Organics - Solutions to Climate Change

Proceedings of the 3rd OFA National Organic Conference

Darling Harbour, Sydney, Australia, 22 – 23 July 2006

Organic Federation of Australia Ltd

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RIRDC Shaping the future

"Organics - Solutions to Climate Change"

Proceedings of the Third OFA National Organic Conference Darling Harbour, Sydney, Australia 22 – 23 July 2006

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PO Box 434, Mowbray Heights TAS 7248, Ph/Fax 03 6266 0330, www.top.org.au

Federal accreditation authority

Organic and Biodynamic Program, Australian Quarantine Inspection Service
Ph: 02 6271 6638 / Fax: 02 6272 3238, www.aqis.gov.au/organic

Conference program

Friday 21st July

1A: Cocktail Party (in conjunction with the Organic Expo)	**6.30 pm**
Opening the Third OFA National Organic Conference	The Hon Sussan Ley MP (Parliamentary Secretary to the Minister for Agriculture, Fisheries and Forestry)

Saturday 22nd July

1A: Organics and innovation **Chair: Eric Love, Centre for Organic & Resource Enterprises**	**9.00 am – 10.30 am**
The importance of organic farming systems to reduce greenhouse gases and climate change	Allan Yeoman, Yeomans Plow Company, Arundel
Organics and soil carbon: increasing soil carbon, crop productivity and farm profitability	Andre Leu, Chairman, Organic Federation of Australia, Mosman
How the soil food web and compost increase soil organic matter content	Elaine Ingham, Director, SoilFoodweb Institute, Oregon, USA

Morning tea (10.30 am – 11.00 pm)

1B: Building natural soil fertility **Chair: Robyn Neeson, NSW Dept of Primary Industries**	**11.00 am – 12.30 pm**
Soil fertility management in Australian agriculture	Maarten Stapper, Principal Research Scientist, CSIRO-Plant Industries, Canberra
Organic carbon dynamics in agriculture	Jan Skjemstad, Senior Researcher, CSIRO-Land & Water, Adelaide
Ecological engineering: pest management solutions for organic agriculture	Geoff Gurr, Program Leader, Charles Sturt University, Orange
Building natural soil fertility	Stuart Larsen, Marra Seeds

Lunch (12.30 pm – 1.30 pm)

Centre for Organic & Resource Enterprises

The Saturday morning sessions are kindly sponsored by the Centre for Organic and Resource Enterprises (CORE)

Saturday 22nd July

1C: Innovations for climate change — **1.30 pm – 3.00 pm**

Chair: Paul Kristiansen, University of New England

Intensive organic production systems and issues of sustainability	David Midmore, Head of Plant Sciences Group, Central Queensland University, Rockhampton
Establishing perennial pastures in dry-land organic farming systems: developing resilience for climate variability	Viv Burnett, Research scientist, Department of Primary Industries, Rutherglen
Feeding above the line: strategic feeding to reduce inputs and increase efficiency of grazing ruminants	Tim Kempton, Stance Agriculture, Kenmore
Pasture cropping: a land management technique	Colin Seis, Farmer, Gulgong

Afternoon tea (3.00 pm – 3.30 pm)

1D: Landscapes and agriculture — **3.30 pm – 5.20 pm**

Chair: Helen Scott-Orr, NSW Dept of Primary Industries

Is agricultural education heading in the right direction and what direction might that be?	Kerry Cochrane, Course Coordinator, Charles Sturt University, Orange
The importance of climate change to agriculture and landscape	Brian Scarsbrick, Chief Executive Officer, Landcare Australia, Sydney
The bio-based economy – hydrocarbons to carbohydrates	Eric Love, Chairman, Centre for Organic & Resource Enterprises, Sydney
Cost benefit of recycled organics in agriculture. A Partnership Project with Department of Primary Industries (funded by NSW Department of Environment and Conservation)	Daren Bragg, Manager, Organics Section - NSW Department of Environment and Conservation, Sydney
Certification: coping with climate change flexibly	Rod May, Technical Director, NASAA, Blampied

Conference dinner — **6.30 pm - late**

Activities include:

* launch of the *Journal of Organic Systems*
* presentation of the OFA Industry achievement awards

