my main concerns for the wider acceptance of broadacre organic farming practices are the availability of cost-effective phosphate fertilizers, especially for alkaline soils, and the need for an organically acceptable broad spectrum herbicide.

Concerning fertilizers, farmers have for many years used what they thought was best, but until further trials such as Dann *et al*.'s (1996) are conducted, yield losses due to inadequate nutrition are unknown. If broadacre organic farming, which is often conducted on quite infertile soils in low rainfall regions of the continent, is to be successful, a lot more needs to be known about suitable fertilizers for this purpose. Herbicides as we know them are for many reasons not allowed within organic farming. However, weed control remains probably the major impediment to the wider adoption of broadacre organic farming practices. With all the best of cultural strategies implemented and judicious cultivation, we can still have a crop riddled with weeds and suffer a resultant large drop in income. To help overcome these problems, I am presently working on two fronts–one involves the use of sheep as a means of weed control in-crop, as some crops such as faba beans, narbon beans, mustard, coriander and chick peas are showing themselves to be quite unpalatable to sheep. The other involves using an imported harrow comb weeder for post-sowing, pre- and post-emergent weed control.

Such tactics still do not provide enough tools for many situations. Perennial weeds in particular require other treatment. A microbial herbicide that was developed in Japan in the 1970s is broad spectrum, made from soil borne Streptomyces spp. bacteria, and is commercially available in the UK. This product could have tremendous potential in this country as a means to free a problem paddock of weeds prior to establishing a crop, and thereby set the paddock up for many years.

The organic industry needs to move into the 21st century utilising the best that science and technology has to offer, so long as it is philosophically and practically compatible with the goals of the industry. Addressing the concerns noted above will certainly assist the industry over the coming years.

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[2] Chris Penfold established the Biological Farming Systems Trial at Roseworthy Campus in 1989 with funding from the Key Centre for Dryland Agriculture and infrastructure input from private industry. Subsequent funding from Land and Water Resources Research and Development and Grains Research and Development has enabled its continuation until now, but continued funding is again uncertain.

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Crop and Pasture Rotations for Sustainable Organic Production

Introduction

Considerable interest has been generated in the supply of niche markets with organic produce. There is a growing network of philosophically committed farmers who are prepared to limit the short term economic advantages of conventional farming practices for the marketing advantages of chemical free produce. Organic agriculture has been slow to establish in mainstream industry and has tended to develop through specialised suppliers of fertilisers, natural spray products, marketing and accreditation systems. However, some mainstream farming producers elect to grow crops such as organic grains and market them within conventional frameworks.

Little information is currently available on the short-term conversion process from conventional to organic farming practices. However, economic studies have highlighted the need for adequate returns in the early stages of conversion (Wynen, 1992a). Previous production studies have examined the use of weed control methods based on tillage, timing of weed suppression, seeding rates, cultivar selection and the use of animals for grazing (Patriquin, 1988). Appropriate combinations of these practices need to be monitored in the conversion phase to organic farming to determine the relative changes which may occur. Importantly, the interactions between limited management tools and local soil and climatic conditions must be quantified to define inputs necessary for organic production in South Eastern Australia.

Annual ryegrass is the dominant weed species of pastures and cereal crops in the absence of chemical control measures in SE Australia. The challenge for weed control in organic systems is to balance the use of tillage, which removes carbon through oxidative processes, with the improvement of soil structure through retention of organic matter. Grazing pressure needs to be regulated to ensure that soil structure is not compromised through compaction by large concentrations of livestock.

In this paper we outline both the operations and outcomes in establishing chemical-free grain and pasture production on land with a history of conventional farming in the 500-600 mm rainfall zone of SE Australia.

Materials and Methods

The demonstration site is located at the Institute for Integrated Agricultural Development, Rutherglen (36' 08' S and 146' 28' E) in north-eastern Victoria. A pasture and crop rotation was devised to produce a crop of organically grown wheat to National Association for Sustainable Agriculture Australia specification within a three year time frame. The rotation consists of first year pasture, followed by second year Balansa clover as a green manure crop and finally wheat is grown in the third year of the rotation. The demonstration consists of a three hectare paddock of each rotation phase (Table 1).

Table 1. Organic Demonstration Pasture and Crop Rotation Schedule.

Year	First Crop	Second Crop
1994a	Wheat	Balansa
1995	Wheat	Balansa
1996	Pasture	Wheat
1997	Balansa	Pasture

(a). The experiment was recommenced in 1995 as a consequence of the dry conditions in 1994 which caused failure of both the crops and pastures.

The soil type across the site is a greyish brown loam (0-10 cm) overlying a grey-brown clay (10-20 cm) graduating into a heavy clay with depth. Soil samples from 20 random sites were taken on 10 February 1995 and composited prior to analysis for a suite of macro and micro nutrients and chemical determinations.

Complete Organic Fertiliser (COF) was the only added fertiliser used at the demonstration site and contained 3% total N as natural organic compound, 3% total P as citrate soluble, 3% total K as sulphate, 12% total S as natural organic compounds, and 2% total Mg.

In 1995, Balansa clover was sown at 5 kg/ha on 19 May with 100 kg COF/ha, wheat cv. Katunga was sown at 90 kg/ha on 27 May with 150 kg COF/ha and the pasture mix (Concorde ryegrass 15 kg/ha and 10 kg/ha of the sub-clovers Leura, Goulburn, Karridale and Trikkala) was sown 19 May with 100 kg COF/ha. N fixing nodules on the roots of Balansa clover were rated on a score from 0 to 5.

Earthworm populations in each of the rotations were sampled on 5 October 1995 to coincide with the time that higher representation of adult classes were likely to appear. The transects in each section were composites from five 35 cm x 35 cm x 10cm deep quadrats and the speciation and numbers of earthworms were determined. Microbial biomass was determined by the method of Amato and Ladd (1987).

Sheep varying in number from 33 to 400 mature wethers were used as a management tool to control weeds in each phase of the rotation. The sheep were contained in an adjoining "hospital" paddock when not grazing the cropping areas, which allowed dissipation of drenching residues off site (NASAA, 1990). Grazing inputs as dry sheep equivalents (DSE; one dry merino wether) were quantified for each rotation phase.

Biomass production was measured in the Balansa by 20 quadrats 0.5m^2 in area taken on 6 October 1995, 4 days prior to incorporation into the soil. A similar number of 0.9 m exclusion cages were used to determine production in the grazed pasture. The wheat was heavily infested with ryegrass and was cut for hay 2 November 1995. Biomass as hay was determined by weighing hay bales after harvest.

Results and Discussion

Soil fertility at the site was adequate for N and marginal for P in the 0-10 and 10-20 cm layers of the soil profile (about 50 ppm and 15 ppm, respectively). Soil pH was 4.5 ($CaCl_2$) and variations in micronutrients or soil chemical parameters between the rotations were small (data not shown).

In 1995, rainfall was greatest at the beginning of the season, which caused localised waterlogging early in crop growth. Rainfall extended well in to spring (Fig. 1).

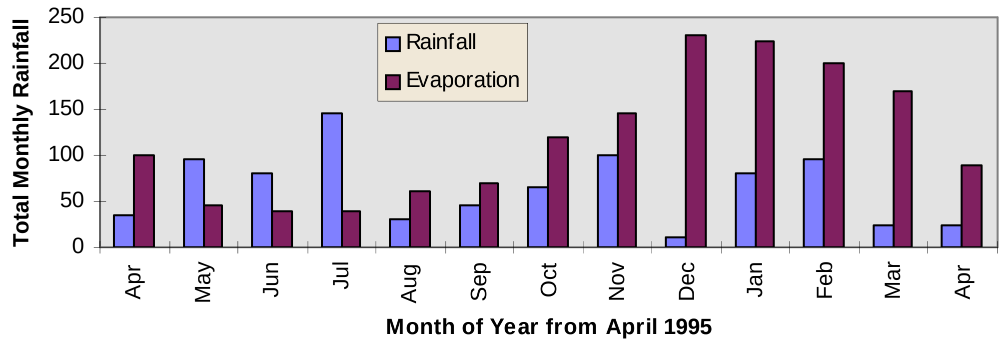

Figure 1. Monthly rainfall and evaporation from April 1995 to April 1996 at the Rutherglen Organic Demonstration Site.

Biomass production from the organic system in the first successful year of operation was impressive and reflected the carry over of nutrients from the failed crops in 1994. Wheat was harvested as hay due to a high ryegrass population, which was exacerbated by waterlogging impacts on early crop competition. A small area was set aside for grain harvest and analysis.

Yields of organic grain at sites in Western Australia have ranged between 2.8 and 0.2 t/ha (Deria *et al*., 1996). Hay production was 144 rolls at 110.4 kg/roll which yielded 5.3 t/ha of dry matter. Gross pasture production as measured by exclusion cages was an average of 11.4 t/ha across the transect and ranged from 9.2 to 13.7 t/ha for the period 26 September to 19 December 1995. Dry matter production in the Balansa averaged 3.25 t/ha immediately prior to incorporation into the soil on 10 October 1995. The green manure crop contained high levels of ryegrass (approximately 40%). However, total nitrogen (N) content was 2.91 % or 95 kg N/ha. The Balansa clover scored 3.6 active nodules per plant, most of which were found on the crown (top 5 cm). Available N in the soil was adequate for crop growth (in excess of 50 kg/ha- in the top 20 cm) and may have limited further nodule development.

Weed suppression using mature sheep as wethers was a balance between the competing demands of ryegrass growth in response to rain and the demands of animal welfare such as control of parasites. The level of grazing pressure was an indirect measurement of the relative weed growth in the different rotations (Fig. 2). Pasture was grazed to determine carrying capacity for wool production and to return organic matter and nutrients to the soil. Therefore, cutting hay from the pasture was not considered appropriate during the early stages of conversion. Despite the high grazing pressure large numbers of ryegrass seed were observed to reach maturity, whereas removal of hay remains a constructive means of lowering ryegrass populations by removal of seed. Total carrying capacity for the pasture, Balansa and wheat was 14.74, 6.38 and 1.41 DSE/year respectively.

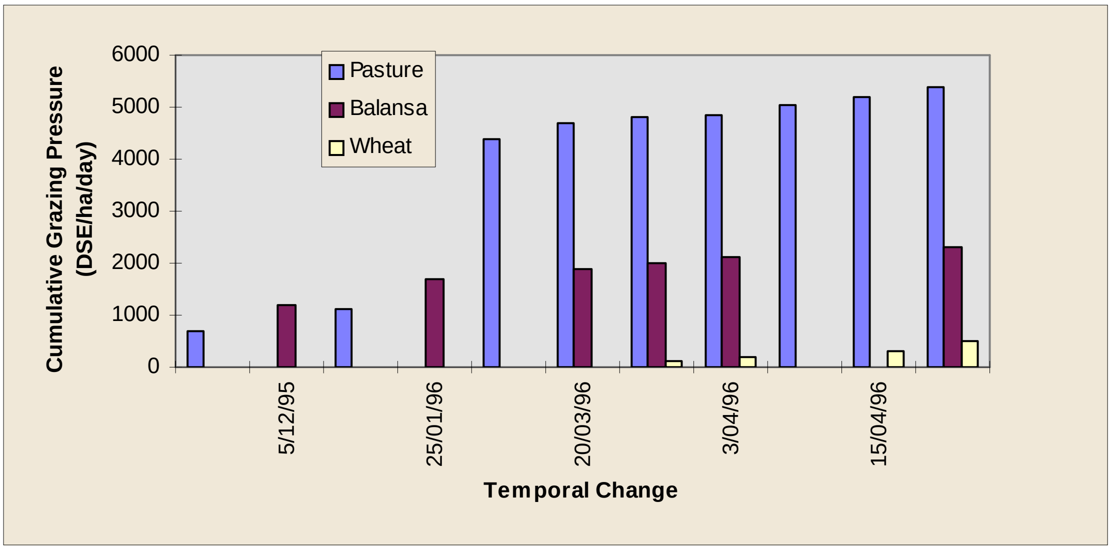

Figure 2. Cumulative Grazing pressure for pasture, Balansa and wheat rotation phases from spring 1995 to autumn 1996.

Weeds were reduced to low levels following the Balansa green manure due to the low standing biomass. Drier soil conditions and less tillage disturbance resulted in weed growth an order of magnitude lower in the post hay harvest wheat stubble (Fig. 2) compared to green manuring. Tillage at sowing consisted of a dual cultivation with a direct drill combine, which removed all visible actively growing weeds. Wheat was sown at seeding rates of 150 kg/ha (70% higher than conventional) to increase competitiveness with later germination of ryegrass.

Earthworm populations across the site were low compared to surveys of cereal and pasture soils in SE Australia (Table 2). There were no apparent differences in numbers of worms present between rotation. However, worm biomass was greater in the Balansa clover. No differences were detected in microbial biomass.

Table 2. Earth worm population and microbial biomass of pasture, Balansa and wheat soils at 5 October 1995.

Rotation	Earthworm N^{o}.m^{-2} (range)	Earthworm weight (g.m^{-2})	Microbial biomass (ug.g^{-1})	
			0-5 cm	5-10 cm
Pasture	29 (0-90)	5.5	365.2	102.5
Green Manure (Balansa)	26 (8-74)	12.7	345.0	96.4
Wheat	25 (0-57)	6.9	346.1	162.8

Conclusions

Grain production is not always the most desirable or feasible outcome within a rotation during the conversion phase from conventional to the organic systems. Hay production provided a viable economic alternative when ryegrass populations approached an estimated 40% of total crop biomass. Crop biomass ratios in organic wheat growing systems have been reported as low as 27% (Patriquin, 1988).

Use of intensive grazing strategies and hay production are necessary to control the high level of biomass production in the pasture phases of the rotation. Stubble burning remains a poor option for weed control due to loss of organic matter from the system and remains incompatible with grazing practices which cover ryegrass seed with soil and protect it from high temperatures (M. Walsh pers comm.).

The analysis of parameters to date suggest that there is scope to witness changes in both nutritional, biological and productivity changes at the Rutherglen site due to the previous history of conventional farming practices. However, changes have been shown to take several years in similar comparisons with different soil/climate environments (Penfold *et al*., 1995).

Acknowledgments

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Comparing Conventional and Organic Farming Systems - A Research Perspective

Introduction

The success or acceptability of broadacre farming systems depends on the degree to which they achieve productivity in the short term (tonnes/hectares or stock/hectares), and sustainability (long-term maintenance of productivity and the condition of natural resources). The advantages and disadvantages of various farming systems to meet these two objectives have been the subject of much research and trial and error by farmers, government departments, CSIRO and agricultural companies. This has resulted in a large bank of knowledge about the productivity and sustainability of a range of farming systems such as direct drilling, reduced tillage and conventional tillage (Angus *et al*., 1995; Charman, 1985; Cornish and Pratley, 1987; Geeves *et al*., 1995a, 1995b).

However most, if not all, of this information relates to conventional farming systems, with little specific information on organic farming systems. Despite this, many principles and relationships established in this research are likely to be applicable to organic farming as well. The use of rotations to control root diseases and weeds, the improvement of soil structure by increasing organic matter levels, and the use of agricultural lime are consistent with organic farming.

Achieving Productivity and Sustainability

To achieve productivity, a farming system needs to solve all the problems outlined in Table 1. The requirements outlined in this table are primarily based on dryland, broadacre agriculture. The requirements to achieve sustainability are outlined in Table 2.

Organic farming is a group of alternative farming systems for solving the requirements of achieving productivity and sustainability. Conventional and organic farming systems differ in that organic farming systems have a different view of sustainability. Organic farming systems place more emphasis on maintaining renewable resources in a broader context, and avoiding the problems the use of chemicals brings such as the effect on humans, the environment, chemical resistance etc. The definition of sustainability used in the assessment of conventional farming systems such as direct drilling and reduced tillage, usually takes a narrower view of sustainability considering only land degradation and the

Table 1. Problems that need to be solved to achieve productivity and the solutions to achieve productivity for different farming systems

Problems	**Solutions**
Variety selection	Product, sowing time, disease and pest control
Good seedbed conditions	tillage, stubble removal by burning, stubble grazing, specialised sowing equipment, friable soil
Weed control	*Industrial herbicides,* natural herbicides, grazing, tillage, rotation, plant variety
Pest control	*Industrial pesticides*, natural pesticides, rotation, plant variety, control of predators

Disease control	Plant variety, *industrial chemicals*, natural chemicals, rotation, biological activity in the soil
Chemical fertility/ nutrients	*Industrial fertiliser*, organic fertiliser, biological activity (VAM, nitrogen fixation), variety, agricultural lime, dolomite, natural gypsum, rock dusts, rock phosphate.
Adequate moisture	Good soil hydraulic properties, fallowing, irrigation
Adequate aeration	Good drainage, soil structure/porosity, irrigation schedule
Harvesting	Soil moisture at harvest
Enhanced biological activity***	Soil micro-organisms (VAM, rhizobia) organic matter levels, nitrogen fixation, soil structure, soil fauna activity

Table 2. Problems that need to be solved to achieve sustainability and the solution to these for different cropping systems

Problem	**Solution**
Minimise soil erosion	Adequate vegetation cover, earthworks, soil hydraulic properties
Maintain soil pH	Minimise nitrate leaching, agricultural lime, balanced pastures
Maintain soil structure	Adequate vegetation cover, organic matter levels, minimise tillage
Maintain nutrient levels in soil	*Industrial fertiliser*, organic fertiliser, biological activity (VAM, nitrogen fixation), variety, agricultural lime
Long-term supply of industrial fertilisers***	Alternative sources of nutrients, organic fertilisers, increased biological activity to make more nutrients available in the soil
Pollution of water in storage and waterways	Not adding nutrient levels higher than those required by plants, not adding fertilisers in a form that is highly soluble in water, reducing erosion, not adding nutrients to highly permeable soils
Minimising effects of artificial chemicals in the environment***	Minimise use of artificial or industrial chemicals, only use those chemicals that are broken down rapidly and completely

italics = practices not used in organic farming
*** = problems specifically addressed by organic farming

degradation of water resources. It is also possible that some sections of the organic farming movement may take too narrow a view of sustainability and not consider land and water degradation issues sufficiently.

Grouping Farming Systems

The allocation of a farming system to a specified group is a difficult problem as discussed by Geeves *et al*. (1995a). The difficulty is that each farmer is likely to have his own unique set of farming practices to solve the problems of his own block of land. It follows that there is likely to be a wide range of organic farming systems but it is possible that organic farmers may be grouped into direct drill (DD), reduced till (RT) and traditional till (TT) as it is possible to do for conventional farmers. This will depend on their tillage and stubble management practices. Neither stocking rate nor the maintenance of vegetation cover is going to necessarily be a criterion to distinguish an organic farmer from a conventional farmer. The practices used by any farmer will depend on the individual paddock, crop types, climate, etc.

Issues Arising from the Comparison of Conventional and Organic Farming Systems

Research into the following issues can help the development of organic farming systems in Australia. The type of research needs to be both diagnostic, looking for specific mechanisms, and on working farms to assess the practical application and overall effects of the management practices.

- Many of the research results and practices from conventional farming are likely to be of relevance to organic farming, particularly those relating to rotations for disease control and the improvement of soil structure, stubble management, direct drilling sowing equipment, variety selection, use of lime and mineral gypsum and so on.

A review explaining how existing research results on conventional farming can be applied to organic farming.

- Many methods and techniques from organic farming are likely to be applicable to conventional agriculture.

A review explaining how existing practices in organic agriculture can be applied to conventional agriculture.

- Depending on the criteria chosen to define organic farming, some organic farming systems, particularly those based on increased levels of tillage, high stocking rates and low levels of vegetation cover, may lead to land degradation and the degradation of water resources through erosion, soil structural decline and salinity. A major difficulty is weed control without herbicides. This is likely to increase the requirement for tillage and high grazing rates in organic farming systems, although the expected build up of organic matter levels in soil is meant to allow more cultivation and higher stocking rates. The effect of the various levels of tillage, stocking rates and stubble management in conventional farming systems can be seen in Geeves *et al*. (1995a). The application of large volumes of organic materials on land next to water courses may lead to pollution of water resources.

Define the range of management practices that are currently being used in organic farming systems. How do these influence problems of land degradation such as erosion, soil structural degradation, acidity and salinity, and water degradation problems of salinity and water pollution?

- The export of nutrients from the land in produce is a major problem for agricultural production no matter what practices are adopted (see Hyland 1995). The availability of a wide range of organic fertilisers does allow for the replacement of most nutrients.

What is the effectiveness of available organic fertilisers in comparison to other conventional fertilisers and should long-term and short-term comparisons be made?

- The low availability of organic matter is a limitation to the development of organic farming practices in drier climates, particularly for cropping in the drier areas of the wheat belt. A range of organic fertilisers is now available to farmers.

Are organic farming systems and their effectiveness likely to vary depending on the climatic and soil conditions of an area? What is the potential for waste organic materials from urban areas and animal production enterprises in organic farming?

- Enhanced biological activity under organic farming is a key issue in the development of organic farming. Enhanced biological activity can potentially affect the access of the plant to sources of nutrients, disease control and improved soil structure. The part of vesicular-arbuscular mycorrhiza (VAM) in increasing the available pool of nutrients such as phosphorus to the plant is a critical issue, as is the activity of rhizobia and perhaps free-living micro-organisms in nitrogen fixation. Are other beneficial organisms also enhanced?