The Saturday afternoon sessions are kindly sponsored by Compost Australia

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The Organic Federation of Australia is proud to be a sponsor of the *Journal of Organic Systems*

Journal of Organic Systems

www.organic-systems.org

Sunday 23rd July

Plenary presentations	**8.30 am – 9.00 am**
Opening address	Senator Lynn Allison. Leader, Australian Democrats
New 5-year plan for the RIRDC Organic Produce Research Program	Don Fraser, Chairperson, Organic Produce R&D Advisory Committee, RIRDC

2A: Soil biology workshops	**9.00 am – 10.30 am**
Developing NPK in the soil food web	Elaine Ingham, Director, SoilFoodweb Institute, Oregon, USA

Morning tea (10.30 am – 11.00 pm)

2A: Soil biology workshops (continued)	**11.00 am – 12.30 pm**
Developing NPK in the soil food web	Elaine Ingham, Director, SoilFoodweb Institute, Oregon, USA

Lunch (12.30 pm – 1.30 pm)

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Sunday 23rd July

2B: Biodynamic workshops	**1.30 pm – 3.00 pm**
Biodynamic options to address climate change	Hamish Mackay, Chief Executive Officer, Biodynamic Agriculture Australia, Bellingen
Biodynamic solutions in the tropics	James Sprunt, Independent trainer & researcher, Melbourne
The Biodynamic preparations – solutions for climate change	Cheryl Kemp, Biodynamic consultant, ??, Bellingen

Afternoon tea (3.00 pm – 3.30 pm)

2C: Organic sector issues: farmer to consumer **Chair: Liz Clay, Bioscape**	**3.30 pm-5.00 pm**
The UK organic market: key drivers and recent mistakes	Alasdair Smithson, Advisor/ Researcher, Australian Certified Organic, Brisbane
Peak oil and the future of food– a Western Australian perspective	Colleen Yates, President, Organic Growers Association of WA, Perth
Fresh thinking: from farm gate to dinner plate	Jane Adams, Chair, Australian Farmers' Markets Association, Sydney
Fools rush in where angels fear to tread: leadership reflections for Oceania Pacific	Brendan Hoare, Convenor/Member, Organic Federation of Aotearoa/IFOAM World Board, New Zealand

2D: Closing session	**5.00 pm-5.10 pm**
Summary address	Andre Leu, Chairman, Organic Federation of Australia, Mosman

The Sunday afternoon sessions are kindly sponsored by Green Planet

Papers presented at the Third OFA National Organic Conference

"Organics - Solutions to Climate Change"

Darling Harbour, Sydney, Australia
22 – 23 July 2006

Opening address: the importance of organic farming systems to reduce greenhouse gases and climate change

Allan Yeomans
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Abstract

Global Warming with its consequential disastrous modification to all our world's climates is by far the greatest threat facing humanity today. It is indeed the greatest threat to all advanced life forms that inhabit this planet of ours. Sir David King, Chief Scientific Advisor to the Government of the United Kingdom along with top scientists and thinkers around the world, all express this same conviction.

Global Warming issues are painted as all doom and gloom. Why is it never seriously suggested that global warming can be terminated? Are we to say "Abandon hope all ye who inhabit this planet?" In my book *Priority One* I say no to that, for I sincerely believe that *Together We Can Beat Global Warming.*

There are two factors in fixing the problem we have allowed our atmosphere to become. One is we end our use and reliance on all fossil carbon based energy sources. The other, and most relevant to this conference, is the massive modification of world agricultural thinking.
Our thinking must change from an emphasis of what we see above the ground, when we grow our plants, to an emphasis on what lays beneath the ground that feeds and nourishes those plants. Our emphasis must be on an understanding of the true nature of soil and soil fertility. For it is creation of fertile soil that will halt global warming.

Life as we know it is based on the strange and unusual abilities of the carbon atom. The global warming problem is that today we have too much carbon in the atmosphere. It exists as carbon dioxide. The simple solution to end global warming therefore becomes extraction this carbon dioxide out of the air and converting it into soil organic matter - itself a carbon based material. Organic farming is the only way to do this fast, efficiently and profitably. There must be a rapid and worldwide expansion and adoption of organic type farming practices. The adoption of organic farming is essential to end global warming.

Therefore organic farmers now have a new role in life - a new responsibility. They must not only farm their own land to make their bread; but now they must become teachers and educators to show farmers all across the world the way to the new agriculture that will save our world from unrelenting and unforgiving climate change.

Organics and soil carbon: increasing soil carbon, crop productivity and farm profitability

Andre Leu
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Abstract

This paper explains how atmospheric carbon is introduced into the soil and how it stored in stable forms. It identifies the farming techniques that are responsible for the decline in soil carbon and gives alternative practices that do not damage carbon. Increasing soil carbon can reduce the 25% of Australia's greenhouse gases created by agriculture and assist in ameliorating climate change. Increasing soil carbon will ensure good production outcomes and farm profitability. Soil carbon, particularly the stable forms such as humus and glomalin increases farm profitability by increasing yields, soil fertility, soil moisture retention, aeration, nitrogen fixation, mineral availability, disease suppression, soil tilth and general structure. It is the basis of healthy soil.

Introduction

Climate change is one of the major issues affecting all of us on our planet. For the first time in recorded history the glacier on Africa's Mount Kilimanjaro is melting and the ice at the North Pole had melted. Another first was recorded in North America - Lake Erie did not freeze over in winter. 2005 recorded the hottest average temperatures on record and produced the most destructive hurricane season ever. In Greenland the ice is melting three times faster than the early 1990s. Experts from NASA are predicting that the intensity of major storms will increase even more as a result of rising ocean temperatures.

Experts expect that climate change will have a negative effect on our food supply due to more frequent adverse weather events leading to increasing crop failures. The security of our food supply concerns all of us.

So what has organic agriculture to do with climate change? One of the central tenets of organic farming is to improve soil health and productivity by increasing organic matter (carbon) levels, particularly humus.

Published studies show that organic farming systems are more resilient to the predicted weather extremes. The studies showed that organic systems have higher yields than conventional farming systems in weather extremes such as floods and droughts. *Drinkwater, L. E., Wagoner, P. & Sarrantonio, M. (1998), Welsh R. (1999),*

Greenhouse Gas Abatement

Very importantly organic agriculture can help reverse climate change. Published peer review scientific studies in North America and Europe show that best practice organic agriculture emits less greenhouse gases than conventional agriculture and the carbon sequestration from increasing soil organic matter leads to a net reduction in greenhouse gases **(**Drinkwater, et al. 1998) , Reganold, et al. 2001, Mäder P et al. 2002, Pimentel 2005).

Organic agriculture helps to reduce greenhouse gases by converting atmospheric carbon dioxide (CO_2) into soil organic matter. Some forms of conventional agriculture have caused a massive decline in soil organic matter, due to oxidizing organic carbon by incorrect tillage, the overuse of nitrogen fertilizers and from topsoil loss through wind and water erosion.

According to Dr Christine Jones (2006), one of Australia’s leading experts on carbon sequestration:

'Every tonne of carbon lost from soil adds 3.67 tonnes of carbon dioxide (CO_2) gas to the atmosphere. Conversely, every 1 t/ha increase in soil organic carbon represents 3.67 tonnes of CO_2 sequestered from the atmosphere and removed from the greenhouse gas equation.'

'For example, a 1% increase in organic carbon in the top 20 cm of soil with a bulk density of 1.2 g/cm^3 represents a 24 t/ha increase in soil OC which equates to 88 t/ha of CO_2 sequestered" (Jones 2006).

Data from the Rodale Institute's long-running comparison of organic and conventional cropping systems confirms that organic methods are far more effective at removing carbon dioxide from the atmosphere and fixing it as beneficial organic matter in the soil.

According to the Rodale Institute "U.S. agriculture as currently practiced emits a total of 1.5 trillion pounds of CO_2 annually into the atmosphere. Converting all U.S. cropland to organic would not only wipe out agriculture's massive emission problem. By eliminating energy-costly chemical fertilizers, it would actually give us a net increase in soil carbon of 734 billion pounds" (Rodale 2003).