The biological activity of soils at organic farming sites needs to be investigated. The activity of VAM and their effect on the availability of nutrients, especially phosphorus *needs to be assessed. The activity of other organisms such as earthworms, rhizobia and free-living organisms on nitrogen fixation also needs to be investigated.*

The main questions remaining are:
Does organic farming offer new solutions for many difficulties facing conventional agriculture? Is conventional farming sustainable in the long term?

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10. Major Reviews of Industry

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Overview of the organic industry in Australia

Organic Agriculture Internationally

Organic agriculture is established worldwide, with many countries having locally based organic production regulated by government and non-government certification organisations. The industry's peak international non-government organisation is IFOAM, the International Federation of Organic Agriculture Movements, established some 25 years ago with a General Secretariat based at Tholey-Theley in the Federal Republic of Germany. IFOAM has 527 member organisations in 92 countries with, for example, Germany having 58 member organisation, USA 22, Argentina 13, Australia 5, New Zealand 4, and Israel 1 (IFOAM, 1996). Reliable global production figures or trade value estimates are not readily available.

Production and trade in organic goods is dominated by the large volumes produced in the European Union (EU) and in North America. Organic agriculture is now a significant part of the whole EU agricultural sector. Substantial subsidies at both the EU and national levels are available to most European farmers for converting land to certified organic production. Some EU countries have active national programs for farm conversion. Sweden has national legislation requiring 10% of its farming land to be converted to organic production by the year 2000. Denmark, Austria, Finland and some states in Germany have similar formal commitments. There has been a resultant rapid expansion in organically managed land across the EU, rising from 0.12 million hectares (ha) in 1986 to 1.2 million ha in 1996, an annual increase of 25%. On average EU countries have 1% of their farm land converted to organic production. This varies greatly between countries with Austria having some 20% of its farm land converted (Lampkin, 1996).

In the United States of America, organic agriculture has also grown rapidly. In 1994 there were estimated to be over 4000 organic producers, an increase of 40% from 1991. These producers were farming some 460,000 ha, an increase of 100% since 1991. The 1995 US market in organic produce was estimated to be worth US$2.8 billion and growing at about 21% annually (Mergentime *et al.*, 1996). This represents some 0.6% of the value of the conventional food industry in the US, but some commentators expect this to rise to about 5% in 5 years (Kraus, 1996). A 1996 single agency directory lists over 280 organic family farms, farming 125,000 ha, and trading some 800 commodities across the country (CAFF, 1996). In 1995 the major Californian certifier, California Certified Organic Farms (CCOF) had 528 certified growers farming 22,000 ha (CCOF, 1996).

Global markets for organic commodities are growing rapidly with major trading opportunities available. These opportunities are available for Australian producers, particularly in Asian markets. It is estimated for instance that in the early 1990s there were 3-5 million (3-5% of the total population) organic food consumers in Japan (Ahmed, 1995). 1995 US organic exports to the Pacific Rim, particularly Japan, were worth about US$715 million (Mergentime *et al*., 1996). World wide there are recognised problems of quality assurance; product recognition; consumer confusion over logos, certification and trademarks; and uncertainty of supply, quality and price. Countries that recognise these problems and invest in the strategies needed to solve them will capture these growing markets.

Organic agriculture in Australia

Organic agriculture in Australia is at a critical point in its development. The last decade has been a time of innovation and activism. This period has seen the emergence of the various certification bodies and the widespread acknowledgment that organic farming has something to offer Australian farmers and the wider Australian community, both rural and urban.

Organic agriculture has been promoted by individuals and organisations because they believed that organic farming could deliver a better future for farmers and consumers of farm products. Many claims about the positive effects of organic agriculture have been made—from increased personal wellbeing through greater profitability to environmental sustainability. Until recently these claims have been activist or practitioner based and have not been subjected to rigorous independent investigation. During the last ten years considerable industry development has occurred, 'organic' products have appeared on the supermarket shelf, and large processing companies have entered the organic food market. Researchers have started major investigations into organic systems, and a variety of research funding agencies support these projects.

Much of the activity at the initial stage of development of the industry has been ideologically driven. It is unlikely to remain so if the organic market matures and expands sufficiently to become a significant part Australian agriculture. Organic agriculture in Australia is widespread but with low numbers of farmers. If the industry is to develop beyond its very small share of agricultural output it must be accepted by the mainstream of Australian farmers and consumers as being of benefit to both.

Recognition of the Industry and the Definition of Organic

In November 1989, the Food Standards Policy Section of AQIS issued a discussion paper: "The Case for a National Approach to Certification of Organically Grown Produce". This discussion paper was the first serious recognition of the Australian organic industry and its needs at a national government level. The paper recommended:

- the urgent need for national accreditation procedures and organic farming standards;
- the need for a national industry body;
- research into production of organic foods and their domestic and export market prospects;
- the establishment of an industry umbrella body via AQIS that would develop a common set of standards and accreditation procedures;
- that government involvement be restricted to advice and facilitation (AQIS, 1989).

OPAC was subsequently formed with membership of the major national organic certification organisations and representatives of national agriculture and food industry agencies. OPAC is chaired by AQIS which also provides secretariat support. In 1992 OPAC produced a set of national export standards for organic and biodynamic produce and a definition of organic agriculture acceptable to all its members. Use of this definition avoids the many conflicting, vague and controversial definitions and descriptions of organic and related forms of agriculture that exist. The OPAC (1992) definition gives organic to mean:

"produced in soils of enhanced biological activity, determined by the humus level, crumb structure and feeder root development, such plants are fed through the soil ecosystem and not primarily through soluble fertilisers added to the soil. Plants grown in such systems take up essential soluble salts that are released slowly from humus colloids, at a rate governed by warmth. In this system, the metabolism of the plant and its ability to assimilate nutrients is not over stretched by excessive uptake of soluble salts in the soil water (such as nitrates). Organic farming systems rely to the maximum extent feasible upon crop rotations, crop residues, animal manures, legumes, green manures, mechanical cultivation, approved mineral-bearing rocks and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and to control insects, weeds, and other pests."

This definition is used in the reviews of the industry in these proceedings. It should be noted that in this definition ‘organic’ is taken to include biodynamic farming systems, although many organic and biodynamic farmers take the view that their farming practices are quite distinct. The word ‘conventional’ is used to describe the mainstream of Australian agricultural practices. The process of the application of organic growing standards and the accreditation of a farm and its products as organic is commonly called ‘certification’; and produce becomes ‘certified’ organic produce.

The size of the industry and its market potential has been the subject of two RIRDC funded reports prepared by Hassall and Associates. These are a report prepared in 1990, *The Market for Australian Organic Food* and the 1996 update, *The Domestic Market for Australian Organic Produce: An Update*. These reports have identified the extent of the industry, a range of market issues, and some research and development needs for the industry.

The organic farm sector in Australia

Unlike some other industrial countries, there has been little government investigation of the general characteristics of organic farming in Australia, its extent, limitations and productive capacity. In 1980, the United States Department of Agriculture (USDA, 1980) published its "Report and Recommendations on Organic Farming". The findings of this report that may be relevant to organic farming in Australia include:

- organic farming is not limited to particular climatic zones or areas;
- organic farming is not limited in size;
- farm size is comparable to conventional farms;
- organic farming is not a return to outmoded forms of agriculture;
- animals are an essential part of many organic farms;
- it does not rely on the carry-over effects of previous conventional farming to be successful.

The report concluded that organic systems of farming had much to offer agriculture in general.

While no similar government report has been undertaken in Australia, other researchers have published some work to similar ends (Conacher and Conacher, 1982, 1983, 1991; Derrick, 1990; Dumaresq and Derrick, 1990, 1991; Dumaresq, 1992, 1993). A summary of some general characteristics for the Australian industry are given below.

Environmental constraints

Organic agriculture does not appear to be limited by region, climate, rainfall, soil type or other environmental variables. Production regions range from the wet and dry tropics, the rangeland pastoral areas through the sheep/wheat belts into the wetter temperate coastal areas. Contrary to much popular and even scientific commentary, organic production is not limited to the wetter, more fertile coastal areas (Dumaresq, 1993; Rovira, 1990; Smith, 1990).

There are a wide range of organic farming strategies available to farmers in most areas of Australia. Existing long-term organic practitioners have spent decades testing commercial organic management systems. While these are often micro-adapted for particular areas, general strategies and principles of operation have been developed for most agroecological regions of Australia.

Farm numbers, areas and distribution

Organic farm numbers appear to be very low. Even in areas of greatest concentration they appear to make up less than one percent of the farms of a production category for that region (based on Australian Bureau of Statistics regions) (Dumaresq, 1992). It is likely that many previous estimates of farm numbers have considerably overestimated the numbers of farms. Many of these estimations are likely to have been ideologically driven attempts to raise the profile of organic agriculture in Australia.

The number of certified organic growers nationally in 1995 was estimated to be 1,462 (compared with 991 in 1990) based on figures from certification organisations (Hassall and Associates, 1996). These farmers operated some 350,000 ha of certified organic land. 75% of organic farmers were horticulturalists operating 10% of the area of organic farms, while 12% of the farmers operated 75% of the farm area for broadacre production. 1995 comparative figures for New Zealand are 305 certified growers using less than 0.1% of New Zealand's land available for production (Bourne, 1996).

At present the numbers of farms registered with certification organisations are the only guide available to the number of organic farms. However, this data needs to be treated with some caution for a range of reasons. Amalgamation of the certification numbers as available from the agencies will over-estimate the number of farms actually certified as some farmers belong to more than one certification organisation. One major national certification agency, the Bio-dynamic Research Institute did not provide farm certification numbers or farm areas for the 1995 Hassall and Associates report. Estimates of the number of farms and the area farmed under this certification scheme vary greatly. Reports range from some 600 farmers farming over a million hectares to more modest estimates of about 120 farmers farming up to 200,000 hectares (Wynen, 1996c). Conversely some organic farmers do not apply for organic certification. Some comparison of the figures obtained by the Hassall and Associates research can be obtained from the Australian Bureau of Statistics figures of 795 certified growers with 911 seeking certification for 1993-94. However, these figures are for different years and determinations of 'organic' may differ. Other estimations of the size of the industry can be found in Sriskandarajah and Dignam (1992).

Until organic certification is uniform and nationally based, has some form of legislative backing with auditing requirements, and certification agencies recognise 'cross' certification, certification data is unlikely to yield good information on farm numbers, size, volume and value of production.

Farm areas under organic production vary considerably from region to region. There appear to be some regions of loose concentration of organic farms with similar production. Some of these regional groupings include wheat in western Victoria, northern

NSW, central Queensland and the southern Western Australian wheat belt; rice in the Murray and Murrumbidgee Irrigation Areas; milk in central Victoria; and a range of horticultural operations around major urban centres and along the Murray.

Commodity production range

Organic agriculture covers most commodity production systems. The main types of production are livestock for meat, milk products, and wool; dryland and irrigated cereals, mainly wheat and oats; fruit of most varieties including exotic and tropical species; and vegetables of all sorts. Lesser areas of production include cotton, oil seeds and grain legumes; nuts; herbs, condiments and sugar; and some beverage production as tea. (Dumaresq, 1993; Hassall and Associates, 1996)

The distribution between farm enterprise types is given below as derived from the Hassall and Associates farm survey data (1996).

Organic production, farm area and organically farmed area, 1995:

Farm type	% of producers	% farm area	% of organic area
Broadacre	12	75	69
Horticulture	75	10	8
Livestock	10	12	17
Other	3	3	6

These figures indicate that 75% of organic farmers are horticulturalists operating 10% of the area of organic farms, while 12% of the farmers operated 75% of the farm area for broadacre production.

Production scale

Organic agriculture is not limited by scale. The scale of operation varies from very small 'backyard' vegetable and egg producers through to enterprises operating tens of thousands of hectares. The widespread view that organic production is only possible at the small scale is not borne out by empirical research. (Dumaresq, 1993)

Farm ownership

Organic farm ownership also varies considerably. While the majority of holdings appear to be owner operated family farms other forms of ownership are present. These include family and non-family partnerships, leasing and share-farming arrangements, and a range of corporate entities from small professional consortiums through to larger private and public companies. There is little evidence that organic farming is necessarily the provenance of the family farmer. As in the United States of America, it is quite likely that organic farming in Australia will increasingly become part of corporate agriculture. (Dumaresq, 1992)

Production levels

The volume and value of various agricultural commodities produced organically is also very difficult to estimate. Farmers and agencies are reluctant to give both quantities and values of produce for reasons of commercial confidentiality. This is further complicated because a considerable number of organic farmers have had to develop their own markets outside the mainstream. Many do some form of on-farm processing or packaging so that values for raw product are hidden. A quantity of organic produce also is traded in the 'grey ' economy either through cash sales or barter. (Dumaresq, 1988; Hassall and Associates, 1996)

Despite the problems in estimating the scale and extent of organic production, it is clear that the total volume is small compared to conventional production. Although yields and areas under crop on any particular farm may not differ significantly from similar conventional operations the small number of operations makes the gross output from organic farms small. This is seen in the Hassall and Associates Report (1996) which indicates that about 0.2% of total food sales in Australia are organic. Current limited production is a major barrier to further development of organic markets.

The very small numbers of established organic farms is likely to be the result of several factors. These are to be found in the short history of Australian agriculture. Such factors may include the failure last century to develop an enduring 'traditional' agriculture in Australia and the extensive application of science to agricultural problems this century which has seen the prevailing of 'science and sense' over 'muck and magic' for most farmers. Government policy, especially post-1945 has actively encouraged a science-based agriculture and discouraged other systems (Dumaresq, 1984). Agricultural systems which have appeared to be based outside science have had little or no encouragement until recently in Australia. The emergence world-wide of a scientific basis for non chemically-based farming systems has started to change these attitudes (Altieri, 1995). The emergence of the low-input strategy in sustainable agricultural research and extension has also brought new prominence to organic systems (Stinner *et al.*, 1987).

The off-farm sector

For the consumer to be able to buy organic produce with confidence, the chain of organic treatment needs to be maintained from farm inputs, through the farming system, to post-harvest treatments, transportation, storage, processing, preservation and packaging. Marketing with appropriate labelling and certification of this chain of processes is an essential part of the organic industry.

Of the little targeted research done in Australia on the organic industry, almost none has been directed towards the off-farm processes necessary for the successful sale of organic products. The exceptions are the certification schemes for organic farm systems and some post-farm processing and marketing.

In the early stages of the organic industry in Australia, prior to the introduction of organic farm certification schemes outside the bio-dynamic "Demeter" system, most organic produce was sold directly to the consumer or retailer or was sold undifferentiated into the conventional market. Farm certification schemes and 'on-farm' concerns became the early focus of industry activity to enable the development of a supply of genuine organic products. Off-farm concerns have only recently emerged from this early domination of the industry by on-farm and farmer issues.

Farm Inputs

A range of farm inputs are allowable under the organic standards. These include fertilisers such as treated animal manures, composts, mulches, soil amendments such as ground rock and lime, foliar sprays based on plant products such as seaweed emulsions, crop protection chemicals such as some lime-sulphur compounds, naturally occurring insecticides and oils, and stock treatments including herbal remedies, natural insecticides and some naturally occurring chemical compounds.

Although considerable work has been done elsewhere in the world on the production and processing of inputs for organic farming systems, almost none has been done in Australia. The certification of the production processes for these inputs and thus the product the farmer may use in an organic farming system is almost entirely absent in Australia. Published research into new products for Australian organic farmers and the appropriate manufacturing and certification processes is negligible. Research on the efficacy of existing or new products is also negligible. What little there is almost all centres around the use and effect of soluble versus non-soluble phosphatic fertilisers (see Boland *et al*, 1988, Dann, 1990 and Dann *et al*, 1996). The research into, and development of, natural pesticides has effectively occurred outside of organic research in the mainstream of conventional agricultural research and the development of 'green' household chemicals (Fry, 1993).

The use of the whole range of chemical inputs to conventional farming is coming under increasing scrutiny and control. Organic farmers may be using a range of naturally occurring and manufactured substances for particular agricultural purposes for which there is no registration. Generally, organic farmers rely on product information on farm inputs from the same sources as conventional farmers and from their farm certification agencies.

Post-harvest

With the possible exception of the very small amount of agricultural produce sold directly by the farmer to the consumer, all agricultural products require some form of post-harvest processing to be successfully marketed. Some produce receives routine on-farm post-harvest processing, eg. the skirting, classing and baling of wool; the washing, waxing, grading and packing of fruit. Some farmers also do value adding through further on-farm processing, eg. the milling of flour. Virtually all produce receives some form of off-farm post-harvest processing that is outside of farmer control. These processes routinely include washing with a range of solvents and detergents; treatment with preservation and pest protection chemicals such as fungicides and insecticides; heating, chilling or freezing, and controlled atmosphere treatments for preservation; re-processing and packaging for safe transportation and storage; and the addition of anti-oxidants. These processes are common place for the safe and sure marketing of 'fresh' produce. 'Processed' foods and fibres are subjected to many more processes. Some of these operations are controversial even for conventional agricultural produce, particularly for newer processes such as irradiation, and the use of genetically engineered organisms. For the organic industry many of these processes are controversial and most are seen by some in the industry as problematic. Most of the chemicals used for these processes are not permitted under organic standards. Consequently, the post-farm handling of organic produce remains difficult for much of the industry. Standard preservatives and even some packaging is unacceptable. Other issues also arise with the difficulty of keeping organic produce separate from conventional produce, and from contamination with the residues of conventional operations in storage, transportation and processing facilities. At all stages, the integrity of the organically farmed product is open to compromise.

The maintenance of the organic food chain has been left primarily to the farm certification agencies which have taken on the role of certifying the post-harvest operations. There is very little information and extension advice for operators wishing to gain 'organic' certification for post-harvest processes.

As the organic industry has grown and become more integrated with the rest of Australian agriculture, it has been able to capitalise on suitable research and development for the post-harvest treatment of produce not particularly directed at the organic industry. In particular the organic processing industry has been an early innovator with non-chemical methods of grain fumigation and insect control. These methods include the use of carbon dioxide and other inert gas fumigation methods, controlled atmosphere storage and the use of diatomaceous earth for the control of insects in stored grain (see Banks H. J., this volume; Champ *et al*, 1989).

Residues

A principle motivation for the organic industry is to supply produce with lower levels of chemical residues than conventional agriculture. A real question for the industry is does organics do this? Some surveys of chemical residues in organic food have been done by state government bodies and by individual researchers. Very little material has been published and none is readily available to consumers. There is no national survey of residues in organic produce equivalent to the national market basket survey for all Australian agricultural produce. There is no information available to indicate whether or not an "average organic diet" has a lower chemical load than the "average Australian diet" as measured by the market basket surveys. The market basket surveys indicate generally a very low level of chemical residues in Australian diets and levels are decreasing (National Food Authority, 1991).

Where organic products have been tested for residues these have mainly been for the presence of organophosphates and organochlorins. Most testing has revealed that organic products have no detectable levels of residues or very low levels. However, some tests have also been confounded by being carried out on both certified and uncertified organic produce. Other contaminants in the food system such as cadmium may be a problem for organic farming in particular areas and for particular crops such as potatoes and some citrus. Whether levels approach or exceed Maximum Residue Levels (MRLs) is unknown in most cases. One comparison study of wheat indicated that conventionally grown wheat had cadmium levels approaching the MRL at very high levels of phosphatic fertiliser application but the equivalent organic grain had much lower levels (Dann et al 1996).

Marketing and Distribution:

Markets

The 1996 Hassall and Associates Report on the Australian domestic market for organic produce in 1995 gives the value of retail sales as:

Product	Total Value ($ million)
Livestock products (including fibres)	7.48
Seeds/grains/cereals	10.44
Fruit/nuts	27.44
Vegetables/herbs	28.06
Tree products (including oils)	2.51
Other	4.57
Total organic sales	80.49
Total all sales	38,909
Organic as % of all sales in Australia	0.20

The report found that national consumption per head of organic produce averaged $0.09 per person per week. There are several limiting factors constraining the sale of organic produce. The major one perceived by all the major retailers is the lack of a regular supply of suitable produce. Others include continuing confusion among consumers as to what constitutes organic produce and how it may be distinguished; multiple logos and certification marks of the different certification agencies creates considerable consumer confusion. Most products are sold locally through solely organic wholesalers and retailers (Hassall and Associates 1996) so that produce may not be readily accessible to most consumers.

Not surprisingly most sellers of organic produce reported a better supply of relatively unprocessed goods and a greater difficulty of supply of more processed and highly processed products. Domestic market opportunities were observed for a wide range of herbs, beans, nuts, fruit, vegetables, seeds, grains and cereal products, and dairy products. Overseas interest in Australian organic wool was noted (Hassall and Associates 1996).

The very dispersed nature of the industry also makes the supply of a single large market with a particular organic product difficult. Economies of scale in storage, processing, packaging and distribution will be difficult to achieve for some time. Hassall and Associates (1996) indicate that organic producers have higher marketing costs than conventional growers. Markets are locally based and are dominated by wholesale distribution, although retailers purchase significant quantities direct from growers. There is only a small export trade.