The correct farming techniques can sequester carbon into the soil and reverse the 25% of Australia's greenhouse gases created by Agriculture. The processes to increase soil carbon can be divided into three steps:

1) Use plants to grow soil carbon
2) Use microorganisms to convert soil carbon into stable forms
3) Avoid farming techniques that destroy soil carbon

Why is carbon important to productive farming?

Soil carbon is one of the most neglected yet most important factors in soil fertility, disease control, water efficiency and farm productivity. Humus and its related acids are significantly important forms of carbon. Below is a summary of the benefits of humus

Humus improves nutrient availability:

- Stores 90 to 95% of the nitrogen in the soil, 15 to 80% of phosphorus and 50 to 20% of sulphur in the soil
- Has many sites that hold minerals and consequently dramatically increases the soils TEC (The amount of plant available nutrients that the soil can store)
- Stores cations, such as calcium, magnesium, potassium and all trace elements
- Prevents nutrient leaching by holding them
- Organic acids (humic, fulvic, ulmic and others) help make minerals available by dissolving locked up minerals
- Prevents mineral ions from being locked up
- Encourages a range of microbes that make locked up minerals available to plants.
- Helps to neutralise the pH
- Buffers the soil from strong changes in pH

Humus improves soil structure:

- Promotes good soil structure which creates soil spaces for air and water
- Assists with good/strong ped formation
- Encourages macro organisms (i.e. earthworms and beetles etc) that form pores in the soil.

Humus directly assists plants:

- The spaces allow microorganisms to turn the nitrogen in the air into nitrate and ammonia
- Soil carbon dioxide contained in these air spaces increases plant growth
- Helps plant and microbial growth through growth stimulating compounds

Helps root growth, by making it easy for roots to travel through the soil

Humus improves soil water relationships:

The open structure increases rain absorption
Decreases water loss from run off
Humus molecules soak up to 20 times their weight in water
It is stored in the soil for later use by the plants.
Improved ped formation helps the soil stay well drained

1. Use plants to grow soil carbon

The most economical and effective way to increase soil carbon is to grow it.

Plants get between 95 and 98% of their minerals from the air and water. If we look at the chemical composition of an average plant, Carbon, Hydrogen and Oxygen account for over 95% of the minerals. The remaining 5% or less come from the soil.

These minerals are combined using the energy of the sun via photosynthesis to produce the carbon based compounds that plants need to grow and reproduce.

The carbon gift - how plants increase soil carbon

It is estimated that between 30-60% of the atmospheric carbon dioxide (CO_2) absorbed by plants is deposited into the soil as organic matter in the form of bud sheaths that protect the delicate root tips and as a range of other root excretions.

These complex carbon compounds contain the complete range of minerals used by plants and are one of the ways that minerals are distributed throughout the topsoil. They feed billions of microbes – actinomycetes, bacteria and fungi that are beneficial to plants. Research shows that the greatest concentrations of microorganisms are found close to the roots of plants. This important area is called the Rhizosphere. These organisms perform a wide range of functions from helping to make soil minerals bio available to protecting plants from disease.

Research has shown that plant roots put many tonnes of complex carbon molecules and bio available minerals per hectare into the soil every year and are a very important part of the process of forming topsoils and good soil structure.

This means that well managed plants can put more bio available nutrients into the soil than they remove from it. Also the nutrients they put into the soil are some of the most important to the crop, to beneficial organisms and to the structure and fertility of the soil.

Managing weeds to increase soil carbon

If we look at weeds from this perspective, we can see that if we prevent the weeds from choking our crop, especially from getting the important sunlight, they can be increasing the fertility and health of the soil and actually helping our crop, rather than hindering it.

If the weeds are managed properly, and their residues are allowed to return to the soil, their nutrient removal from the soil is zero. In fact, as they are adding between 30% to 60% of the organic compounds they create through photosynthesis into the soil they are increasing soil fertility.

Studies of weed fallows and the microorganisms that they feed, show that they help with increasing the bioavailability of the minerals that are locked into the soil. Soil tests show an increase in soil fertility after weed fallows and when plants are grown as green manures.

It is one of the reasons why ground cover fallows restore soil health. They return tonnes of carbon into the soil, feed the microorganisms that make nutrients bio available and reduce soil pathogens.

The important thing is to ensure that the soil has adequate levels of all the minerals and moisture necessary for growth and that the weed management practices allow the crop to be the dominant plants.

Techniques where weeds are cut down, pulled or grazed and so that their residues will return to the soil will feed the crop. Cutting and grazing plants will result in significant percentages of roots being shed off so that the weed or cover crop plants can re-establish an equilibrium between their leaf and root areas.

These cast off roots not only add carbon and feed the soil microorganisms, they release nutrients to the crop and significantly lower nutrient and water competition. This addition of nutrients encourages the crop roots to grow deeper in the soil, below the weed roots resulting in larger crop root systems and better access to water and soil nutrients.

With these techniques, we are actually increasing the efficiency of the farm surface area capturing sunlight and using photosynthesis to make the carbon based molecules that eventually result in the fertile soils that feed our plants.

It is the nutrients that we lose off farm, either through selling the crop, through soil leaching or erosion that need to be replaced every year. Good fertilisation should always ensure that our soil has the optimum level of all the necessary minerals. If we do not replace the minerals that we remove from our soil when we sell our crop, we are mining our soil and running it down.

One of the reasons why good organic farmers notice that weeds do not become a problem in their systems is because they ensure they have excellent soil nutrition and health by using weed management techniques that build up the soil. **The process becomes one of effective weed management rather than weed eradication**.

One of the problems with herbicides is that by killing the ground cover plants, they stop the food supply that feeds these beneficials thereby lowering the count of beneficial species. Consequently soil borne pathogens like *Phytophthora* and *Fusarium* can take over, as the species that kept them under control are significantly reduced.

2. Use microorganisms to convert soil carbon into stable forms

The stable forms of soil carbon such as humus and glomalin are manufactured by microorganisms (Ingham 2003). They convert the carbon compounds that are readily oxidised into CO_2 into stable polymers that can last thousands of years in the soil (Handrek 1990).

Some of the current conventional farming techniques result in the soil carbon deposited by plant roots being oxidised and converted back into in carbon dioxide. This is the reason why soil organic matter (carbon) levels continue to decline in these farming systems.

The other significant depository of carbon are the soil organisms. Research shows that they form a considerable percentage of soil carbon. It is essential to manage the soil to maintain high levels of soil organisms.

Also it is essential that farming techniques stimulate the species of soil microorganisms that create stable carbons, rather than stimulating the species that consume carbon and convert it into CO_2.

Creating stable carbon

The process of making composts uses microbes to build humus and other stable carbons. The microorganisms that create compost, continue working in the soil after compost applications, converting the carbon gifted by plants roots into stable forms. Regular applications of compost and/or compost teas will inoculate the soil with beneficial organisms that build humus and other long lasting carbon polymers. Over time these species will predominate over the species that chew up carbon into CO_2.

Regular applications of composts and/or compost tea also increase the number and diversity of species living in the soil biomass. This ensures that a significant proportion of soil carbon is stored in living species that will make minerals plant available and protect the health of the plants.

Composts bring a significant number of other benefits

Research shows that good quality compost is one of the most important ways to improve soil. It is very important to understand that compost is a lot more than a fertilizer. Compost contains humus, humic acids and most importantly a large number of beneficial microorganisms, that have a major role in the process of building healthy soils. Compost provides the following benefits:

Humus

- Adds humus and organic matter to the soil
- Inoculates soil with humus building microorganisms.
- Improves soil structure to allow better infiltration of air and water.
- Humus stores 20 times it weight in water and significantly increases the capacity of soil to store water

Nutrients

- Mineral nutrients
- Organic based nutrients
- Contains a complete range of nutrients
- Slow release
- Does not leach into aquatic environment

Beneficial micro-organisms

- Supplies a large range of beneficial fungi, bacteria and other useful species
- Suppresses soil pathogens
- Fixes nitrogen
- Increases soil carbon
- Release of locked up soil minerals
- Detoxifies poisons
- Feeds plants and soil life
- Builds soil structure

3. Avoid Farming Techniques that Destroy Soil Carbon

The continuous application of carbon as composts, manures, mulches and via plant growth will not increase soil carbon levels if farming practices destroy soil carbon. The following are some of the practices that result in a decline in carbon and alternatives that prevent this loss.