As has been indicated many organic producers have developed their own small markets. These are local, national and export and tend to be jealously guarded. Many farmers realise that individually they can only supply a small niche market but can operate well at that level. By themselves individual farmers cannot develop larger markets, and in turn the larger markets are unlikely to develop if there is no adequate assured supply.

Organic agriculture may well be in danger of becoming trapped in its own smallness. Small niche markets can be served well but the larger markets cannot. Until the larger markets are developed there will be little incentive for many more farmers to move into organic production. Competing for local or even national niche markets against well established suppliers will be difficult.

The failure of the certification organisations to recognise each other's certified farms and produce limits the market for organic goods through increased consumer confusion; and increased farmer and processor costs through the need for multiple certification to obtain market coverage.

Environmental Impacts of Organic Agriculture

In the EU, organic agriculture is well accepted as making a substantial contribution towards environmental protection. Lampkin (1996) argues that from research evidence in Europe, organic agriculture delivers a variety of environmental benefits. These include soil and wildlife conservation, reduced usage of non-renewable resources, and reduced pollution. However, he indicates that there are limitations to these environmental benefits from organic farming. Organic farming alone is not guaranteed to deliver a specific benefit or change in a particular location. Other measures may also be necessary to achieve the required change. Organic farmers are bearing the cost of implementing changes that may bring about environmental benefits. In a competitive market they will only be able to do this 'internalising' of costs for a short period without some form of subsidy or price premiums. Lampkin sees that EU subsidies are in part a return for organic farmers in Europe for providing some environmental benefits that other farmers do not produce.

The 1980 USDA report concluded that many of the management practices used by organic farmers were those cited as best management practices by the USDA and the US Environmental Protection Authority. However, within the USA organic farming does not have the level of acceptance as an environmentally friendly approach to agriculture as it does in Europe. Organic farming is regarded by many in the USA as "just another technical approach to production" (Henderson, 1996).

There is little evidence available in Australia to indicate whether or not organic agriculture is more environmentally sound than conventional systems. There are a range of issue that need to be considered to assess the environmental impact of organic systems. For example, by not using a range of agricultural chemicals as inputs organic farming is likely to lessen the general environmental load imposed by such usage. However, any such benefit needs to be weighed against possible costs. Such costs may, for example, result from reduced output through lower yields. This in turn may lead farmers to use land more intensively, increasing the need for off-farm inputs. Greater farming intensity may also induce soil degradation through excessive tillage or other management changes. Any overall loss of agricultural output through the increasing adoption of organic farming may also accelerate the conversion of non-agricultural land (‘natural’ ecosystems) into agricultural production. A range of these farm-based issues are considered in other papers in this volume.

Off-farm environmental impacts are more difficult to assess. If the widespread adoption of organic methods throughout the food supply system led to a substantial reduction in the use of preservation and protection chemicals then environmental benefits could be gained. These benefits would have to be offset against any possible increase in food losses. Other solutions to safeguarding the food supply may therefore need to be found.

As Lampkin has indicated it will be difficult to convince farmers and others to convert to organic methods of production, processing and preservation unless the outcomes are of some direct benefit to the operator.

Conclusion

Production, processing, distribution, marketing, research and development of organic products is done by a range of fragmented government and private industry institutions and individuals. OPAC produces and oversees national organic standards. There is no national peak body for industry coordination and policy making as a whole. While the industry is a very small part of Australian agriculture, it is growing quickly and has the potential for very large growth in the future. It could make a substantial contribution to "clean green " Australian agriculture.

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An Economic Assessment of Organic Agriculture and Implications for Future Research

Introduction

When discussing research needs in the area of the economics of organic agriculture, the target group of the research needs to be defined first. Differentiation should be made between research which serves the interests of the established organic sector, potential entrants and policy makers.

For the last two groups evidence that organic agriculture does not necessarily mean a substantial set-back in financial terms is very important. Direct comparisons between farms under organic and conventional management are therefore often the first research called for (but not necessarily paid for) when organic agriculture starts to be of interest to more than a few. For those who are established in organic farming at present, questions are not so much about whether organic agriculture is financially feasible. Questions here are more about how decisions regarding input use influence the farm as a whole, and its short- and long-term capacity to produce outputs and financial returns. Most of the research into the economics of organic farming in Australia has been carried out as surveys comparing organic and conventional farming.

In this chapter two surveys are reviewed: one in broadacre cereal-livestock farming in south-eastern Australia, another in irrigated bio-dynamic (b-d) dairy farming in Victoria. Future research needs, related both to production and policy, are then discussed.

Farm surveys

A survey was carried out on established broadacre farms for the year 1985-86 (Wynen 1989). The main results are summarised in Table 1.

The following conclusions can be drawn:

- Although the hectares operated are not significantly different between the two systems, the area cropped is less than half of arable area on organic farms and more than three quarters of arable area on conventional farms. This indicates a rather drastic difference in rotation between the two farming systems;
- variable costs (such as fertilisers, pesticides and fuel) are significantly lower on organic than on conventional farms;
- fixed costs: costs of machinery and equipment (measured as depreciation) are lower on organic farms;

Table 1: Comparison of inputs used, production and output variables per hectare operated on organic and conventional cereal-livestock farms in South-eastern Australia (1985-86)

	ORGANIC	CONVENTIONAL
INPUTS		
hectares operated	755	928
area cropped as % of arable area	47	77
fertilisers	3.0	19.1
pesticides	0.4	14.1
fuel	11.5	21.4
machinery and equipment	31.3	73.8
labour	34.9	40.9

PRODUCTION		
wheat yield	2.4	2.5
stocking rate (per non-cropped area)	1.91	1.27
RETURNS		
total cash costs	76	128
total cash receipts	181	262
farm cash operating surplus	105	134
return to capital and management (adjusted for interest and rent)	41.9	37.3
adjusted returns with average wheat prices (no premium prices for wheat)	31.1	34.8

From: Wynen (1989)

- labour (mainly family) can not be shown to be significantly lower;
- the wheat yield and stocking rates are not significantly different;

These conditions make the total cash costs the only financial measure which is statistically significantly different (lower for organic farmers). The other measures, cash measures and those taking into account non-cash costs (the return to capital and management, which is the farm cash operating surplus minus depreciation and family labour) are not different between the systems. This is the case also when no premium prices are paid for wheat.

A second comparison of financial costs and returns was carried out on bio-dynamic and conventional dairy farms in the Goulburn Murray Irrigation District in Victoria in the years 1989-90 to 1991-92 (Wynen 1994). Some of the results can be seen in Table 2.

Table 2 shows the following:

- the total effective dairy area on b-d farms is similar or lower than on conventional farms;
- those variable costs which are most influenced by the system of farming, such as cost of fertiliser, feed and animal health, are considerably lower on b-d farms than on conventional farms;
- total labour used is similar;
- production of milk per effective dairy hectare is, on average, 32 per cent lower on b-d than on conventional farms;
- all the financial measures per effective dairy hectare are lower on the b-d farms than on the conventional farms;
- although the total cash costs are lower on b-d farms, the difference between the cash receipts is such that the cash surplus and the net returns to capital and management are still considerably lower on b-d farms.

Table 2: Comparison of inputs used, production and output variables on bio-dynamic and conventional dairy farms in Victoria per effective dairy area (1989-90 to 1991-92)

	B-D	**CONVENTIONAL**
INPUTS		
total effective dairy area	66	71
feed costs (eg. fertiliser, agistment and concentrates)	250	471
herd costs (eg. animal health)	55	96
labour used (weeks)	1.81	1.85
PRODUCTION		

milk (litres)	6043	8935
RETURNS		
total cash receipts	1576	2438
total cash cost	1105	1492
farm cash operating surplus	471	946
return to capital and management (adjusted for interest and rent)	114	793

From: Wynen (1994).

In summary, the two surveys give a completely different picture. In the first survey (cereal - livestock) data indicate that net private financial benefits from organic farming can be similar to those in the conventional sector. In the second survey (dairy), private net returns to the b-d farmers surveyed are lower than to the conventional farmers, under prevailing input and output prices. In neither cases are the external costs of production taken into account.

Economic research

If the organic industry is to expand, it is necessary that potential entrants are aware of the financial consequences of a change towards organic farming, and also of the cause of the differences between the two. Established organic producers could also use this information to improve their performance.

The two surveys quoted above give rise to a number of questions, the main ones of which are:

- what are the characteristics of industries which make private financial benefits of some enterprises similar to those on conventional farms, and others different?
- what actions can be taken to make the enterprise more profitable within the organic/bio-dynamic guidelines?
- what kind of negative off-farm effects are associated with the different enterprises, so that a comparative benefit/cost analysis can be done which shows the full benefits and costs to the society as a whole?
- what is the effect on returns to farming in the two different systems of a change in policies towards some aspects of farming (such as input and output prices)?

There is not a lot of information available in Australia to answer the above questions. For example:

- for a number of industries there is a complete lack of comprehensive data (such as in horticultural industries);
- for some industries the available data is somewhat outdated. For example, over the last 10 years developments in conventional cereal-livestock farming have occurred regarding different crops in the rotations and marketing possibilities. Developments in organic farming since the 1980s have not been traced, nor have comparisons continued to be made with conventional agriculture;
- for some industries data are available for only a small area (for example, in the dairy industry, irrigated bio-dynamic farming in the Shepparton Region in Northern Victoria).

Besides providing data on comparative financial benefits, the comparisons of organic and conventionally managed farming enterprises, can also be used to analyse the differences between the two systems of some of the risks at different stages in farming. In the decision to adopt organic farming, risks during the conversion process are likely to be an important factor and deserve special attention in research.

The lack of an up-to-date database on financial results of different enterprises in different areas under different conditions makes it difficult, if not impossible, to research optimal production decisions on organic farms (such as rotation sequences, enterprise mixes, farm size). A dearth of information in the area of market analysis (expected demand and supply with its effects on prices in different markets) means that predicting future returns to organic farming, for which expected prices are important, is extremely hazardous. Lack of these basic data has a direct bearing on the reliability of 'bigger-picture' (for example national) research, essential to get an understanding of the consequences of policy changes which favour organic farming (see, for example, Wynen 1996b).

Infrastructure, such as research funding institutions, marketing arrangements (licensing, legal recognition of the word 'organic', marketing boards which do not allow organic producers to be paid a premium) and input pricing, influence the viability of farming. The present infrastructural arrangements are relevant for, and favour, conventional farming. Ideally, changes in the existing structure are likely to be contemplated if policy makers are convinced that society as a whole benefits from a shift towards organic farming. On-farm changes, which can be monitored by the financial comparisons mentioned above, show only a partial picture. Research into comparisons of costs and benefits of off-farm effects are necessary to complete the picture. These two measures together would indicate the desirability of a country changing its infra-structure such that the socially most desirable form of agriculture can function in an optimal environment.

Research is then needed into the economic effects of changes in policies towards a number of issues, including the direction of research, input costs (incorporating off-farm costs instead of reflecting only production costs), marketing, education, extension and risk management.

The economic research requirements, as discussed in this Section, can be summarised as follows:

<u>On-farm research</u>

Comparisons of financial results and an analysis of differences, which needs to include:

- all major industries
- different years (different annual circumstances, and developments over time)
- different regions
- details about the conversion process in the different industries
- details on management practices
- risk assessment
- optimisation of farming practices
- marketing analysis: expected demand, supply, price changes in different markets
- marketing institutions

<u>Off-farm research</u>

- off-farm effects of different forms of farming (externalities due to farm production);
- policies towards inputs, such as taxation and regulation
- the effect of a shift towards organic farming on the farm sector (returns to farming), and non-farm sectors (input and output industries); and
- other policies such as education, extension and risk management

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The Importance of the Soil Biota for the Functioning of Organic and Biodynamic Farms.

Introduction

Organic and biodynamic (alternative) farmers both claim that enhancing the functioning of the soil biota is critical to the successful functioning of their farms: a belief echoed by researchers and reviewers (Lopez-Real, 1985; La Rooj, 1989; National Research Council, 1989; Wynen, 1992; Macgregor, 1994; Penfold *et al*., 1995; Sinnamon, 1996). Indeed the Australian National Standard for Organic and Biodynamic Produce states that such produce is defined by being "*produced in soils of enhanced biological activity, determined by the humus level, crumb structure and feeder root development, such that plants are fed through the soil ecosystem and not primarily through soluble fertilisers added to the soil"* (AQIS, 1992).

This statement suggests that a particularly important role of soil organisms is to supply plants with nutrients from relatively insoluble sources in the soil. It also implies that soil biological activity is either reduced, or of little significance, on conventional farms.

This paper begins with a broad summary of the role of the soil biota and then reviews the existing evidence regarding the role of soil organisms in the functioning of alternative systems, generally by referring to studies where comparisons have been made between farms under alternative management and farms under conventional management. Soil organisms are examined under four broad headings: microbial biomass/activity; soil fauna; pathogens; and symbiotic organisms involved in plant nutrient uptake. Australian examples are used when possible, but as limited literature is available, overseas studies are also referred to when necessary. Conclusions are drawn about whether the composition and functioning of the soil biota will differ between alternative and conventional farms under Australian conditions and the reasons for any such differences.

The Soil Component of the Ecosystem

The functioning of the soil biota is likely to influence the functioning of the entire ecosystem (Price, 1988). Most organisms in terrestrial ecosystems live in the soil and the biomass and production of the soil organisms is often far greater than that of the above-ground organisms. For instance, Coleman *et al*. (1976) estimated that below ground production in a lightly grazed prairie was 83% of total production. Also, soil micro-organism communities are extremely diverse, often with large populations and short generation times and consequently their capacity to respond to environmental change is generally much greater than that of organisms at higher trophic levels.

In addition, some of the key links in terrestrial ecosystems are in the soil and consequently the soil ecosystem affects the functioning of organisms at all trophic levels. For instance, plant growth is mediated by the availability of nutrients and water in the soil. Nutrient cycling primarily occurs through biological decay processes in the soil which transform nutrients from organic forms back to ionic forms that plants can access. Soil organisms may also significantly influence plant growth by directly providing nutrients, particularly nitrogen (N) and phosphorus (P), to plants through symbiotic relationships. Soil organisms also contribute to soil structure through their role in the formation and stabilisation of soil aggregates.

Thus soil organisms are involved in soil processes which are vital for the healthy functioning of agricultural systems. A diverse and complex soil biota may also contain mechanisms to maintain equilibrium and may contribute towards an agricultural system being relatively resilient to change and unlikely to suffer outbreaks of pathogens.

However, until recently, the soil biota has received relatively little attention from agricultural researchers. In part, this may be due to many of the major functions of soil organisms being considered redundant in systems where the inputs and management techniques of modern industrialised agriculture are used. For instance, the role of soil organisms in the release of nutrients in a form available to plants may be less critical when large quantities of soluble fertiliser are being added to a system. In addition, there are inherent difficulties in researching and developing an understanding of complex systems such as the soil ecosystem.

The abundance and activities of soil organisms are both controlled by environmental constraints, in particular, the level of soil moisture, soil temperature and the availability of an energy source, generally organic matter. All farming practices, especially crop rotations, tillage, stubble management, fertiliser application, biocide application and irrigation, will affect the soil biota through their influence on these environmental factors. Any consistent differences in the soil biota between alternative and conventional agricultural systems should arise from differences in management practices. Studies which have examined the soil organisms present on alternative and conventional farms are reviewed below.

Comparisons of Soil Biota between Alternative and Conventional Farms

a) *Microbial biomass/activity & the microflora (bacteria and fungi)*

The microflora generally constitute the largest portion of the biomass of organisms in the soil. They are involved in many soil processes and are particularly important in cycling of nutrients. However, the large volumes and number of individual species of bacteria and fungi in the soil makes quantification of the biomass and activities of individual species virtually impossible. Consequently, researchers often make broad measures of these organisms through methods which estimate microbial biomass or activity. Although there are some cases, discussed later, where particular microbial groups have a prominent function which makes measurement possible, for instance, pathogens and symbionts which directly affect plant growth.

Total microbial biomass is generally broadly positively correlated with the level of soil organic matter (carbon) (Witter *et al*., 1993). For example, in a long term field trial in Sweden, Schnürer *et al*. (1985) examined a number of treatments involving cropping of wheat with treatments of artificial fertilisers, straw incorporation, and farmyard manure. Both microbial biomass estimates and activity measurements showed a highly significant correlation with soil organic matter levels.

It appears that additions of large volumes of organic matter will generally lead to increased microbial biomass. For instance, in an Australian trial comparing growth of vegetables under organic and conventional management, the populations of fungi, bacteria and actinomycetes were found to be greater in the organic plots where a high rate of compost (80-120 t ha^{-1}) had been added (Sivapalan *et al*., 1993).

Studies conducted overseas on alternative and conventional farms have tended to produce similar results to Sivapalan *et al*. (1993). Reganold (1988) examined a pair of adjacent organic and conventional farms in Washington State, USA. The organic farm had higher soil enzyme levels and microbial biomass than the conventional farm, indicating a more active microbial community. Differences were attributed to the inclusion of a green manure crop every third year in the crop rotation of the organic farm and different tillage practices. Elmholt and Kjøller (1989) also found higher numbers of saprophytic fungi in soil from a Danish biodynamic farm compared with a conventional farm. The results were attributed to the biodynamic farm including legumes and grasses in the rotation, regularly applying composted manure and not applying pesticides.

Often when alternative farms have been found to have higher microbial biomass, there has been the inclusion of legumes in the rotation. Robertson and Morgan (1996) found that cropping with legumes had a positive effect on soil fungi, microbial biomass and soil water content. It was suggested that this could have been due to improved water retention by decomposition and humification of the residues, as much to increased carbon and N supply (Robertson and Morgan, 1996).

However, many other management practices and environmental parameters may influence soil organic matter levels and microbial biomass. For instance, Sivapalan *et al*. (1993) also found that plots which were previously under pasture for 10 years supported a higher microbial population than those previously cropped with vegetables: an effect which continued for up to three years after the pasture was removed. Lower soil organic matter, greater soil disturbance and greater use of pesticides on the previously cropped plots may all have contributed to this result. Robertson and Morgan (1996) also found that compared with pastures, cultivated and harvested crops generally produced less organic residues, partly because soil carbon and N reserves were reduced by cultivation. Reducing tillage has been shown to result in increases in soil micro-organisms (Gupta and Roper, 1994). Sivapalan *et al*. (1993) also noted that a halving in the soil moisture content at one sampling date resulted in low numbers in all microbial groups.

However, addition of organic matter does not necessarily result in increased levels of soil micro-organisms. Robertson and Morgan (1996) studied the effects of converting vegetable plots to organic management at Frankston, Victoria. They found that 2-4 fold increases in annual organic matter inputs, applied as compost (6 - 42 t ha^{-1} supplying 50 - 352 kg ha^{-1} N), did not increase microbial biomass. They attributed this to either the quantity or quality of the compost, other factors limiting soil microbes such as water, or sudden bursts in activity which were not detected by their sampling. They also noted that while the labile fractions of organic matter additions will be responsible for short-term fluctuation in microbial biomass, older stabilised residues are probably more important in determining the long-term size of the biomass. Support for this conclusion comes from a long term experiment in Sweden where Witter *et al*. (1993) found the soil microbial biomass to be predominantly influenced by soil organic matter with an age of 30 years or more. It was also noted that organic matter added to the soil was no longer available, or was insignificant in amount relative to the older material, within one year (Witter *et al*., 1993).

Thus, even if regular organic matter additions are greatly increased after a farm converts to alternative management, it may be a long time before these are reflected in soil organic carbon levels. For instance, Penfold *et al*. (1995) examined South Australian trials which compared organic, biodynamic, integrated, and conventional broadacre farming systems in large replicated field plots. It was found that 6 six years of radically different management had no significant effect on organic carbon levels. However, there was an indication that organic and biodynamic treatment plots had higher levels of microbial activity, as measured by loss of tensile strength by cotton strips. Similarly, Derrick (1996) found that after 30 years of stubble retention and organic management, soil organic matter levels were 1.17 mg kg^{-1} on an organic wheat property in south-east Australia and 1.06 mg kg^{-1} on a conventional neighbour where stubble was routinely burnt: a non-significant difference.

In addition, the extensive nature of most agriculture in Australia means that acquiring, composting and spreading large volumes of organic matter is simply not practicable. Consequently, the volume of organic matter applied on most broadacre Australian alternative farms would not differ from their conventional neighbours, particularly when stubble retention, which is increasingly popular with conventional farmers, is practiced by all farmers. Thus any differences in microbial biomass between alternative and conventional farms would generally have to result from the other factors such as tillage or rotation. However these may also differ only a little between many alternative and conventional farms.

For instance, in the most comprehensive comparison of alternative and conventional farms in Australia, 10 pairs of biodynamic and conventional irrigated dairy farms in Victoria were examined by Small *et al*. (1994). The biodynamic farms had been managed biodynamically for, on average, 16 years. In paddocks under permanent pasture, organic carbon levels and soil microbial biomass did not differ between the two management systems (Small *et al*., 1994).

The lack of differences in the above study are of additional interest as all the biodynamic farms were regularly applying the homeopathic preparation BD500. BD500 is applied for a variety of reasons, including to stimulate soil life. Penfold *et al*. (1995) also found BD500 to have no detectable impact on the microbial biomass over two years of measurement. However, it is possible that the preparation affects the biomass and activity of particular organisms: an effect which may not be detected by broad measures of biomass or activity.

Ryan (1992) examined cellulose decomposing fungi in soil from neighbouring organic and conventional wheat farms: the organic farm had been retaining stubble for 30 years and the conventional farmer generally burnt crop stubble. Over 40 species of fungi were distinguished by their colony morphology on cellophane which had been placed on slides in the soil. Overall, species diversity appeared similar on the two farms, although there were a number of species that were present only on one farm, or were more numerous on one of the farms. There was an indication that cellulose decomposing ability was higher on the organic farm, but the results were not significant. As mentioned above, organic carbon levels were higher on the organic farm, but the difference was not statistically significant (Derrick, 1996). In other studies, retention of crop stubble has been shown to result in increased population sizes of cellulolytic bacteria and fungi (Gupta and Roper, 1994).

Thus there is some indication that alternative farms tend to have higher levels of microbial biomass, particularly if their management regime includes addition of high levels of organic matter, such as compost. Inclusion of pasture phases and legumes in the rotation and stubble retention will also tend to increase microbial biomass. If soil organic carbon levels are similar, then microbial biomass may not differ between alternative and conventional farms. However, even under these circumstances, differences in the biomass or activities of specific groups of micro-organisms may still exist between alternative and conventional farms. This is an area which has received little attention from researchers.

b) *Soil fauna*

Like the microflora, soil micro-, meso-, and macrofauna are responsible for the decomposition of organic matter in the soil and, due to their larger size, also tend to play a role in the movement of organic matter through the soil profile and its initial fragmentation. Being larger and less numerous than the microflora, the investigation of the activities of individual genera and species has been possible and current knowledge for agricultural situations has been summarised by Gupta (1994) and Fraser (1994).

One group of macrofauna which has received a large amount of attention are the earthworms. Worms can have dramatic positive effects on soil structure and fertility and there is a lot of interest in enhancing their roles in agricultural systems (Baker *et al*., 1994; Buckerfield and Auhl, 1994). In an Australian study of biodynamic and conventional irrigated dairy farms, Small *et al*. (1994) found a higher biomass of worms on the conventional farms ($87 g.m^{-2}$) in comparison to the biodynamic farms ($59 g.m^{-2}$). Two factors were considered to be responsible for this result. First, on the biodynamic farms, milk production was limited by P. The resulting lower milk production required less intake of feed, leading to a lower faecal output on the biodynamic farms and consequently less food available for worms. Secondly, the longer irrigation intervals over summer on the biodynamic farms may have reduced worm numbers.

Springett (1994) examined two pairs of adjacent organic and conventional farms in New Zealand, one dairying and the other mixed cropping. Indices of species diversity, richness, and evenness for soil fauna were slightly higher for the organic farms. Two key species, oribatid mites and spiders, were present on the organic farms and absent from the conventional farms. Earthworm numbers were greater on the organic farms, however species composition was the same. On the dairy farms the length of earthworm burrows was much higher on the organic farm (410 cm m^{-2}) than on the conventional (154 cm m^{-2}) (Springett and Gray, 1994). It was not determined which management practices were responsible for these differences.

Werner and Dindal (1990) examined the soil biota in the 5th year of a trial in Pennsylvania where three treatments had been established: organic-manure, organic-legume, and conventional. They found that several groups of organisms were more abundant and more active during various portions of the growing season in the organic treatments. Nematodes, prostigmatid mites and collembola were all more abundant on the organic plots, apparently in response to the organic matter inputs. The predatory mesostigmatid mites were also most abundant in organic-manure plots and appeared to be positively affected by weed growth in the plots. Oribatid mites were strongly suppressed in all treatments by tillage, and earthworms were also strongly negatively affected by tillage.

Thus, as with the microflora, the level of organic matter in the soil is probably the most important factor in regulating soil fauna populations, as it directly or indirectly provides all organisms with food and energy. Additions of organic matter may quickly result in increased numbers of organisms such as earthworms (Werner and Dindal, 1990; Penfold *et al*., 1995) and management practices which reduce organic matter levels, such as tillage and stubble removal, may quickly have a negative effect on population levels (Werner and Dindal, 1990; Pankhurst *et al*., 1995; Penfold *et al*., 1995). Soil fauna are also likely to be significantly affected by environmental factors such as soil moisture and other management factors such as rotation, and fertiliser and pesticide application.

c) *Pathogens*

Management practices can significantly affect the occurrence of soil-borne diseases and may be used to reduce outbreaks to acceptable levels. However few management strategies give consistent responses across a range of environments and the majority are unpredictable, partly due to a lack of understanding of the mechanisms involved (Neate, 1994).

The literature on severity of plant disease on alternatively managed farms has been reviewed by van Bruggen (1995) who found that root diseases and pests generally occurred at similar levels on alternative and conventional farms or were less severe on alternative farms. Foliar diseases showed more variability, perhaps due to the large influence of climatic factors on these diseases, although some foliar diseases have been found to increase when N fertiliser is used (Daamen *et al*., 1989). The lower levels and severity of root disease on some alternative farms was ascribed to the regular application of organic matter and elimination of pesticides. Together these were assumed to have increased the general level of soil microbial activity and have resulted in increased competition and/or antagonism in the soil. The lower disease level on the alternative farms was also thought to have been influenced by longer rotations breaking the disease cycle (van Bruggen, 1995).

Workneh and van Bruggen (1994) examined the soil organisms present in the rhizosphere of tomato plants grown on organic and conventional farms in California. The most significant differences between the samples were the higher populations and increased diversity of actinomycetes in the organic soil. As actinomycetes play an important role in organic matter decomposition, this difference was ascribed to the use of compost and green manures on the organic farms. Overall, the soils from the organic farms had higher microbial activity and the level of microbial activity correlated strongly with suppression in severity of the disease corky root (*Pyrenochaeta lycopersici*).

Similarly, in an Australian trial comparing the growth of vegetables under organic and conventional management, a number of soil-borne pathogens including *Alternaria brassicicola*, *Botrytis cinerea*, and *Rhizoctonia solani*, were found only on the conventional plots (Sivapalan *et al*., 1993). Antagonistic fungi, fungi with the potential to kill or weaken pathogens or prevent their infection, were found in much greater frequencies in soil from the organic plots. It was suggested that the addition of organic matter (80- 20 t ha^{-1} of composted manure, brown coal and grass clippings) to the organically farmed plots had encouraged the presence of antagonistic fungi. Thus when organic management involves addition of large amounts of compost it is possible that the levels of antagonistic organisms in the soil will increase and reduce the incidence of disease (Hoitink and Fahy, 1986).

There have been no quantitative studies of the levels of soil-borne diseases on broadacre alternative farms in Australia, systems where large inputs of compost are unlikely to occur. However, anecdotal evidence suggests that after a 3-4 year conversion period, farms converted from conventional to alternative management will then experience lower levels of disease than before conversion. Researchers of conventional systems have found that, under certain circumstances, over time soils may simply become suppressive for a particular disease. For instance, in a long-running field trial, Roget (1995) found that the incidence of rhizoctonia root rot (*Rhizoctonia solani*) increased to severe levels over the initial 5 years and then decreased to negligible levels over the following 6 years. This phenomenon has been noted elsewhere and is presumed to result from a build-up of populations of suppressive soil organisms. However, the mechanisms behind suppressive soils are not fully understood and it is generally not possible to predict their development. It is possible that suppressiveness may build-up on alternative farms after conversion, thus the initial increase in disease incidence noted by Roget (1995) could correspond to the conversion period when yields have been found to decrease (Janke *et al*., 1991; Wynen, 1992).

d) *Symbioses enhancing plant nutrient uptake*

In view of the nutrient poor status of many Australian soils (Leeper and Uren, 1993), a group of potentially important soil organisms are those which form symbiotic relationships with host plants and result in plant nutrient uptake being enhanced. As alternative farmers tend to apply less fertiliser and/or use relatively insoluble fertilisers, it is possible that these relationships are of particular importance in alternative systems. Two organisms which form symbiotic relationships with many agricultural plant species are bacteria in the genus *Rhizobia* and vesicular-arbuscular mycorrhizal fungi.

Rhizobia form a relationship with legumes and have been widely utilised in Australian agriculture. As these bacteria fix atmospheric N and supply it to the host plant, they are likely to be an important part of any sustainable agricultural system. Proper management of legume crops and pastures can eliminate the necessity to add N fertiliser. For instance, agriculture in south-east Australia is largely based on rotation of cereals with pasture containing legumes. Five to eight years of pasture containing subterranean clover can provide sufficient N to support up to three subsequent cereal crops (A. Ellington, unpublished data, in Coventry *et al*., 1985). In these systems, soil pH is an important factor controlling nodulation, with liming of acid soils improving nodulation (Coventry *et al*., 1985).

In a comparison of irrigated pasture on biodynamic and conventional dairy farms, the number of nodules on white clover was found to correlate positively with the concentration of P in the shoots of pasture plants (Figure 1; M. Ryan, unpublished data). Consequently, the level of nodulation tended to be lower on biodynamic farms where P fertiliser was not applied. This effect was probably mediated through the host plant (Ledgard and Steele, 1992), with clover in conventional pasture having enhanced growth due to better P nutrition and therefore being able to support more nodules. Lower nodule numbers may, therefore, be reducing N-fixation and further limiting pasture growth on the biodynamic farms.

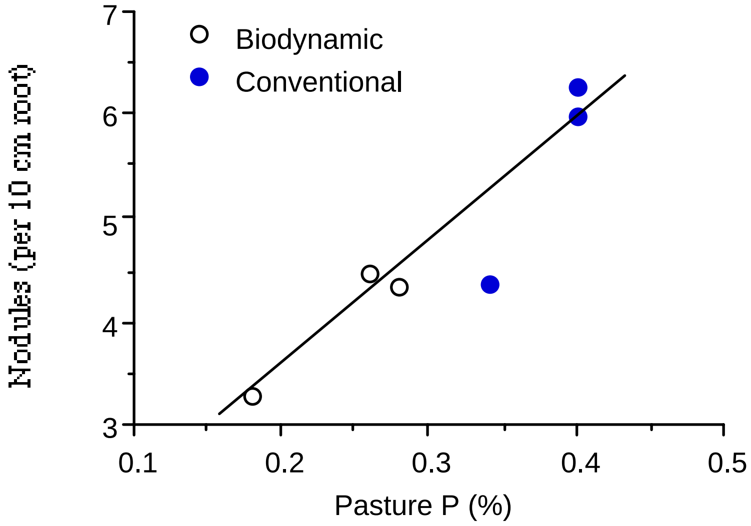

Figure 1. Relationship between frequency of nodules on roots and pasture P concentration in permanent pasture on 3 pairs of biodynamic and conventional dairy farms in northern Victoria (mean of 15 sites per paddock).

A second widespread group of symbiotic organisms are vesicular-arbuscular mycorrhizal (VAM) fungi. Mycorrhizal fungi are obligate symbionts, relying on the host plant for all their carbon requirements. In return, the fungi provide the plant with nutrients, particularly P. VAM fungi colonise the roots of most crop and pasture species, with canola and lupins being two of the few exceptions. The level of dependency of plant species varies, but a low level of colonisation can result in significantly reduced plant growth in dependent species such as linseed (Thompson, 1994).

Alternative farms have often been found to have higher levels of VAM colonisation than conventional neighbours (Lengnick and King, 1986; Bokhorst, 1989; Werner *et al.*, 1990; Sattelmacher *et al.*, 1991; Ryan *et al.*, 1994). In a 4 year study of VAM on wheat properties in south-east Australia, (Ryan *et al.*, 1994; Ryan, unpublished data) crops on organic and biodynamic farms consistently had significantly higher levels of VAM colonisation than neighbouring conventional farms. Results from the 1993 season are shown in Figure 2: The differences were most marked in the early stages of growth prior to tillering, 75 days after sowing. In fertiliser trials conducted on one pair of farms it was again found that wheat on the organic farm had higher levels of VAM colonisation (Figure 3).

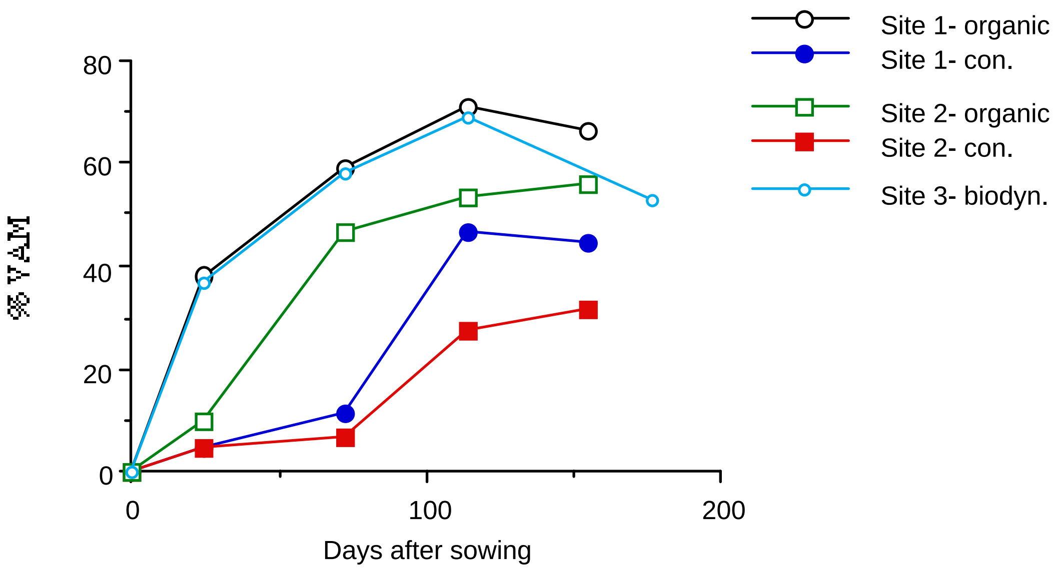

Figure 2. Percentage of root length colonised by VAM fungi in paired wheat crops at three sites in SE-Australia over the 1993 wheat season (mean of 20 sites per paddock).

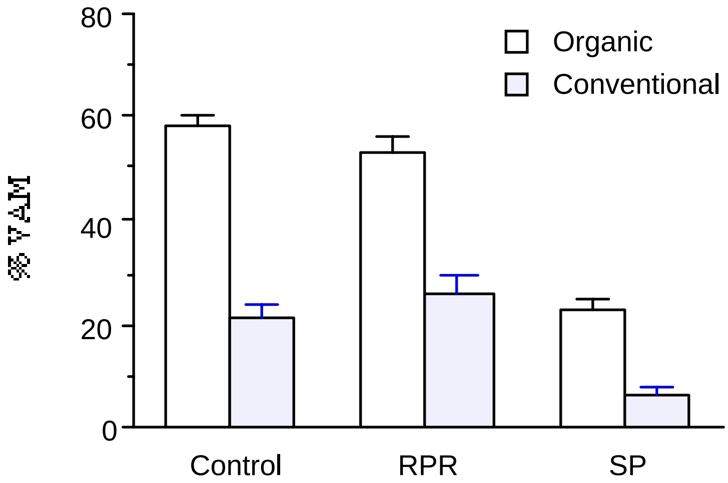

Figure 3. Percentage of wheat root length colonised by VAM fungi at tillering in fertiliser trials on adjacent organic and conventional farms. Treatments applied were no fertiliser (control) and 40 kg ha^{-1} of P as reactive rock phosphate (RPR) or superphosphate (SP) (mean ± s.e.m, 20 sites per treatment).

On each farm the addition of superphosphate significantly reduced the level of VAM colonisation, while the less soluble reactive rock phosphate had no effect (Dann *et al.*, 1996). Thus the lower levels of VAM colonisation in conventional crops compared with organic neighbours, shown in Figure 2, are due to use of superphosphate on the conventional farms. When the host-plant has easy access to available P it has no need for the fungi and consequently when the concentration of P in the host plant is high, VAM colonisation is restricted.

VAM fungi may influence other aspects of the soil ecosystem, including reducing the effects of pathogenic organisms (Thompson and Wildermuth, 1989), enhancing plant uptake of other micronutrients such as zinc (Thompson, 1994) and improving soil structure (Tisdall and Oades, 1979). Factors which may influence the level of VAM in Australian systems are summarised by Abbott and Robson (1994). In addition to soluble P fertilisers, VAM colonisation levels may be substantially reduced by long fallows (Thompson, 1994) and drought (Ryan and Ash, 1996).

Thus, for two soil organisms known to enhance plant uptake of nutrients, the evidence is contradictory. Biological fixation of N by Rhizobia may be limited by lack of P on alternative farms, while low P availability may enhance levels of VAM colonisation. However, as shown in section 4, the enhanced levels of VAM on the organic farm do not necessarily compensate for the effects of lower levels of soil available P on crop growth.

Case Study: Adaptation of the Soil Biota to 30 years of Organic Management

The complexity of the soil ecosystem often makes it difficult to assess the contribution of individual components to the functioning of the entire system. Thus even if a difference is identified between alternative and conventional systems, it may still not be possible to draw conclusions about the effect of this on the functioning of each system. Under such circumstances it may be more useful to measure the functioning of the entire system. This was attempted by Dann *et al.* (1996) who examined growth of wheat under various rates and types of fertiliser addition on adjacent conventional and organic farms.

The farms were located in the south-east wheat belt of NSW where P was the major limiting factor for crop growth and yield. The organic farm had ceased applying superphosphate 30 years previously and had subsequently been applying rock phosphate to crops. Rock phosphate contains P in a relatively insoluble form, however, it was speculated that over 30 years the soil biota may have adjusted in response to the use of rock phosphate, and perhaps the organic management regime in general, to allow plants to access the P from the fertiliser. Conversely, it was thought that on the conventional farm where the plants had been supplied with soluble P from superphosphate for many years, the biological mechanisms to allow plants to access the P in rock phosphate may no longer be present, or may have been less efficient than on the organic farm.

To test these hypotheses, yield of wheat grown under various rates of superphosphate and rock phosphate was compared with an unfertilised control on each farm in two consecutive years. In 1991, a relatively dry year, there was little difference in yield between the trials on each farm (Dann *et al.*, 1996). However, in 1992, a wetter year, yields were much higher on the conventional farm (Figure 4).

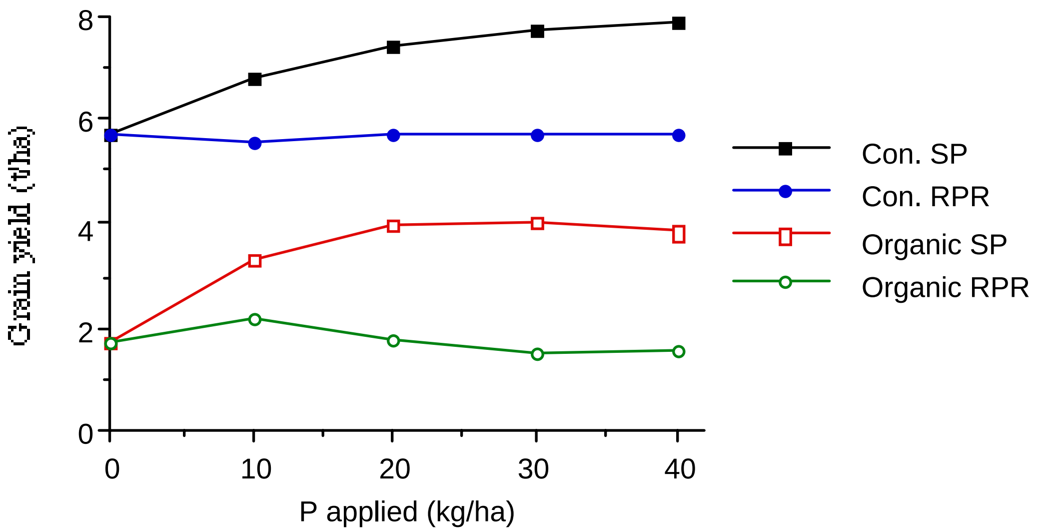

Figure 4. Response of wheat to addition of 4 rates of superphosphate (SP) and reactive rock phosphate (RPR) in field trials conducted on adjacent organic and conventional farms (Dann *et al*., 1996).

In both years the addition of superphosphate increased crop growth and yield on both farms, while the addition of rock phosphate had no significant effect. Thus after 30 years of organic management and rock phosphate addition, there was no evidence that the soil biota on the organic farm was better able to make the P in the rock phosphate available to the crop than the conventional soil biota. Indeed the similar growth and yield of the crop in the control and the rock phosphate treatments on both farms indicates that the wheat plants were not able to access significant amounts of P from the rock phosphate, even when heavily colonised by VAM fungi.