Reduce nitrogen applications

Synthetic nitrogen fertilisers are one of the major causes of the decline of soil carbon. This is because it stimulates a range of bacteria that feed on nitrogen and carbon to form amino acids for their growth and reproduction. These bacteria have a Carbon to Nitrogen ratio of around 30 to 1. In other words every ton of nitrogen applied results in the bacteria consuming 30 tons of carbon. The quick addition of these nitrogen fertilisers causes the nitrogen feeding bacteria to rapidly multiply, consuming the soil carbon to build their cell walls.

This process results in the stable forms being consumed causing a decline in the soil carbon levels. The best analogy is money in a bank. The addition of the large doses of nitrogen fertiliser is the equivalent of a large withdrawal.

Freshly deposited carbon compounds tend to readily oxidise into CO_2 unless they are converted into more stable forms. Stable forms of carbon take time to form. In many cases it requires years to rebuild the bank of stable carbon back to the previous levels.

Ensuring that a carbon source is included with nitrogen fertilisers protects the soil carbon bank, as the microbes will use the added carbon, rather than degrading the stable soil carbon. Composts, animal manures, green manures and legumes are good examples of carbon based nitrogen sources

Where possible plant available nitrogen should be obtained through rhizobium bacteria in legumes and free living nitrogen fixing microorganisms. These microorganisms work at a stable rate fixing the nitrogen in the soil air into plant available forms. They can utilise the steady stream of newly deposited carbon from plant roots to create amino acids, rather than destroying humus and other stable carbon polymers.

Carbon eaters rather than carbon builders

The use of synthetic nitrogen fertilisers changes the soil biota to favour microorganisms that consume carbon, rather than the species that build humus and other stable forms of carbon. By stimulating high levels of species that consume soil carbon, the carbon never gets to increase and usually continues to slowly decline.

The use of composts with microorganisms that build stable carbons will see soil carbon levels increase if the farm avoids practices that destroy soil carbon.

Reduce herbicides, pesticides and fungicides

Research shows that the use of biocides (Herbicides, Pesticides and Fungicides) causes a decline in beneficial microorganisms. As early as 1962, Rachel Carson quoted research about the detrimental effect of biocides on soil microorganisms in her ground breaking book 'Silent Spring' (Carson 1962). Since then there have been regular studies confirming the damage that agricultural chemicals are causing to our soil biota.

Recently the work of one of the worlds leading microbiologist, Dr Elaine Ingham has shown that these chemicals cause a significant decline in the beneficial microorganisms that build humus, suppress diseases and make nutrients available to plants. Many of the herbicides and fungicides have been shown to kill off beneficial soil fungi (Ingham 2003). These types of fungi have been shown to suppress diseases, increase nutrient uptake (particularly phosphorus) and form glomalin.

Glomalin is a stable carbon polymer that forms long strings that work like reinforcing rods in the soil. Research is showing that they form a significant role in building a good soil structure that is resistant to erosion and compaction. The structure facilitates good aeration and water infiltration.

Avoiding the use of toxic chemicals is an important part of the process of developing healthy soils that are teeming with the beneficial species that will build the stable forms of carbon.

Use correct tillage methods

Tillage is one of the oldest and most effective methods to prepare planting beds and to control weeds. Unfortunately it is also one of the most abused methods resulting in soil loss, damage to the soil structure and carbon loss through oxidation when used incorrectly.

It is important that tillage does not destroy soil structure by pulverising or smearing the soil peds. Farmers should be aware of the concept of good soil 'tilth'. This is soil that is friable with a crumbly structure. Not a fine powder or large clumps. Both of these are indicators of poor structure and soil health. These conditions will increase the oxidation of organic matter turning it into CO_2.

Tillage should be done only when the soil has the correct moisture. Too wet and it smears and compresses. Too dry and it turns to dust and powder. Both of these effects result in long term soil damage that will reduce yields, increase susceptibility to pests and diseases, increase water and wind erosion and increase production costs.

Tillage should be done at the correct speeds so that the soil cracks and separates around the peds leaving them in tack, rather than smashing or smearing the peds by travelling too fast. Good ped structure ensures that the soil is less prone to erosion.