Thus the often repeated claim that on organic farms the soil life "releases substances that transform insoluble natural fertilisers into readily available plant nutrients" (Sinnamon, 1996), was not found to be the case, even thought the nutrient involved, P, was the major limiting nutrient for plant growth. However, it is possible that while the P from the rock phosphate wasn't being utilised, uptake of P from other sources in the soil was being stimulated by soil organisms, and may have been significantly contributing to growth of the control and rock phosphate treatments on one or both farms. The environment at the trial site is not considered favourable for the effective use of rock phosphate (Bolan *et al*., 1990), and it is possible that different results would be obtained under conditions of higher rainfall.

Summary: Factors Responsible for Influencing Soil Biological Activity on Alternative Farms

It appears that the level of soil microbial activity may vary between alternative and conventional farms, with alternative farms having higher levels under some circumstances. The differences appear to occur in response to specific management practices, discussed briefly below. The most significant factor influencing soil biological activity appears to be soil carbon levels and additions of organic matter.

Addition of large quantities of organic matter, such as compost, is often a feature of alternative systems of agriculture in Europe. However, in Australia, the composting and spreading of organic materials is often not such an integral part of our agricultural systems, due to their extensive nature. In addition, the concentration of population along the eastern seaboard makes the transport and use of urban waste in many major agricultural areas prohibitively expensive. However, intensive horticultural operations or orchards may potentially be able to produce and apply large volumes of organic matter. Soil organic matter levels can also be increased through use of green manure crops, longer pasture phases, and retaining stubble. Although not exclusive to alternative farming systems, these are all practices which are often employed by alternative farmers. Further research is required to quantify the effect of these management practices. In particular, research into the role of organic matter additions, especially compost, in stimulation of antagonistic organisms and development of suppressive soils could prove profitable.
A management practice which is likely to have a large negative impact on the soil biota is tillage. Tillage acts both through its negative effect on soil organic matter levels and also through its effects on organisms not adapted to cope with disturbance (Werner and Dindal, 1990). The combination of reduced tillage and stubble retention has been found to increase soil microflora and microfauna (Gupta and Roper, 1994). However, alternative farmers in Australia may make greater use of tillage (and fallow) than conventional farmers, as herbicides are not an option for weed control.

The non-intensive nature of much Australian agriculture may result in slight differences in management not leading to detectable differences in the soil biota. For instance, Fettell *et al*. (1994) found that in low rainfall environments where crop stubble production is relatively low and where tillage operations are rarely intensive, the choice of stubble management and tillage methods did not have a large or long-term impact on the soil biota.

However, a major difference between alternative and conventional farms in Australia involves the use of fertilisers, particularly phosphatic fertilisers. The use of soluble P fertilisers on conventional farms will dramatically reduce the level of colonisation by VAM fungi, which could potentially have a negative effects in a number of areas including maintenance of soil structure (Gatehouse, 1995). There is little information available on other effects of fertilisers on soil organisms, however it has been suggested that all significant effects will be mediated through the influence of the fertilisers on plant growth (Rovira, 1994). The effect of soil organisms other than VAM fungi on plant nutrient uptake is another area requiring further investigation

Biocides have been shown to effect the functioning of various groups of soil organisms (Fraser, 1994; Gupta, 1994), with insecticides, fungicides and fumigants generally having more severe impacts than herbicides. Studies that report enhanced biological activity in soils on alternative farms generally do not directly attribute this to the use of biocides in the conventional system. Although, presumably the use of biocides in conventional intensive horticulture or orchard operations could result in differences in the soil biota in comparison to alternatively managed operations. However, in extensive cropping or livestock operations in Australia the use of these chemicals is minimal and may have no significant impact on the soil biota, particularly in the long-term.

While the addition of organic matter or other management practices on alternative farms may lead to increased soil biological activity, there is little known about the effects of this on the functioning of the entire system. For instance, it is not known whether enhanced biological activity results in a system being more resilient to disturbances and stresses, such as drought.

Conclusions

Although there has been little research it appears that enhanced soil biological activity, relative to conventional systems, may be a feature of alternative farms in Australia. In particular, this is likely to be the case in more intensive operations, such as horticulture and orchards, where large inputs of organic matter may occur under alternative management. However, when the biomass or composition of the soil biota differs from conventional farms, there is a lack of information about the consequences of this for the functioning of the entire system.

It is likely that important differences, as yet undetected, may exist between alternative and conventional systems in the occurrence or activities of particular groups or species of soil organisms. These differences may not be reflected in broad measures of microbial activity, yet may result in different pathways being present for processes such as disease suppression and plant nutrient uptake.

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Soil Bio-physical Processes in Organic Agriculture

Introduction

It has become evident in recent years that agricultural practices that aim only to maximise productivity and ignore the problems of land degradation are leading to the progressive decline of an essentially non-renewable soil resource base. This realisation has facilitated a shift in emphasis of agricultural research from a productivity-oriented approach to one that aims for long-term sustainability as well as productivity.

The cereal-livestock zone in south-eastern Australia is a typical example of an enterprise that cannot maintain long-term sustainability under present management practices. The region is suffering from serious land degradation problems which include soil structural decline, acidity, salinity, sodicity, nutrient depletion and root diseases (Rovira, 1993).

Recently, attention has focused on alternative farming systems such as organic farming in the search for more sustainable agricultural practices. It has been suggested that such systems offer strategies for reducing some of the adverse environmental impacts of agriculture and may be superior in terms of soil quality and sustainability than conventional agricultural systems (Saffigna, 1993).

It is said that soil quality is superior under organic farming systems mainly because such systems avoid the use of agricultural chemicals and rely to a greater degree on soil biological activity. For example, organic farming does not rely on harmful herbicides or other chemical inputs to control weeds and pests, and depends to a greater extent on natural methods of maintaining soil fertility, such as biologically fixed nitrogen, and enhanced populations of mycorrhizal fungi to compensate for lower levels of soluble phosphorus in the soil. Even though organic farming does rely on tillage to control weeds, some studies report better soil physical properties in organic farming systems compared to adjacent conventional systems (c.f. Reganold, 1988; Logsdon *et al*., 1993; Jordahl and Karlen, 1993).

If the claims made about organic farming are justified, it implies that the key to sustainability in agriculture lies in understanding the complex biological, chemical and physical interactions operating in soils, and the role that organic farming practices have in enhancing and improving these interactions. To date, however, there has been only limited research into the effects of organic farming systems on soil properties and processes.

The aim of this paper is to examine a range of soil processes, especially biological processes as they relate to soil structure, in organic agricultural systems. Emphasis is placed on comparing processes in conventional and organic farming systems in the cereal-livestock zone of south-eastern Australia. However before discussing farming systems, the importance of soil structure and a brief overview of the role of the soil biota in soil structural processes is given. This is followed by a description of comparative studies of organic and conventional farming systems and finally a discussion of research issues relating to organic farming, conservation tillage techniques and the effects of organic farming on the hydrologic balance.

Soil Structure and the Role of the Soil Biota

(i) Definition of soil structure

Soil structure is defined by Oades (1993) as the arrangement of particles and associated pores in soils across a range of sizes from nanometres to centimetres. In the majority of soils, particles group together to form aggregates, and the size and stability of these aggregates, as well as the pores that arise from aggregation, are all important aspects of soil structure.

Soil structure is an important soil physical property because it influences a range of vital soil processes including the transport of water, nutrients and gases into and through the soil profile, and the activity of soil organisms, which in turn regulate key soil processes such as soil organic matter decomposition and nutrient recycling (Elliot & Coleman, 1988). Good soil structure for plant growth depends on the presence of stable and porous aggregates within the size range of 1 to 10 mm diameter (Tisdall and Oades, 1982) that can resist breakdown by such disruptive forces as wetting, raindrop impact and cultivation (Charman and Murphy, 1992).

Tisdall and Oades (1982) developed a model that incorporated the concept of aggregate hierarchy and the role of various organic materials in the structure of aggregates. Depending on the size range of the aggregation, different agents in the soil are active (Fig. 1).

(ii) The role of organisms in soil structure

Diverse groups of organisms occur in soils and influence soil structure. Micro-organisms such as yeasts, algae, streptomycetes, bacteria and fungi are involved in the formation and stabilization of soil aggregates. Larger soil fauna such as earthworms, termites, beetles and spiders create channels and pores within and between aggregates and hence influence soil porosity (Lee and Pankhurst, 1992; Oades, 1993).

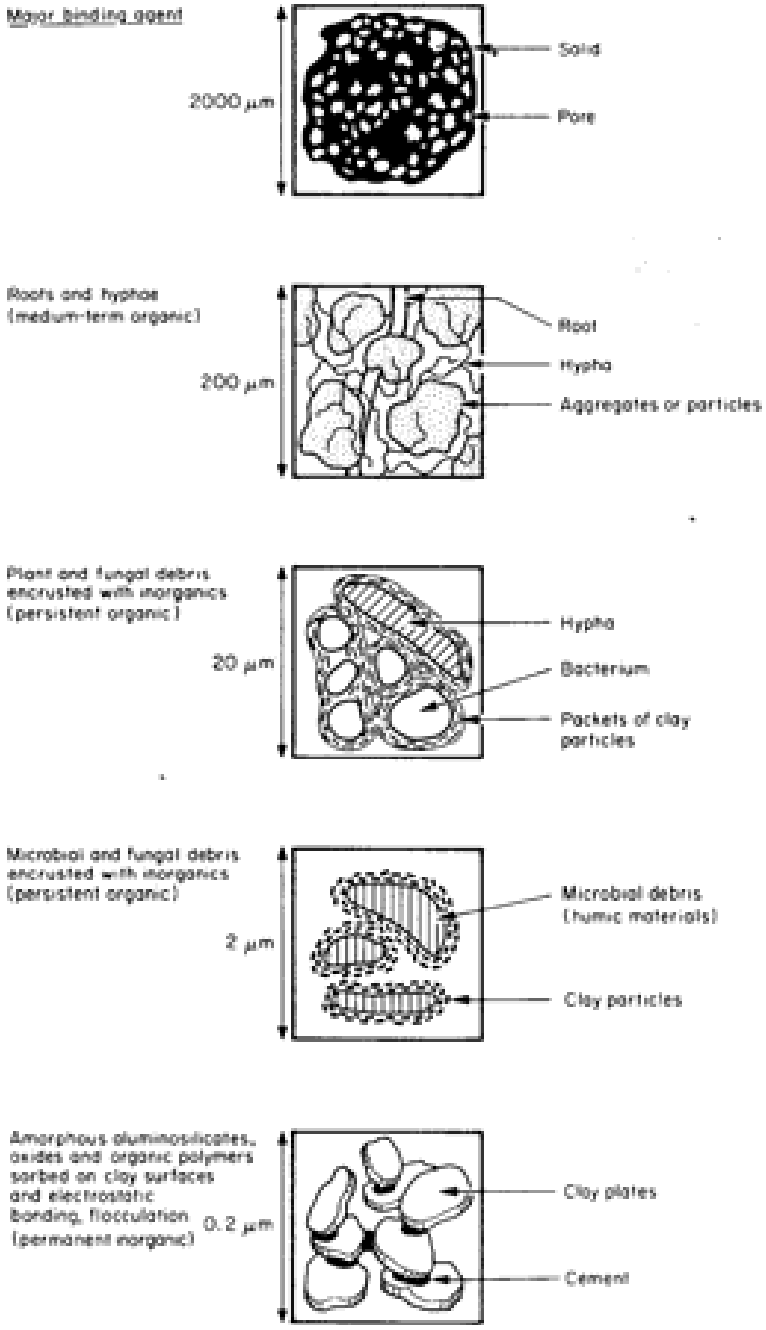

Figure 1: A hierarchical model of aggregate organisation and the binding agents that are dominant at each scale (from: Tisdall and Oades, 1982 p.150).

The initial formation of soil aggregates is primarily the result of physical stresses such as wetting and drying, and freezing and thawing, and aggregation of soil particles is controlled by the relative proportions of clay and sand, or soil texture (Kay, 1990). The roots of plants are major agents of shrink-swell processes because they exert a local drying effect in soils when they continually remove water. Moreover, roots ramify through the soil forging new channels and voids or enlarging existing ones as they grow (Tate, 1987; Russell, 1988). Living roots also provide a food source by way of root exudates and sloughed tissue for a myriad of other soil fauna and flora that influence soil structure (Allison, 1968).

The stabilization of aggregates involves both biotic and abiotic binding agents. Biotic binding agents include physical mechanisms such as the entrapment of soil particles among the fibrous networks of roots and fungal hyphae, and chemical mechanisms such as the synthesis of organic binding agents. Soil micro-organisms play a vital role in the production of organic binding agents during microbial conversion of plant residues and organic matter to polysaccharide gums and glues (Tisdall and Oades, 1982; Russell, 1988). Abiotic binding agents include metallic oxides and the attractive forces between clay particles.

Research suggests that, in general, fungi may be the most effective aggregators among the micro-organisms because they have the added advantage of an extensive mycelium and greater biomass in the soil (Martin and Waksman, 1940; Hubbell and Chapman, 1946; Martin, 1946; Swaby, 1949; Martin *et al*., 1959; Griffith and Jones, 1965; Harris *et al*., 1964 and 1966; Lynch, 1983; Eash *et al*., 1994). The hyphae of both saprophytic and mycorrhizal fungi enhance and maintain soil aggregation (Tisdall and Oades, 1979; 1980a; 1980b; 1982; Tisdall, 1991; Miller and Jastrow, 1990; Bethlenfalvay and Barea, 1994; Tisdall *et al.* 1997). Fungal hyphae form and stabilize soil aggregates by physical entanglement, secretion of organic and amorphous materials that cement particles together, and by sorption of clays to hyphae (Harris *et al*, 1966; Tisdall and Oades, 1982; Elliot and Coleman, 1988; Gupta and Germida, 1988; Chenu, 1989; Tisdall, 1991; Dorioz *et al*, 1993)(Fig. 2).

It is suggested that vesicular-arbuscular mycorrhizal (VAM) fungi may be relatively more important as aggregators than saprophytic fungi because they are able to persist in the soil for longer and build up in the soil as root systems grow (Tisdall and Oades, 1982; Tisdall, 1991). This is because VAM fungi receive a constant supply of carbon from the host plant whereas saprophytic fungi must rely on the availability of substrates in the soil.

The role of soil fauna in the formation of soil structure is not well understood. But it appears that the larger, more widely distributed species that are generally present in large numbers have the most significant impact (Lee and Foster, 1991). Mites and springtails, the most abundant mesofauna, are less important than the macrofauna because they rarely produce their own channels but enlarge and stabilize existing voids locally (Boersma and Kooistra, 1994).

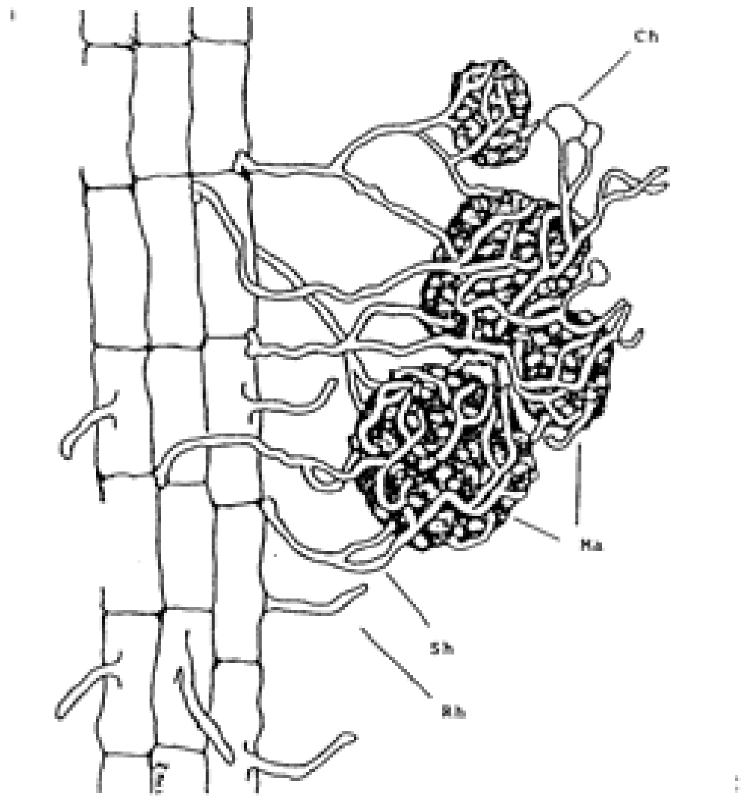

Figure 2 The enmeshment of soil aggregates by the external hyphae of VAM fungi. (Rh) root hair; (Sh) soil hyphae; (Ma) macroaggregates; (Ch) chlamydospore, (from: Miller and Jastrow, 1992 p.32).

The best studied of all of the soil fauna are earthworms. Earthworms improve soil porosity by burrowing and hence promote infiltration of water. Earthworm casts can make up the bulk of aggregates in the upper layer of the soil and the casts can be quite stable (Lee and Foster, 1991). However, the relative importance of earthworms in comparison to other large soil fauna in semi-arid cropping regions is uncertain. It is likely that ants and termites, are as beneficial to soil porosity as earthworm because their abundance is high in dry climates (Lobry de Bruyn and Conacher, 1990), while earthworm abundance is generally low in dry climates (Baker *et al*., 1994).

Soil management practices can have both positive and negative impacts on the populations and activities of soil organisms (Roper and Gupta, 1995) and this in turn can impact soil structure. Recently, agricultural researchers have begun to look at ways to manage the soil biota so that the activity of beneficial organisms can be enhanced to supplement or replace less sustainable management practices (Pankhurst *et al*., 1994). Attention has focused on organic farming systems because it is often claimed that organic farmers have had some success in harnessing the benefits of soil organisms by avoiding the use of agricultural chemicals.

Comparative Studies of Organic and Conventional Farms

(i) Background to studies

In many agricultural areas of Australia, there is increasing pressure on farmers to increase production. This is particularly the case in the cereal-livestock zones of southern Australia, where cereals are grown in rotation with pastures. Increasing production will usually involve cropping more frequently (shorter rotations) and/or converting existing land currently under permanent grazing into cropping. In some cases cereals are grown for several years in succession before converting to pastures. However, it is critical to maintain the balance between short-term productivity and long-term sustainability of natural resources.

Recently, organic farming systems have been considered as alternatives as a means of overcoming many of the land degradation problems associated with conventional farming systems. Following are the results from a number of studies carried out in Europe, North America and Australia comparing conventional and organic farming systems

(ii) Comparative studies

A small number of overseas studies have been published that compare soil properties on neighbouring organic and conventional farms to establish if there are any differences in soil quality between farms under the different management regimes. Many of these studies have reported enhanced biological activity and improved soil structure in organically managed soils.

For instance, the *Dutch Programme on Soil Ecology (1985-1992) of Arable Farming Systems* compared biologically mediated soil structure in conventional farming systems with low input (integrated) systems. Results generally showed that soil structure was better as a result of increased biological activity in the low input system (Boersma and Kooistra, 1994). The most important factor in the increased biological activity and better soil structure was determined to be reduced tillage disturbance (Boersma and Kooistra, 1994).

Another study by Reganold (1988) reported significant differences in a range of physical, chemical and biological properties between a pair of organic and conventional wheat farms in eastern Washington, USA. A later study by Reganold *et al.*, (1993) compared soil data from seven sets of paired farms in New Zealand. Favourable soil physical, chemical and biological properties were equal to, or better on the biodynamic farms than on the conventionally managed counterparts.

Jordahl and Karlen (1993) compared soil aggregate stability on adjacent alternative and conventional farms and found greater water stability of aggregates, higher soil organic matter content, and lower bulk density on the alternative farm. In a similar study, Logsdon *et al.,* (1993) reported higher infiltration rates, lower bulk densities, and higher volumes of large pores under alternative farming systems.

Better soil physical properties on the organic farms in the above studies were attributed either directly or indirectly to higher levels of soil organic matter. Higher organic matter levels were in turn attributed to different crop rotation systems; inclusion of green manure crops (legumes) in the rotation; additions of animal manures or other organic amendments; and reduced tillage (Reganold, 1988; Reganold *et al*., 1993; Jordahl and Karlen, 1993; Logsdon *et al.,* 1993).

There are relatively few published studies that compare soil physical properties on organic, or other alternative farming systems, with conventional farming systems under Australian conditions. One study compared soil physical and chemical properties on adjacent bio-dynamic and conventionally managed irrigated dairy pastures in the Goulburn Valley of north-eastern Victoria (Lytton-Hitchins *et al.*, 1994). Results showed that soils from the bio-dynamic farm had greater macroporosity, lesser soil strength and bulk density, and a greater organic matter content in the upper 50 mm than soils from the conventional farm. The more favourable soil properties on the biodynamic farm were attributed to less grazing pressure and taller pasture growth, longer intervals between irrigation, horn-manure and compost application among other things. Wells (1996) also reported better soil quality and lesser off-site effects in soils farmed under an organic vegetable growing system than soils under conventional treatments. Organically treated soils had higher levels of organic carbon, higher cation exchange capacity (CEC) and pH.

Penfold *et al*. (1995) compared soil physical, chemical and biological properties (among other things) on plots managed under organic, conventional, integrated and biodynamic treatments in a biological farming trial at Roseworthy campus, Adelaide. While this trial is still at an early stage, after 7 years of treatment, the organic, integrated and conventional plots all had more P applied than extracted, while the biodynamic plot had more P removed than applied. The only form of nutrient applied to the integrated plot was sewage sludge. There was a trend toward greater microbial activity on the organic and biodynamic treatments.

A number of studies have compared the microbial biomass of soils under different management treatments. A high microbial biomass is thought to indicate better soil quality and more sustainable farming practice and may be indicative of greater availability of nutrients. Daniel *et al*. (1994) reported inconclusive results from studies of pairs of conventional and biodynamic dairy farms. Bell *et al*. (1994) found no differences in soil organic matter levels between pairs of organic and conventional wheat farms, but microbial biomass and activity tended to be greater on the organic sites. Patulot-Marqueses *et al*. (1994) studied soil properties on organic and conventional orchards and vineyards and found no consistent pattern for C/N ratio and soil mineral N between farms, but found significantly higher biomass carbon and nitrogen on organic farms where soil C was less than 2% and soil total N less than 0.2%.

Sustainable soil fertility is a major concern to agricultural practitioners. As such a number of studies have compared soil chemical properties in relation to crop yield on organic and conventional farms. Bell *et al*. (1994) studied 4 pairs of organic and conventional wheat farms in Western Australia and found that N inputs from symbiotic nitrogen fixation in legume-based pastures were in general adequate for subsequent crop growth in both organic and conventional soils, while soil P was the limiting nutrient in 15% of organic farms. Grain yields on the organic sites were equal to those of conventional farms where soil P levels were adequate. However, where soil P had become depressed after harvesting, and was not replaced, substantial reductions in wheat yield were observed. Thus maintaining adequate soil P supply is a major concern in the sustainability of organic farming systems.

Lefroy *et al*. (1993) suggest that a more ecological approach to soil fertility is required, where agricultural systems try to incorporate features that mimic natural ecosystems. Such features might include recycling of nutrients and enhancement of microbial activity by the addition of organic residues. Organic farmers in the northern hemisphere frequently supplement or replace chemical fertilizers with organic amendments such as green manure, animal manure and municipal sludge. The replacement of chemical fertilizers by organic amendments might explain why soil biological activity and consequently soil physical properties are often superior in organic farming systems.

The crucial role of micro-organisms in the aggregation process has long been recognised. As early as the 1940s researchers discovered that when various plant and organic residues were added to the soil, aggregation improved significantly, but only when micro-organisms were present. Organic residues had little effect on aggregation in the absence of micro-organisms (Gilmour *et al*., 1948; McCalla *et al*., 1957; Martin *et al*., 1959; Eash *et al*., 1994).

In Australia, broadacre organic cereal farmers typically replace soluble phosphatic fertilizers with insoluble rock phosphate, rather than use organic residues, which is often impractical over large areas. The substitution of organic residues with rock phosphate might explain the inconsistencies in results of the microbial biomass studies of Daniel *et al*., (1994), Bell *et al*., (1994), and Patulot-Marqueses *et al*., (1994), who incidentally did not describe specific differences in management practices between sites in the cited abstracts. By contrast, Sutton *et al*., (1994) found higher yields, associated with greater microbial biomass, on sugar cane farms where green cane trash is retained rather than burned.

Among the reported impacts on biological activity attributed to replacement of soluble fertilizers with insoluble ones is higher levels of root colonisation by VAM fungi on organic (and biodynamic) farms where soluble phosphatic fertilizers are not used (Ryan, 1992; Ryan *et al.*, 1993; Ryan and Small, 1994). However, no evidence has so far been found to show that VAM fungi are able to compensate for low P levels, and further that this is reflected in crop yield. Recent research has shown that higher VAM fungi levels do not increase yield in wheat crops compared to those fertilized with soluble P (Dann *et al*., 1995).

A major study was undertaken by Gatehouse (1995) to investigate soil physical properties on an organic farm. The study investigated the relationship between soil structure, soil management and VAM fungi in a neighbouring organic and conventional farm near Ardlethan, NSW. Measurements were taken at the beginning of the season (fallow) and at intervals throughout the growing season. At all stages fungal hyphal lengths in the soil were found to be greater in organically managed soil than in conventionally managed soil (Fig. 3).

The higher density of fungal hyphae in organically managed soil compared with conventionally managed was highly correlated with the percentage of water-stable aggregates > 0.25 mm in the two soils (Fig. 4).

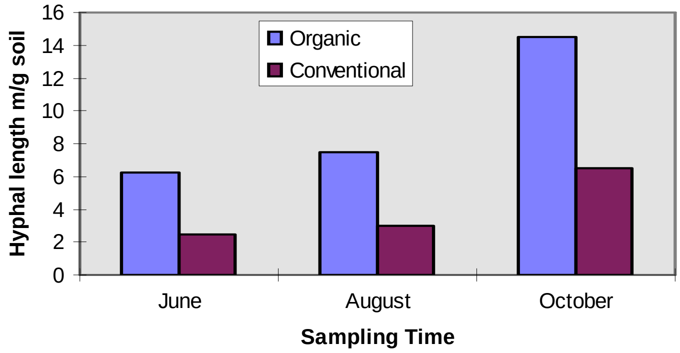

Figure 3 Mean density of fungal hyphae in m g^{-1} of soil from an organically and conventionally farmed paddock.

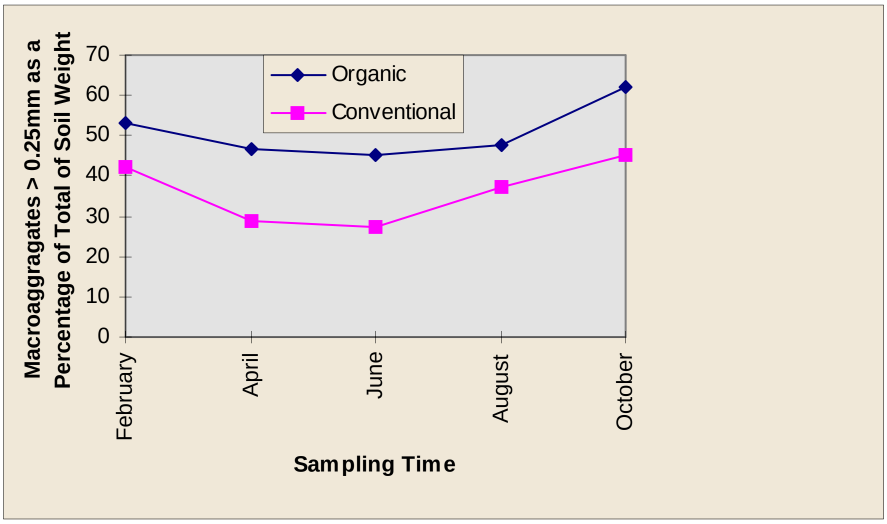

Figure 4 Changes in the percentage of water-stable macroaggregates over the growing season in soils from an organic and conventional paddock.

These results are consistent with those of Tisdall and Oades (1979) who showed that under growing plants the hyphae of VAM bind microaggregates (<250 μm diameter) of an alfisol into water stable macroaggregation. The improved aggregation resulted in higher infiltration rates into the soil (Fig. 5).

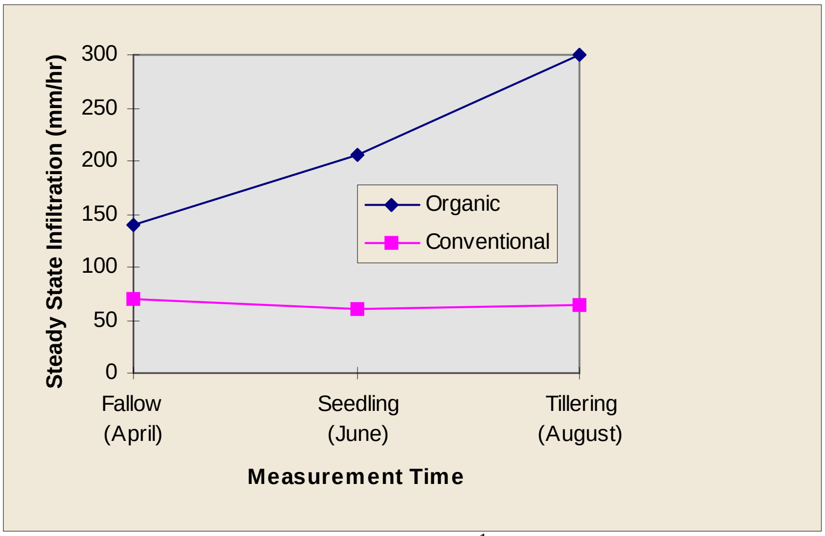

Figure 5 Changes in the steady state infiltration rates (mm hr^{-1}) of an organically and conventionally managed paddock from fallow to wheat tillering.

Research Issues

The previous section illustrates that many issues are still not completely understood about organic farming systems, particularly in relation to their effects on soil processes. Many of the research results and practices from conventional farming are likely to be of relevance to organic farming. Similarly, many methods and techniques from organic farming are likely to be applicable to conventional agriculture. However, some major difficulties still exist. Several of these key issues will now be discussed.

(i) Conservation tillage and soil structure

The various studies comparing the properties of conventional and organic farming systems have highlighted the role that tillage practices may have on soil physical properties. Tillage is commonly used in cropping systems of the cereal-livestock zone to prepare a suitable tilth in the soil seed bed, to control weeds, inhibit pests and pathogens, conserve soil moisture, and to mineralise nutrients (Jarvis *et al.*, 1991). However, excessive tillage can lead to severe soil structural decline (Rovira, 1993; Martin, 1994). Therefore, over the past decade, considerable effort has gone into the development of conservation farming techniques including minimum or zero tillage, direct drill and associated stubble retention to counter the effects of excessive cultivation (Rovira, 1993). Most of this work on conservation farming has been on conventional farming systems, with very little on organic systems. However, as a lot of the principles developed on conservation tillage on conventional farms will be applicable to organic farms it is important to highlight some of its main features.

The work on conservation farming techniques including minimum or zero tillage, direct drill and associated stubble retention has shown that there are long-term benefits of improved soil structure, higher infiltration, less runoff and reduced erosion, less compaction and crusting as well as a build up in soil organic matter and soil biota (Steed *et al.* 1993; Doube *et al.* 1994). However, while the new conservation tillage systems (such as direct drill etc) have the potential to alleviate problems of soil structure decline, they create other problems. These include an increased need for herbicides to control weeds, and increased severity of root fungal diseases such as rhizoctonia. Rhizoctonia has limited the adoption of direct drilling in cereals in Australia (Rovira, 1986) and has been implicated in the slower growth and reduced yield of direct-drilled plants compared to plants in cultivated soils (Kirkegaard *et al.*, 1995). It is clear that other avenues of research are needed to overcome the adverse effects of tillage on soil structure.

Since the organic farming system cannot use herbicides sprays, organic farmers are forced to use cultivation and/or grazing techniques for weed control. Murphy (1996) has even suggested that some organic farming systems, particularly those based on increased tillage, high stocking rates and low cover levels, may in fact be increasing the level of land degradation due to soil structure decline. However, many organic farmers tolerate higher weed infestation and use strategic grazing to overcome this problem. In these cases soil structure improves (Gatehouse 1995). The relationship between different types of organic farming practices and changes in soil structural stability is therefore an important area requiring further investigation.

(ii) Consequences of changed hydrologic cycle on erosion, nutrient losses, acidity and salinity

The higher infiltration rates reported for organic farms compared with conventional farms (Logsdon *et al.* 1993; Gatehouse 1995) raises the issue of what effect is this changed hydrology having on soil processes, both on and off-farm? A range of processes dependent on the hydrological balance in soils are erosion, nutrient loss, acidity and salinity.

Erosion: Wells (1996) in his study of different vegetable growing systems found less erosion from organic systems than conventional systems. Gatehouse (1995) also observed that there was less erosion from a wheat paddock under organic agriculture than from a paddock under conventional agriculture.

Nutrient losses: The interaction between nutrients such as nitrogen and phosphorus and the hydrological balance is a key issue in land degradation. For example, in many areas of Australia, phosphorus and nitrogen concentrations in surface runoff from agricultural land are elevated relative to uncleared land, resulting in associated off-site effects such as eutrophication of waterways (Clarke 1992). Major nutrients such as phosphorus and nitrogen are mainly adsorbed onto finer soil particles which have a larger specific surface area and CEC than coarser particles (Pallis *et al.*, 1990). These fine soil particles tend to be the first particles lost in erosive events (Eldridge and Greene, 1994).

Nutrient losses from organic farms are likely to be considerably less than those of conventional farms. Not only are the levels of soluble P in the soil solution lower (Ryan *et al.*, 1994), but the higher infiltration capacity reported on organic farms will also result in less runoff and erosion of fine soil particles. Well (1996) also reported less off-site effects from leaching of nitrogen on organic farms.

Soil acidity and salinity: Even though increased infiltration may lower nutrient losses, the fate of the excess water entering the profile needs to be considered. In terms of on-farm effects, enhanced water entry into the profile may increase nitrate leaching if the crop is incapable of utilising the excess water. Nitrates accumulate in the root zone of legume based pastures, particularly long term pastures that are often a feature of organic farms. If nitrate leaching occurs, the nitrate will be leached in association with exchangeable cations such as calcium and magnesium. When this occurs aluminium and hydrogen will replace these cations on the clay, resulting in soil acidity (Chartres and Geeves, 1992).

Another consequence of the crop's failure to utilise the excess water is the likelihood of increased off-site salinity due to rising water tables (Peck 1993). If the organic farm is an area of excessive recharge upslope of a saltland, the excess infiltration will exacerbate the problem by further altering the imbalance of the hydrologic cycle.

Very little is known of both these effects resulting from changed soil hydrology and further research is urgently required before organic farming practices in broad-scale sheep/wheat farms can be adopted without concern for undesirable on/off farm effects.

Conclusions

The above results indicate that even though organic farming systems appear to have many advantages in terms of improved soil physical properties, it is not always clear how to achieve these properties. The adoption of conservation farming techniques is currently severely limited by root diseases and the need to use herbicides.

Even if improved physical properties do result in favourable consequences such as more infiltration and less runoff, erosion and nutrient loss, the fate of the excess water entering the root zone needs to be understood. If crops cannot use the water, soil acidification and salinity may result.

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Organic Agriculture in Australia: On-farm Research

This chapter reviews the published on-farm research into organic farming which has been conducted in Australia and discusses the future research requirements for organic farming. It has focussed on research which has been specifically called organic, although information which may be relevant to organic farming can be found in published conventional research. The majority of agricultural research in Australia is conducted by government agencies such as CSIRO at a national level and by state government departments of agriculture at the state level. Funding is provided by research corporations and by government. For the purposes of this report this research may be divided into three categories:

Conventional specific

Conventional specific research is research which yields information which is only of value to conventional farmers. For example research involving the use of herbicides or genetically engineered organisms are not relevant to organic farmers as neither of these are permitted under organic standards. A large proportion of current research would fit into this category.

Organic specific

Organic specific research is research which is only of value to organic farmers. In fact, few results from such trials would be solely of use to organic farmers as there would be no reason to prevent conventional farmers using organic methods if they chose. However, it is likely that conventional farmers might consider such knowledge irrelevant to their farming systems. For example, a conventional farmer might not consider worthwhile the effort involved in non-chemical methods of weed control when herbicides provide a convenient and effective means of weed control.

System neutral

System neutral research produces results which are useful to both organic and conventional farmers. For example, research into the ecology of pests provides an understanding of life cycles and may provide insights into improved means of control for both organic and conventional farmers. Another example would be the CSIRO research which has developed the methods of controlling pests of stored grain by the use of carbon dioxide instead of insecticides. Such methods can be used by organic and conventional farmers. A problem with this kind of research is that its results are generally in the form of information or public goods. It may not result in increased sales of inputs or in the development of patents, consequently in a climate where there is increased emphasis on external funding for research or joint ventures between government and private enterprise such research is less likely to be funded.

Linkage with conventional research

Hassall and Associates (1996) estimated that the proportion of Australian farmers who were certified as organic as less than 1% of the total. However, if those seeking organic certification are included this figure increases to somewhere between 1.1% and 1.4% (Hassall and Associates, 1996). Given the small size of the organic industry it is unlikely that much organic specific research will be funded. If this is the case then the most effective way of obtaining useful information is likely to be from system neutral research. To achieve the best results from this it will be necessary to form linkages with conventional research.

Types of research into organic farming

Lockeretz (1985) classified agronomic research into organic farming systems into five categories each with a particular goal:

1. Descriptive: such studies are designed to obtain information about organic farming systems such as the management techniques used by organic farmers. According to Lockeretz (1985) such information is 'vital for intelligently designing other studies'.

2. Evaluative: these studies are designed to answer the question 'how good is organic farming in comparison to conventional farming'? Various criteria such as soil fertility, crop yields and energy inputs can be used to make the comparison. This type of research is best conducted on working organic farms.

3. Applied: these studies are designed to produce improved organic farming methods.

4. Diagnostic: Lockeretz (1985) describes such research as collecting data which might ultimately provide the basis for further general explanatory work. Such data will be a contribution to a pool of data which may ultimately allow the understanding of the underlying principles. Diagnostic research differs from descriptive and evaluative research in that data is collected about additional factors which may not be of interest to the farmer.

5. Explanatory/Predictive: this type of research uses empirical data to attempt to produce broader principles related to the functioning of organic farming systems.

On the basis of Lockeretz's categories it is first necessary to do descriptive research to obtain the necessary information to design appropriate experiments.

Research into organic farming in Australia

There has generally been little interest shown in organic farming by traditional research organisations such as CSIRO and state departments of agriculture. Some state departments have now appointed officers to deal with organic farming (Madge, 1995). A good deal of the available information about organic farming in Australia can be found in the proceedings of conferences related to organic farming; some examples are listed in Table 1.

Table 1: Some Australian conferences relating to organic farming

Year	Conference title	Location
1987	Sustainable agriculture: a new direction	Dookie College
1988	The growing alternative	Victorian College of Agriculture and Horticulture (VCAH)
1988	Towards better agriculture	University of Western Sydney, Hawkesbury
1989	The future for farming. First Australia-NZ ecological agriculture conference	Brisbane
1989	Organic agriculture and the soil*	Dareton, NSW.
1989	Organic food production	VCAH
1990	Go organic, food you can trust	VCAH
1990	Organic farming in field crop production (QDPI Crop Production Conference)	Toowoomba
1990	Organic broadacre farming and horticulture	Orange, NSW
1990	Australian organic agriculture conference	University of Adelaide

1992	Organic agriculture: farming for the future	Sunraysia Horticultural Centre, Mildura
1992	Organic and conservation farming - bridging the gap	Charles Sturt University, Wagga Wagga
1992	Alternative farming systems	University of Adelaide, Roseworthy
1993	Organic agriculture - a serious form of agriculture	Moama, NSW.
1994	Environmental agriculture towards 2000	Gold Coast

What published research there is about organic farming in Australia dates from the early 1980s. For the purposes of discussion the research has been separated into the categories described by Lockeretz (1985).

Descriptive research

A number of surveys have been conducted to obtain information about various aspects of organic farming in Australia.

Conacher and Conacher (1982)

The first survey of organic farmers in Australia was conducted by Conacher and Conacher in 1981 and 1982. The survey had six objectives:

i) Identifying all the organic farmers in WA.
ii) To establish farmers' reasons either for converting from conventional to organic methods or for commencing farming organically.
iii) To identify the methods used by organic farmers.
iv) To determine the degree of success of organic farming methods as perceived by organic farmers.
v) To identify the problems faced by organic farmers.
vi) To obtain comparative data from successful organic farmers from other parts of Australia.

Conacher and Conacher faced a problem as at this time there was no commonly agreed definition of organic farming in place in Australia, so an overseas definition was used. This survey was intended to be an information gathering operation prior to more detailed research on specific aspects of organic farming. The survey covered all types of farming and a range of property sizes. It was conducted mainly by post. Questionnaires were sent to 248 farmers and 18 farms in WA were visited. The largest single category of commercial organic farms was grain/sheep farms. This category contained 24 farms, 17 of which were in WA and 7 were in the eastern states. A range of information about cultural methods was provided. In this category 16 of the 24 used superphosphate although at a lower than average rate, and six used urea. A number used various herbicide sprays and one mentioned the use of DDT.

Conacher and Conacher concluded that "most products could not be sold as organic by any reasonably strict definition" although at the time organic standards were not in place. The use of superphosphate and herbicides is not permitted under current production standards (Organic Produce Advisory Committee, 1992). It is not clear from the data if any of the farmers were wholly organic. In the discussion Conacher and Conacher note that most farming categories in the survey, including grain/sheep, had at least one and usually more farmers who considered themselves wholly organic.

The use of a postal survey was the most practicable technique considering the large geographical area covered. Postal surveys have some drawbacks. In particular they provide no opportunity for a researcher to discuss items in detail. Farmers faced, for instance, with a question such as "please describe your farm rotation practice" may describe it in a very general way. A general answer such as the rotation is wheat and pasture does not give detailed information about a key area of organic farming. At the time of this survey as there were no organic standards in Australia definitional problems were inevitable. Now that standards are available there is a yardstick against which farm practices can be measured. This survey was a worthwhile exercise at the time, but given the unfavourable manner in which many of the farmers' practices compare to current organic standards, the data collected is now of limited value.