Deep tillage using rippers or chisel ploughs that result in minimal surface disturbance while opening up the subsoils to allow better aeration and water infiltration, are the preferred options. This will allow plant roots to grow deeper into the soil ensuring better nutrient and water uptake and greater carbon deposition.

Minimal surface disturbance ensures that the soil is less prone to erosion and oxidation thereby reducing or preventing carbon loss.

Control weeds without soil damage

A large range of tillage methods can be used to control weeds in crops without damaging the soil and losing carbon.

Various spring tines, some types of harrows, star weeders, knives and brushes can be used to pull out young weeds with only minimal soil disturbance.

Rotary hoes are very effective however this should be kept shallow at around 25mm to avoid destroying the soil structure. The fine 25mm layer of soil on the top acts as a mulch to suppress weed seeds when they germinate and conserves the deeper soil moisture and carbon. This ensures that carbon isn't lost through oxidation in the bulk of the topsoil.

There are several cultivators with guidance systems that ensure precision accuracy for controlling weeds. These can be set up with a wide range of implements and can be purchased in sizes suitable for small horticultural to large broadacre farms.

Organic farmers in the USA, Europe and Australia are using these to get excellent control over weeds in their crops.

Avoid erosion

Erosion is one significant ways that soil carbon is lost. The top few centimetres of soil is the area richest in carbon. When this thin layer of soil is lost due to rain or wind, the carbon is lost as well.

Avoid burning stubble

Practices such as burning stubble should be avoided. Burning creates greenhouses gases as well as exposing the soil to damage from erosion and oxidation.

Encourage vegetation cover

Vegetation cover is the best way to prevent soil and carbon loss. As stated in the previous section '*Managing Weeds to Increase Soil Carbon*', it is not always necessary to eradicate weeds. Effective management tools such as grazing or mowing can achieve better long term results.

Bare soils should be avoided as much as possible

Research shows that bare soils lose organic matter through oxidation, the killing of microorganisms and through wind and rain erosion. Cultivated soils should be planted with a cover crop as quickly as possible. The cover crop will protect the soil from damage and add carbon and other nutrients as it grows. The correct choice of species can increase soil nitrogen, conserve soil moisture through mulching and suppress weeds by out competing them.

Conclusion

Effective management of soil carbon not only reduces greenhouse gases by sequestrating carbon, the increase in soil carbon will increase the profitability of the farm by increasing soil fertility, increasing beneficial species, suppressing diseases, increasing water retention, improving drainage and aeration and increasing crop yields.

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How the soil food web and compost increase soil organic matter content

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Abstract

Soil organic matter comes from plant material that is decomposed through the action of microorganisms. Compost is therefore, a form of organic matter produced in conditions not necessarily in contact with soil. The types, activity and functions of each group of microorganisms must be understood in order to produce organic matter which will benefit plant growth, regardless of that decomposition occurs in windrows, in bins, on the soil surface, or mixed into the soil by various processes.

In general, as aerobic decomposition by an enormous number of species of bacteria and fungi produces the plethora of forms of sugar, proteins, carbohydrates, organic acids, lipids, fulvic and humic acids which comprise organic matter, soil or compost or worm compost as the case may be, plant production will increase, sooner or later, relative to plant production without these additions. Nutrient cycling, disease suppression and water holding are all improved as aerobic biology and thus aerobic soil organic matter amounts and diversity are enhanced. Decomposing plant material contains the balance of nutrients that the microorganisms require, but in addition, bacteria and fungi can solubilise nutrients directly from the bedrock, and from the sand, silt and clay produced as parent material weathers.

Certain plants can pull nutrients which have been lost from the surface of the soil back into aboveground tissue, but only if the roots of those plants can penetrate into deeper soil layers. Roots require aerobic conditions in order to function properly. Thus compaction, water logging during the active parts of the seasonal cycle, or too massive inputs of organic matter can result in conditions where roots are harmed.