An updated version of this survey was published in 1991 (Conacher and Conacher, 1991) and dealt with the organic industry as a whole rather than individual sectors or farmers. This paper provided details on issues such as the number of growers, area under organic management, consumer demand and marketing. In this regard it was very similar to the report produced by Hassall and Associates (1990) which was acknowledged to contain the most detailed appraisal of the organic farming industry in Australia at the time.

Wynen (1988)

The second major Australian survey was conducted by Els Wynen in 1985 and 1986 and reported in 1988. Wynen located farmers by postal survey which covered a range of industries. Replies were received from cereal/livestock and mixed cropping enterprises, grazing, dairy and horticultural enterprises. The wheat/livestock enterprise was ultimately selected for study.

Wynen compared the practices of the farmers to the NASAA grade one standard at the time and used this to select 13 sustainable farmers (Wynen regarded organic as sustainable). These were divided into 8 fully sustainable farmers and 5 semi-sustainable farmers according to their degree of adoption of sustainable practices. For farmers to be considered fully sustainable they had to avoid the use of synthetic fertilizers or pesticides as described in the NASAA grade one standards. In addition they had to be using techniques such as green manuring and crop rotation in the management system. The reason for this division was to prevent large differences between fully sustainable and conventional farmers being masked by smaller differences between the semi-sustainable and conventional farmers. In addition, differences between the two groups of sustainable farmers could be measured.

For the survey each sustainable farm was paired with a conventional farm in the same district with similar enterprises and operated with a similar level of management skill. Data on a range of variables were collected for each pair of farms and various statistical techniques were used for analysis.

Results from this survey provided a broad comparison of the two management systems. Both groups had similar interest costs per hectare operated, suggesting similar levels of debt. Both groups had land of similar value (an indication of land quality) and similar arable area although the arable land on the sustainable farms constituted a smaller percentage of the total area, meaning the sustainable farmers had greater areas of poorer land. The ages of the farmers and the number of years farming experience were similar. The returns to capital and management were similar for both groups and remained similar when adjusted by removing rent and interest charges or by calculating returns using wheat board prices. The average price for wheat received by the sustainable farmers was higher because some farmers sold their wheat at a premium in specialised markets and not through the Australian Wheat Board.

Wynen's study also provided some details of cultivation practices, an assessment of the managerial skill of the farmers and their motives for farming organically. A problem identified by sustainable farmers was a lack of information on sustainable farming, weed control and availability of organic inputs. Wynen provided some discussion of factors such as age, indebtedness and stage of life which can affect a farmer's management and the difficulty of pairing farmers for management ability. These are factors which can affect the results of any comparative study. The conclusion of this study was that for 1985-6 sustainable farmers achieved financial returns equal to conventional farmers. This was despite unfavourable relative output prices (ie the relationship between wheat and sheep returns), the lack of information available on sustainable farming and the lower level of management skill of the sustainable farmers. One problem with a survey of this type is that it is based on one year only. Relative performance of systems may vary according to weather conditions (Klepper *et al*., 1977). Relative levels of cropping can also vary according to prevailing economic conditions.

Hassall and Associates (1990 and 1996)

In 1990 the then Australian Special Rural Research Council, which is now the Rural Industries Research and Development Corporation (RIRDC), commissioned the consultants Hassall and Associates to conduct a survey of the organic farming industry. The survey had three aims:

i) determine which organic food products Australia has the potential to supply in significant quantities;
ii) determine the domestic and export market opportunities for these organic products; and
iii) develop market strategies which will maximise the likelihood of such opportunities being maximised.

All types of organic food production: fruit and vegetables, grains, meat, dairy and other animal products, were covered. The following methods were used: desk research; collating and analysing previous work; interviewing industry operators, government officials and others studying the organic industry; and by undertaking limited survey work.

Hassall and Associates finally arrived at a figure of 491 certified organic growers. Most of the organic farmers in this survey were in New South Wales and Victoria. It was found that almost all the interviewed farmers had strong philosophical beliefs in organic farming. They suggested that the large recent increase in organic methods has increased the need for extension help, especially in the conversion period. They also felt research was required into areas such as weed control. Hassall and Associates tried to predict the likely increase in organic farming, the mid range projection was a 240% increase in organic area by 1994. The latter part of the report was devoted to the domestic and export markets for organic produce. Grains were felt to have considerable potential.

An updated version of this report was produced in 1996 (Hassall and Associates, 1996). The number of certified growers had increased from 491 in 1990 to 862 in 1995. This figure may be an overestimate as it was based on figures from certification agencies and some farmers would have been counted more than once. Less than 1% of Australian farmers are organic. Hassall and Associates estimated there were 115 broadacre organic farmers who were responsible for the majority of land under organic management in Australia. Wheat was the main crop grown on these farms. Most reported a drop in yields during a conversion period which lasted four to five years. Most farmers reported no change in labour requirements with a change to organic management. Hassall and Associates found there had been considerable growth in the market for organic produce throughout Australia and estimated the market would continue to grow at around 3% per annum until the year 2005. Consumers were found to be concerned about the issue of clean food but were confused by labelling systems.

Dumaresq and Derrick

From 1990 to 1992 a survey was conducted into the management techniques of organic broadacre farmers. The farmers were interviewed about their farms and their management techniques. The results from this survey have been reported in a number of publications, for example: Dumaresq and Derrick (1990), Derrick (1990), Dumaresq and Derrick (1991), Dumaresq (1992) and Derrick and Dumaresq (1993).

The survey ultimately covered 22 farmers. The farmers had been using organic methods for varying periods of up to twenty eight years. The farms ranged in location from the summer rainfall dominant areas of northern NSW through to the winter rainfall dominant areas of southern NSW and the Wimmera in Victoria. Annual rainfall varied from 356 mm to 610 mm. The farms ranged in size from 255 ha to 6073 ha and were on soil types ranging from light sands through to heavy cracking clays. The farmers were using typical equipment for wheat belt farming. The management techniques used were similar to the those used by conventional farmers. The main differences were the use of rock phosphate based fertilizers instead of superphosphate or similar fertilizers and the avoidance of herbicides. The farmers used a range of strategies for weed control including hard grazing of the pasture in a paddock in the year prior to cropping and the use of heavier seeding rates. The main cereal crop was wheat and the majority of farmers were using currently recommended varieties. Other crops grown were barley, oats, rye and triticale. Only very small areas of grain legumes and oilseeds were being grown. Most farmers reported yields close to the district average for their area. In general the organic farmers were using rotations which contained greater lengths of pasture than conventional farmers in the same area.

Wynen (1992a)

Wynen (1992a) conducted a study into the process of the conversion to organic farming in the broadacre farming sector (see also Wynen, this volume). Seven successful farming businesses were studied, an assessment of the resources available on the farm was made and the managers were interviewed to find out what problems had been experienced in the conversion process. An analysis was made of the costs of conversion using economic data from two South Australian organic farms.

Fritz

Fritz (Undated) produced a report on organic animal husbandry which provided details of suggested organic methods and some comments and information from organic animal producers in Australia.

Evaluative studies in Australia

Forman (1981)

Probably the first comparative study of organic and conventional farming in Australia (Forman, 1981) compared a biodynamic cereal/livestock farm with a neighbouring conventional farm in northern NSW. On the biodynamic farm pH ($CaCl_2$), P ($CaCl_2$ extract) and organic carbon were significantly higher ($p = 0.01$). Total N and extractable P (Colwell) were appreciably, but not statistically significantly, higher on the biodynamic farm. There was no difference in the levels of K ($CaCl_2$ extract) between the two farms. On the conventional farm the levels of Na and Mg ($CaCl_2$ extract) were significantly higher.

Wynen (1988)

Wynen's study, mentioned previously, was also evaluative as it compared the financial performance of the organic and conventional farms. Sustainable farmers grew smaller areas of crop both in absolute terms and in terms of percentage of arable land cropped. They spent less on fertilizers and pesticides, had smaller and older tractors and a lower level of depreciation per total farm area. Depreciation per cropped area was similar so the reduced overall depreciation was due to a lower level of cropping. A similar result was found for fuel costs where per cropped area they were similar but sustainable farmers had lower costs per total farm area. Although the number of crops grown per farm was similar, wheat made up a smaller percentage of the cropped area on sustainable farms. Accordingly wheat returns represented a lower percentage of total returns for sustainable farmers. As a result of a lower level of cropping, sustainable farmers had a lower return from crops per hectare farmed. As returns to capital were similar for both groups the sustainable farmers had a larger income from livestock to compensate for this. The returns from all crops per hectare grown were similar for both groups. Wheat yields were similar and the value of wheat per hectare was similar.

Robinson and Atkinson (1991)

This research reported results from a survey of two organic banana producers in the northern rivers area of NSW. Gross margins per ha were similar but organic price premiums were required as organic crops had 40% higher labour costs, nearly double the fertilizer costs and 25% lower yields. Atkinson (1994) provided data from unreplicated plots at Alstonville Tropical Fruit Research Station. The quality of the bananas was good and so were economic returns although organic yields were 25% lower.

Morgan (1992)

This study was undertaken at Frankston and involved the conversion of land, previously used for conventional vegetable production, to organic vegetable production. Plant nutrient requirements were met using compost (made from chicken manure, brown coal and grass clippings), green manures and legumes. A range of soil chemical and biological parameters were measured. The effects of converting to organic farming on soil micro-organisms were studied by Sivapalan *et al.* (1993). Robertson and Morgan (1996) also monitored the effect of organic management on soil micro-organisms. They also measured the effect of composting on the mineralization of C and N from organic materials (Robertson and Morgan, 1995).

Moxham (1992a and b)

Organic and conventional rice production in the Riverina area of New South Wales were studied using four organic farms. The organic crops had higher gross margins largely due to reduced input costs. The organic crop yields were above the district average in three of the four crops monitored. The organic crops were sod sown and consequently required less inputs in terms of fuel for cultivation. The organic farmers were not applying fertilizers but were reliant on biological N fixation in the pasture phase of the rotation to supply N to the rice.

Goncalves (1992)

In this research the faecal egg counts of internal sheep parasites were measured in lambs raised under different management systems, including organic management. Four pairs of farms were used and the egg counts were variable. There was no evidence that organic management resulted in higher egg counts although the organic farmers did not use the drenches used by conventional farmers.

Small and McDonald (1993)

An evaluative study was conducted into biodynamic and conventional dairy farms in the Goulburn Valley (Small and McDonald, 1993). Seven biodynamic farms, which have been biodynamic for at least three years, were paired with a conventional neighbour. Samples of soil, pastures, blood, tissue, milk and faeces samples were taken to provide data for comparison. Milk production was lower on the biodynamic farms and profits were also lower. Lytton-Hitchens *et al.* (1994) found better soil structure on the biodynamic farms (see also Gatehouse and Greene, this volume). The major, statistically significant, difference found was a higher level of extractable P in the surface organic mat of pasture and the top 500 mm of mineral soil on the conventional farms. Other soil measures such as pH, organic carbon and exchangeable cations were not significantly different (Small and McDonald, 1993). Parker (cited in Small and McDonald, 1993) found the conventional farms had a positive P budget but there was a net loss of P from the biodynamic farms. Soil microbial biomass was similar under each system (Daniel *et al*, 1994). There was little difference in pasture composition but concentrations of N and P were higher in the conventional pastures. In the blood of the cattle concentrations of P were lower in the biodynamic cattle but the concentrations of Se were higher. There was only minimal use of drenches for internal parasites on the biodynamic farms. Faecal egg counts were higher but despite this the biodynamic cattle had fewer health problems than the conventional cattle. Analysis of milk revealed no difference in mineral concentrations. Small and McDonald (1993) concluded that the biodynamic farms had better soil quality, healthier and more fertile cattle, were less reliant on outside inputs and possibly had less adverse impacts on the environment but had lower yields and incomes.

Ryan et al., (1994)

Ryan *et al.* (1994) studied the level of vesicular-arbuscular mycorrhizal (VAM) fungi infection of wheat crops on organic and conventional farms at Ardlethan. Levels of VAM infection were much higher on the organic farm and this was attributed to the use of fertilizer which did not contain water soluble P.

Gatehouse (1995)

This research was also undertaken on the same organic farm at Ardlethan as used by Ryan *et al.* and a conventional neighbour. Soil physical properties were measured. This study found that soil on the organic farm had better aggregation, higher porosity, lower bulk density, faster infiltration rates, higher hydraulic conductivity and higher organic carbon levels. It also found higher levels of VAM infection on the organic farm.

Penfold (1995)

The Biological Farming Systems Trial (BFST) was established at Roseworthy Agricultural College in 1989 (Penfold *et al*., 1995, also Penfold this volume). This trial compares four farming systems: conventional, organic, biodynamic and integrated. The organic and conventional would be similar to the systems used on the farms at Ardlethan. The integrated treatment is somewhere between the organic and conventional treatments, it uses minimum tillage and herbicides but relies on municipal sludge for fertilizer rather than high analysis synthetic fertilizers. This trial is close to being a whole system experiment but does not qualify because the size of the plots does not allow the incorporation of livestock as part of the treatments. This would be necessary to mimic these farming systems in practice because livestock are an integral part of most Australian broadacre farming systems, especially organic ones.

This trial has only been running for six years so it is possible that the long term effects of organic farming are not yet apparent or that the effects of previous management still have a large effect. After six years of operation some differences between the treatments have emerged. Concentrations of extractable P in the soil have fallen under biodynamic and organic management but have increased under the conventional and integrated treatments. The biodynamic treatment had the best cash flows and the highest accrued (cumulative) gross margins, next best was the conventional treatment followed by the organic treatment with the integrated treatment producing the poorest gross margins.

Cornish et al.*, (1992)*

This research commenced in 1991 and is comparing four vegetable growing systems in the Sydney basin. One system is organic and the remainder are different conventional systems. The four systems are being compared for productivity, profitability, their effects on the soil and the pollutant loads they contribute to run-off water and groundwater. The latest results are reported in Wells (1996). The organic crops have produced the lowest yields and the fourth lowest gross margin. The organic treatment has performed better in regard to soil qualities. The organic soil has higher levels of organic carbon, higher CEC and higher pH. Plants grown in the organic soil had deeper roots and more mycorrhizal infection. The organic soil had the lowest run-off under rainfall. The organic soil was also found to be contributing least to pollution of water off-site through the leaching of N or the loss of soil particles in run-off.

Bell et al*. (1994)*

These researchers provided an initial report on four sites from paired site comparisons in the West Australian wheat belt. Certified organic farmers were paired with a conventional neighbour. Soil organic matter levels were similar. The yields measured in 1992 were variable; at two sites the organic yield was higher but on the other two it was lower. The grain contained similar concentrations of N but the organic grain contained higher concentrations of P. Deria *et al.* (1996) provided data on all eight pairs of farm in the study which were monitored from 1992 to 1994. Crop yields were variable but overall organic yields were 15% lower. The lower yields on the organic sites were attributed to lower soil extractable P concentrations, later sowing and lower levels of N in the soil.

Dann et al*. (1996)*

This research used organic and conventional farms at Ardlethan as the sites for experiments to compare the response of wheat to different phosphatic fertilizers under the different management systems. There was no response to P applied as reactive phosphate rock on either farm. However, there were considerable responses to P applied as superphosphate on each farm. The responses were evident in increased tillering, crop biomass and grain yield. This response occurred on the organic farm despite over thirty years of organic management which is claimed to increase nutrient availability through increased biological activity in the soil (Lampkin, 1994). Analysis of grain samples showed that the use of superphosphate significantly increased the concentrations of P and Cd on both farms. However, the use of reactive phosphate rock had no effect on the concentration of these elements in the grain.

Derrick (1996)

This agroecosystem level study compared a well established (28 years) organic broadacre farm at Ardlethan in southern NSW with a conventional neighbour. The organic farm was the same one used by Ryan *et al.,* (1994) and Gatehouse (1995). Fieldwork commenced in March 1991 and ended in December 1993. The functioning of the organic and conventional systems were monitored by taking soil and plant samples from crops and pastures, measuring crop, pasture and livestock production and by measuring energy and labour inputs into each system. Crop growth and yields were consistently higher on the conventional farm, particularly in the wet growing season of 1992. The difference in crop yields was attributed to lower P availability as the concentrations of extractable P in the soil and of P in the plant tissue were consistently lower on the organic farm. However, despite lower concentrations of soil extractable P on the organic farm, pasture biomass production was similar although the grazing pressure was higher on the conventional farm. The data for crop and pasture production were used to estimate the production of each system for a 24 year period (three rotations on the organic farm and four rotations on the conventional farm). This comparison showed considerably higher grain production on the conventional farm as a result of increased crop yields and more frequent cropping. Meat production was also higher on the conventional farm but wool production was higher on the organic farm. Nutrient balances for each system indicated the only major difference was the greater loss of K from the conventional system which resulted largely from stubble burning. Energy inputs into the conventional system were higher as a result of the energy costs of the fertilizers and pesticides used. Estimating energy use through a 24 year period showed considerable energy savings in the organic system although the conventional system had a superior energy efficiency (energy output divided by energy inputs). Total labour inputs into each system were similar in each system although the organic farmer spent far more time organising the marketing of his products.

Other studies

Patulot-Marqueses *et al.* (1994) measured microbial activity under organic and conventional management of various farming systems including vineyards, orchards, pastures and cereal crops. In most soils biomass carbon and nitrogen were higher under organic management. There was no consistent pattern for C/N ratio or levels of mineralizable N. Respiration and specific respiration were lower under organic management. O'Reilly (1993) provided some data comparing the mineral contents organic and conventionally grown wheat. A demonstration site has been established at Rutherglen Research Station to monitor the conversion process from conventional to organic grain production (Newton, 1996). To date only initial results are available from this experiment.

Applied research in Australia

There is no research centre dedicated to organic research in Australia and the research into organic farming has been largely descriptive and evaluative. However some research done in conventional farming systems is applicable to organic farming, for example research into the control of pests in stored grain using CO_2 is equally relevant to both organic and conventional farming systems. Individual farmers would also have done research of this kind on their own farms but results of such trials are not readily available. Some information may be found in journals such as Acres Australia or in books describing the experiences and methods of organic farmers; see for example Bock (1995).

Diagnostic research in Australia

Only some of the research done in Australia would fall into this category. The BFST at Roseworthy may ultimately produce data which allow the generation of underlying principles. However the BFST has not been running long enough to meet Lockeretz's requirement that diagnostic research needs to be done on well established organic systems. By using an agroecosystem approach, the research of Derrick (1996) provided insights into the functioning of the studied organic broadacre farming system. The research into biodynamic dairy farms by Small *et al.*, (1994) and McDonald *et al.* (1994) did attempt to link various data such as milk production, fertilizer use, soil P levels and pasture mineral content and quality to gain an understanding of the functioning of these farming systems.

Explanatory/Predictive research in Australia

Lockeretz described this research as attempting to produce broader principles relating to the functioning of organic farming systems. Given the small amount of research which has been conducted in Australia it is not possible to suggest principles which may apply to all organic farming systems. Data from the study into biodynamic dairy farms and the various studies of broadacre farming may permit the development of principles which apply to those particular farming systems. The long term research process that is being undertaken at Ardlethan by researchers based at the Australian National University, should ultimately provide an understanding of the functioning of this broadacre organic farming system.

Summary of Australian organic research

Apart from the whole industry surveys by Conacher and Conacher and Hassall and Associates research into organic farming in Australia has been largely focussed on broadacre production. Only a few studies (for example, Moxham, 1992a and b; Small and McDonald, 1993; and Wells, 1996) have focussed on other agricultural industries. This makes it difficult to draw conclusions about general differences between organic and conventional farming in Australia. However, one factor which appears common to all the studies is the critical role of P. This is not surprising considering the low levels of P in Australian soils.

The role of on-farm research

The only experiments on research stations are the BFST at Roseworthy, the recently established experiment at Rutherglen Research Station and the trial of vegetable growing systems at Gosford. Consequently organic farming research in Australia will, at least in the short term, have to be focussed on established farms.

Lockeretz (1987) suggests that on-farm research is more likely to be used to deal with less general or 'basic research'. On-farm research should only be used where the use of a working farm will provide data which will best answer the research question. Lockeretz lists seven situations where on farm research is likely to be particularly suitable.

1. To obtain particular soil types or physical conditions that are not available on research stations.
2. To study phenomena that must be studied on a larger area than is available on a research station.
3. To analyse systems that involve interactions among several individual enterprises or that intrinsically of a whole farm nature.
4. To compare a system's performance under farm conditions to experimental conditions.
5. To evaluate production techniques which are highly sensitive to management skill.
6. To study the long-term effects of a production method which has been in use on a farm for a long time.
7. To analyse a production method or management system that is already practiced by some farmers but has not received attention from researchers.

Limitations of on-farm research include:

1. Inability to control the experiment.
2. Risk of loss of experiment.
3. Difficulties of monitoring a distant site.
4. Limitations to what can be achieved if relying on the farmer to collect data.

The best results will be attained by the appropriate combination of on-farm research and research station based research to use the particular benefits of each method.

Research questions for organic farming

Is research necessary?

At organic conferences there is sometimes a feeling against science and researchers. Is research required at all, would it best be left to organic farmers? Given the obvious benefits gained from conventional agriculture research it would seem foolish not to undertake research into organic farming. The misgivings of some people in the organic movement may be overcome by involving organic farmers in the design and implementation of research projects.

Are different approaches required?

Wynen (1996a) argues that a different research paradigm may be needed. Whilst the same techniques, such as soil or plant analysis, might still be used the focus of the research would be different. For example there would be more emphasis on biological processes or ecological solutions to problems.

Farmer knowledge

At present in Australia the vast bulk of knowledge of organic farming rests with organic farmers who have been farming this way, often for years. Biodynamic farmers in the Demeter organisation have a system for helping new farmers and the BFA have just introduced an advisory service. There is a role for researchers to help collate farmer knowledge to avoid duplicating research and to provide information to farmers wishing to convert to organic farming.

Sources of information

Compared to their conventional counterparts organic farmers do not enjoy access to the same level of information. There are a number of sources which may provide information. These include: conference proceedings, magazines such as Acres, some books, occasional papers in conventional journals and other farmers. The Organic Retailers and Growers Association of Australia (ORGAA) has a large database on organic farming which is available to members (Alenson, this volume). There is a limited amount of information available from state departments of agriculture, for example Burlace (1990) and Burt (1996).

Industry requirements and priorities

All research has to be funded. There are a range of organisations and systems in place for the funding of conventional research. To date these organisations have experienced difficulty in assessing funding applications for organic research because there has not been a unified industry body to identify priorities. Identification of research priorities for each commodity will be one of the key functions of an organic industry body.

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Part B:

Public Forum

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Organic Farming and the State of Australia's Environment

The Australia: State of the Environment 1996 report has just been released after about 2 years of work by several hundred scientists from all parts of Australia. It is the most complete statement thus far attempted, providing an assessment of pressures on, and the condition of, Australia's environment. It also assesses the responses of government and other bodies to the condition of our environment.

The report finds that parts of Australia's environment are in good condition. We have no significant acid rain, and urban air pollutants have declined in recent years. Urban drinking water is generally very good, as is the standard of our food with low levels of chemical residues and metals. Oceans and estuaries, away from major cities and areas of development, are in good condition. Urban housing is generally of good quality.

However, we are experiencing serious environmental problems. The loss of biological diversity is probably the most serious problem, from the coast to the interior. Waste disposal in cities continues to have adverse impacts on water quality and biodiversity. Our inland waters are in poor shape, thanks to nutrients and salt. The ozone layer continues to thin, exposing people and other species to increased UV radiation. Soil erosion, salinisation, acidification, organic matter loss, and structural decline are all serious problems for soils in rural Australia. Old growth forests continue to be logged. Our cultural heritage is under severe threat, particularly in the loss of indigenous languages and the health of indigenous Australians.

Australians have responded well to many of these complex environmental and cultural problems—but not to them all. The most successful responses so far have been by means of integrated approaches, exemplified by the Murray-Darling Basin Commission, the Great Barrier Reef Marine Park Authority, and, at a more regional level, the pooling of resources to solve the eutrophication problem of the Peel-Harvey Estuary in W.A. The traditional compartmentalised approach is now viewed as a failure, though realists recognise that whole-system approaches, while commendable, are extraordinarily difficult to achieve.

Organic farming reflects a desire for sustainability—of health, income, and the environment affected by farming. Perhaps organic farming already has many of the answers being sought by those in conventional farming who are also concerned that our future on this continent is not sustainable. But the organic farming community does not seem to be positioning itself squarely in the mainstream environmental debate. It is my opinion that just as organic farming has to be professional and customer-oriented in its commercial dealings, it has a lot to offer to environmental concerns other than human health.

Does organic farming offer solutions to land and water degradation? How does organic farming relate to the objectives of catchment management? How can biodiversity management benefit from organic farming? Are agro-ecosystems really sustainable on organic farms?

These are profoundly important questions for both organic and conventional farmers. Yet data do not appear to exist to answer them. One of the objectives of future research of development in support of organic farming should be to answer these questions.

JULIAN CRIBB

Science and Technology Writer

Organic farming: trailblazing the 21st Century

'And he gave it for his opinion that whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country than the whole race of politicians put together"
Swift, Gulliver's Travels, 1726

Jonathan Swift had a fair idea of what was the most important issue for humanity. Two hundred and seventy years later, his epigram seems more relevant and perceptive than ever.

The world we will inhabit in the coming 30 years will be very different and far more perilous than that of the late 20th century.

Much has been made of the spectacular potential for economic growth and development in the Asia-Pacific region in particular, of the sweeping away of old borders and Cold War hatreds, of the globalisation of business and industry, of the spread of knowledge and information across boundaries both geographic and political.

But the clear image of the New World Order paraded by many western leaders is already starting to fracture and disintegrate like a looking-glass in the face of unassailable realities.

In a prophetic article entitled *"The Coming Anarchy"*, journalist Robert Kaplan examined how, in society after society, a state of war already exists between the haves and the have-nots. In many cities and countries this inarticulate rebellion of the poor, the angry and the dispossessed has already nullified, if not actually eliminated, government. In Rio de Janeiro, as in Sierra Leone, as in Liverpool, England, the police and even the army are powerless to enforce the law over tribal packs of alienated youths and the henchmen of feudal drug-barons.

"Sierra Leone," writes Kaplan "is a microcosm of what is occurring, albeit in a more tempered and gradual manner, through ... much of the underdeveloped world: the withering away of central governments, the rise of tribal and regional domains, the unchecked spread of disease, and the growing pervasiveness of war."

The world map with which we grew up, with its neatly-ruled borders and colourfully tinted nations is a fiction. It no longer exists, save in the minds of cartographers.

One of the many things it does not mark are the new cities, the festering mountains of hovels and shanties which have sprung up as satellites of the old cities. Places where gang rule and the AK47 are the only law, where cocaine and heroin are the life's ambition of ten year olds, where no school opens and policemen fear to tread. Where the privileged and the bureaucrat live and work in barbed-wire compounds shielded by guard-dogs and electronic alarms.

To the western media, politicians and bureaucrats, says Kaplan, conflicts such as those of sub-Saharan Africa or the clashes between Hindu and Moslem extremists in India are merely the contemporary manifestation of age-old religious and ethnic hatreds.

However in his argument these are not the triggers for conflict, but rather its symptoms and its pretexts.

The deeper underlying causes are poverty and the deprivation of those key means of human sustenance, food, land and water.

The military scholar Martin van Crefeldt argues that the 400-year-old concept of war as something which takes place between states is today being transformed into a thousand smaller, more vicious and ultimately destructive struggles between tribalised groups of warriors—from slum kids to Chechens, from Bosnian Serbs to Iraqi Kurds.

Between now and 2025, human numbers will swell from 5.5 billion to 8.5 billion. Virtually all of that growth will take place among the impoverished nations and communities of the world.

The stress on already-depleted resources of land, water, food, timber and energy will be inconceivable.

We go into such an age with 40 per cent of the world's croplands and almost one quarter of its pastures and forests already degraded...

What is less commonly known is that world consumption of water is rising twice as fast as population growth. According to the International Food Policy Research Institute in Washington and the International Rice Research Institute in the Philippines, water is already looming as a major potential cause of war.

To take one example: India has threatened to divert the Indus—an act which, if carried out, would deprive Pakistan of three quarters of its food supply. Pakistan has warned such an act will spell war. Both nations have nuclear arms. Both have fought three times in the past 50 years.

Similar situations recur around the world. The water which sustains Israel comes from aquifers which lie beneath neighbouring Jordan and the Palestinian state. Below the overt political tensions lies the deeper anxiety that the supply could be cut off.

Turkey is building 22 new dams including the massive 16-story Ataturk impoundment across the headwaters of the Euphrates-Tigris, which supply the warlike nations of Syria, Iraq and Iran. In Asia dams are being planned or built on the upper Mekong which feeds Laos, Thailand, Vietnam and Kampuchea. In Africa, Ethiopia and Egypt are in dispute over the upper Nile.

In China, where it takes 5 000 kilos of water to grow a single kilo of rice, the booming mega-cities are encroaching on farmers' supplies at a frightening rate. The mere installation of a flushing toilet in a city home will consume 30 000 litres of extra water a year, and reduce rice output by 6 kilos - a week's supply of staple food for a Chinese family. The Philippines last year imported half a million tonnes of rice because it lacked sufficient water to grow it.

Across the whole of Asia, denuded catchments are falling into the rivers, silting up dams, polluting estuaries. In Pakistan, India, China, Egypt and parts of the Middle East, salinity is devouring farmland remorselessly–and in economic terms, irreversibly.

Over the coming 25 years, world grain output must rise by 70 per cent, or more than 800 million tonnes–or confront large portions of humanity with Ethiopian-style famines. That means additional grain must be produced off less land, using less water and with fewer inputs.

Even in that last source of bounty to humanity, the oceans, resources are dwindling. Seventeen of the world's top twenty fisheries are in decline. With five million fishing vessels ploughing the seas, the global catch has stagnated.

While the eyes of the world's financial press are magnetically drawn to the miracles of the emerging high tech cities in Asia, they remain largely blind to the growing poverty and deprivation which affect the vast majority of its people, the 800 million who lack sufficient food for a healthy life, the 1.3 billion who are abjectly poor, the 400 children who die every 15 minutes from malnutrition-related disease.

And they are blind to the implications this holds for future political stability and economic growth.

Canadian scholar Tad Homer-Dixon has argued that world environmental degradation is today of a speed, complexity and magnitude unprecedented in history: "Scarcities of renewable resources," he says, "often produce insidious and cumulative social effects such as population displacement and economic disruption. These can lead to clashes between ethnic groups, as well as civil strife and insurgency."

Kaplan takes the argument further: "For a while the media will ascribe riots and other violent upheavals to ethnic and religious conflict. But as these conflicts multiply, it will become apparent something else is afoot, making more and more (countries) ungovernable."

"It is time to understand the environment for what it is," he says: "the national security issue of the early 21st century."

As the director general of IFPRI, Dr Per Pinstrup-Andersen says: "The carnage wreaked by poverty and hunger is very often out of sight, out of mind. But the tragedy unfolding in the developed world will affect Australia and other industrialised nations. The widespread food insecurity in developing countries today will threaten global security tomorrow... "

The pivotal issue of the early 21st century is whether we can sufficiently contain the explosion of poverty to avoid the gradual rending of the social fabric of the planet through a corrosive anarchy, to avoid tidal flows of refugees fleeing eco-political disasters, to prevent outright wars being fought over scarce resources.

We are confronting what a growing body of analysts believe to be the great security issue of the 21st century.

An issue of the human destiny that will overshadow even the threat posed by weapons of mass destruction in the present century.

But the outlook is not wholly bleak. Another scholar of international standing, our own Professor Derek Tribe, argues that with support for just one single area–international agricultural research–the world has a better than even chance of forestalling the larger crises.

Tribe argues that agriculture is the cornerstone of economic development. It is the essential without which no society can raise itself sufficiently to overcome pervasive poverty, establish education and health services, free women from drudgery, move to good government, build its secondary and tertiary industries and curb its population through higher living standards. It is central to the control of one's own destiny.

Yet paradoxically, governments worldwide have slashed the one thing which can lay the foundation of prosperity. At home they have cut rural research because of a perception it engenders surpluses or serves a sunset sector. Abroad they have cut donations to research and development because other forms of aid are more pleasing to their voters. Their myopic focus is next week, next year, next election–not next century, the price for which must be paid by our children.

"The world community must acknowledge now," Tribe says, "that sustainable agricultural development is *the* vital key to the global problems of population, poverty, hunger and the environment. "

The question is: who is to rivet world attention on this issue–and how?

What on earth, you may well be wondering, has all this to do with organic farming in Australia? The immensity of the crisis and the perils I have just depicted seem in odd contrast to the quiet efforts of the individual Australian primary producer to farm in a more sustainable way.

Yet the global crisis which I have outlined has much in common with the challenges facing the organic farmer here.

On a world scale, human wants and needs have now come into direct collision with the capacity of the planet to satisfy them. Our efforts to squeeze more food often result in the decline and destruction of the very resources of soil, water and biodiversity which underpin it.

Our endeavours to overcome the pervasive threats of hunger, and poverty, and the chaos and violence they breed, must surely spring from similar principles to those of the organic farmer–principles of conservative use of soil and water, reduced use of chemicals and other high-intensity inputs, principles of forethought and planning, principles of living with Nature instead of fighting against it.

Though I have reported on organic farming in this country for more than 20 years, I can't honestly claim to know precisely what it is–the definition varies on every farm I visit.

As a science writer, I see it as an activity based upon sound scientific and agricultural principles rather than on a set of beliefs which may or may not be true and which are sometimes unsubstantiated. I suppose you could dub me an organic rationalist.

The reason I give emphasis to this is that we have just seen the full scale of the problem confronting humanity. Unless we can devise sustainable farming systems which are also high yield, humanity will simply ruin the earth and ourselves into the bargain.

Neither organic farmers, nor any others, can afford the luxury of producing less food off an acre of land or a megalitre of water. Those who argue that it does not matter if yields fall are disconnected from reality; they are in fact advocating the farming of a far greater acreage, which will cause the obliteration of the world's forests, and the destruction of its fragile semi-arid and hilly regions.

Those who urge us to produce less food are simply calling for the death of a greater number of children which is not an ethically acceptable choice.

So we need to think carefully before advocating systems that will lower total food output.

Neither can we afford to abandon the use of benign chemicals if it means that we damage or lose soil by having to plough more frequently, or if we simply replace chemical with mechanical energy and burn more fossil fuel in the process of food production.

As I said before, we need to grow 800 million tonnes *more* grain a year simply to feed the people who will be born in the coming 30 years.

If those people wish to enjoy anything other than a life of abject poverty, misery, suffering and premature death then we must raise global farm output two- or three-fold over present levels. And we must do so using less land, less water, fewer chemicals and fertilisers and with less impact on the environment.

That is the challenge. The question is how Australia shapes up to it.

In this task, I will argue, we are uniquely qualified. We have assets and skills which no other nation on earth can match.

Only in Australia do we farm the crops and the livestock of six continents. We do so under a wider array of climatic and environmental conditions that any other people. If you put together everything we know about farming, it exceeds the knowhow of any other country in the world. Quite simply, when it comes to food, Australia does it best.

Many of our farming systems are already as close to organic as it's possible to get. The extensive grazing industry, in particular, delivers products which are singularly free from the contaminants which affect so many of the foods of advanced countries, while more and more graingrowers, livestock and horticultural producers are moving to low-input and fully organic systems.

Thus we have a superb base on which to devise and build sustainable farming systems for every different environment – temperate, Mediterranean, semi-arid, subtropical and tropical.

To me, the need to reduce the use of synthetic chemicals and fertilisers is not a question of ideology, but more a matter of practicality. It is important to lower the total cost of farming–the cost to the environment as well as the cost to the farmer–and to satisfy consumers who demand a healthier diet.

But we must approach this challenge in a scientific way. We need to understand natural systems far better in order to raise production without having to use more artificial inputs. Let me give a couple of illustrations.

In WA a small firm, hired to evaluate soil bacteria for a multinational drug company, has identified 27 naturally-occurring bacteria which have a dramatic effect in increasing crop yields. They achieve this through their antibiotic action against soil-biome diseases, and by giving the growing plant access to nutrients which are normally locked-up and unavailable.

Now here, it seems to me, is a thoroughly organic method for raising crop yields, reducing the use of synthetic fertilisers and pesticides, and lowering farm costs. You might term it a win-win-win solution. It involves farming the soil microflora and fauna in such a way that you increase production above the ground.

It is the kind of technology which Australia must pioneer, not only for our own sake, but in order to encourage a more sustainable agriculture worldwide.

A second example, and one I am sure will make everyone shudder in horror: cotton is once more being grown on the Ord River in the northwest, after a 25 year hiatus since the chemical holocaust of the early 70s.

But the new cotton industry is based on natural methods of pest control–integrated pest management, the use of trap crops, sugar sprays to attract predators like ladybirds and lacewings. Most importantly, the new development is based on the genetic engineering of the Bt pest resistance gene, a totally natural product which just happens to give caterpillars a guts-ache.

Certainly there is room for caution and circumspection in how we deploy the new generation of supercrops–but it is already happening. On the Ord, as they introduce the Bt cotton there are even plans to create special havens to *protect* the pest insects. The idea is to ensure that a vulnerable population of pests always exists to interbreed with others and to prevent resistance becoming dominant. Now that is smart.

For the first time we are learning to live in balance with pests, rather than seeking to obliterate them.

If the world is to feed itself in future, it will need to make maximum use of Nature's enormous genetic richness and diversity to achieve the dual goal of raising yields and reducing our use of toxic or hazardous inputs. I believe this will, in time, be recognised as the true organic revolution.

I cannot stress strongly enough the overwhelming importance of adopting a scientific approach to organic systems and to determining what is sustainable and what is not. To date, far too little of the total quantum of agricultural research in this country has been devoted to this goal–and we run some serious risks because of it.

For example, if we fall behind the front-runners in the adoption of organic or pesticide free technologies, then we face being shut out of export markets because of it.

In America they are planning to ban 36 common pesticides that have links either to cancer or other forms of disease, many of which are in common use on Australian farms. In Sweden, Denmark and the Netherlands there are moves to phase out farm chemicals in several industries and to reduce overall use by more than half. These developments herald a sea-change?? in global attitudes to chemical and organic agriculture.

The organic revolution is one in which Australia must be a leader, not a follower.

That means we must develop a better scientific understanding of what it means to farm organically than any competing nation, that we must set the international pace–and the international standards.

The challenge, in a continent which is unbelievably poor in nutrients, is to use what we have many, many times more efficiently. To unlock the nutrients in the soil which are unavailable to plants. To bring up from deep down in the soil profile nutrients out of reach of crop roots, using worms or rotations involving deep-rooted species such as trees and shrubs. To recycle nutrients on the farm, and off it. To reclaim the hundreds of millions of dollars-worth of elemental phosphorus and nitrogen which our cities now dump in the ocean, and develop inventive ways to disperse it back onto the land. To prevent our nutrients from washing down the creek and killing the river. These are all challenges for science–and they can help achieve our triple goal of better yields, lower costs and fewer artificial substances.

I would now like to issue a challenge to the organic farmers and scientists of Australia.

It is this: that from your deliberations here today you develop a business plan to market the organic knowledge and technologies we already possess to the world.

Your knowledge of how to farm sustainably is pure intellectual property, just like the stuff that Microsoft's Bill Gates sells. The difference between him and you, is that he makes a lot more money out of it.

Knowledge, or intellectual property, is the gold of the 21st century.

If we are to make the research investment necessary to solve the problem of how to grow more food with fewer inputs and less ecological damage, then we need a powerful income stream.

I propose that the organic industry develop a clear and coherent export strategy for its knowledge and technology, as well as its commodities and food.

If you go about it the right way you will find, as Bill Gates has proved, that knowledge is vastly more profitable than commodities.

And you will be able to reinvest the profits in research and development to keep Australia at the world forefront of the field, instead of struggling to keep up with the most advanced farmers of America and Europe.

We will also generate sufficient income and new knowledge to enable us to share it more cheaply with the developing world, to help poor countries overcome the vast and formidable problems they face.

Let me remind you: there is no better investment an Australian farmer can make than one which raises the incomes of the poor. Already more than half of our agricultural markets are in countries who have managed to raise themselves from poverty to comparative prosperity in the space of a couple of decades.

Agriculture is the key to economic lift off. If you give a poor country the secret of sustainable farming, you ultimately give it the road to higher incomes, stable government and reduced population growth. And, at the same time, you create consumers who can afford to buy value-added Australian farm produce, a market which did not exist before.

The performance of the organic industry is central to the performance of Australian agriculture as a whole in the 21st century.

If you perform in a professional way, if you see yourselves as knowledge producers and purveyors first and foremost, then you will not only prosper but also help to make the world a safer, more stable place for our grandkids.

It is time to stop talking and start acting. I wish you the best of fortune in your endeavours.

Appendix 1: Consolidated Bibliography

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Appendix 2: Some agricultural databases and information sources

ABOA: Australian Bibliography of Agriculture
Covers all aspects of agricultural production, systems and sustainability.

ARRIP: Australian Rural Research in Progress
Covers all current and recently completed research agricultural projects in Australia.

Streamline: Australia's Natural Resources Database
Provides information on all forms of land degradation and rehabilitation, catchment management, Landcare, sustainable systems, water and other resource use.

These databases are available on CD-ROM from Infoscan Pty Ltd, GPO Box 155, Canberra ACT 2601, email: infoscan@acslink.net.au.

WWW Bookmark for Agriculture and Resource Management - provides access to a range of relevant websites and databases.
http://www.agfor.unimelb.edu.au/bookmarks.ag.aust.html

WWW IFOAM site - information on organic agriculture world wide:
http://ecoweb.dkifoam
Or contact through:
http://www.ids.ac.uk/eldis/data/d017/e01754.html

WWW USDA Internet site - The United States Department of Agriculture Internet site. It will provide access to the relevant libraries and databases in the USA and elsewhere in the world:
http://www.nalusda.gov/other internet sites/accessw3.html