Unfortunately, anaerobic bacteria and fungi (yeasts) can decompose plant material but the resulting anaerobic soil organic matter is typically highly detrimental to roots. If anaerobic conditions rule, nutrient concentration will decrease as major nutrients are lost as gasses. Anaerobic conditions benefit and select for disease-causing, pathogenic organisms, which attack and destroy roots, and thus reduce productivity. However, if oxygen returns, aerobic processes will return, and the detrimental conditions can be alleviated, except for the lost nutrients.

Aerobic soil organisms help build air passageways, help select against the growth or survival of disease-causing organisms, help retain moisture in the soil, and retain nutrients in the soil. Thus, it is critical to understand that it is not just organic matter content, but the type of organic matter produced in which types of conditions, that determine benefit to plant production. Without living organisms, soil cannot develop, but to select for the growth of the plants we desire, we need to understand the relationship between the production conditions, the organisms doing the work of decomposition, and the result which influences plant growth.

Soil fertility management in Australian agriculture

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Abstract

Soil fertility is the capacity to receive, store and transmit energy to support plant growth. The processes involved require healthy soils. Such soils are living, self-organising systems and are the foundation of life on Earth with humic substances as important drivers. Therefore, management of agricultural production systems has to evolve around the soil for the soil to feed the plant. Carbon is of critical importance and needs to be maximised through capture with solar energy, and optimum storage and use. A healthy soil is whole, having its physical, chemical and biological components functioning and in balance. Continuous use of acidic synthetic fertilisers, insecticides, fungicides and herbicides disrupt this delicate balance. Organic Farming has recognised this but needs to follow its leaders to an active soil management. Before we can hope to change things, we must understand why they are the way they are. The following will show the ‘big picture’ of how the current ‘Healthy Soils’ issue has arisen. How we, in practice and science, can help to actively manage soil biology to improve and maintain soil fertility and achieve more sustainable, productive farming systems producing healthy food and fibre on our fragile soils in a highly variable and changing climate.

Key Words

soil fertility, healthy soils, soil biology, soil organic carbon, humus, biological inputs, Organic Farming, Biological Agriculture, Agricultural Science, sustainable agriculture

Problems

The long recommended use of fertilisers, pesticides and other synthetic chemicals to address problems in agricultural production has been leading to poor soil health and resistance in insects, diseases and weeds. More soluble nitrogen fertiliser makes plants more susceptible to diseases and insects, and increases weed problem. As renowned soil scientist Dr William Albrecht said “*insects and diseases are the symptoms of a failing crop not the cause of it*”. The petrochemical solution is not working – all such production systems in the world are on a treadmill, needing more and more chemicals and fertilisers to keep yields up as natural soil processes are increasingly weakened in their role to support plant growth. This makes soils and plants dependent on these inputs. Such production systems are not sustainable and we currently harvest the outcomes of the gross oversimplification of fertilisation and ‘plant protection’ practices.

Agricultural systems are addicted to the soluble acidic-based NPK fertilisers and this addiction, supported with pesticides and herbicides, leads to soil degradation. The humic substances which are pivotal in soil fertility and plant nutrition have gradually been destroyed (Pettit 2006). Humus is the bond between living and non-living parts in soil and is part of the soil organic carbon that has severely declined since cultivation started. Curing any addiction is a slow process, requiring understanding, patience and commitment. This, however, has not yet been accepted by a science world which seems driven by commercial interests. Those in organic-biological farming remain the exception.

The problems arising from the petrochemical approach were first exemplified in Rachel Carson's 'Silent Spring' (1963), which exposed the effects of indiscriminate use of pesticides, and eventually resulted in the banning of DDT. Nevertheless, in spite of this warning, industrial manufacturing and widespread agricultural use of chemicals continue to affect our environment. Consequently, many registered chemicals have been taken off the market when negatives of long-term use became apparent. Consumers concerned about effects of chemicals on food quality and health will increasingly demand food free of chemical residues.

To improve soils, farming methods in annual cropping have recently changed from intensive cultivation to minimum tillage and no-till systems as being environmentally better and with good returns. Such 'sustainable' systems, however, are empirical as they are developed without a full understanding of long term outcomes. Impact of associated intensive chemical use is the unknown factor. It is the combined and repeated impact of chemical use that affects the system, factors not tested in product registration process or long-term field research. Negative soil related developments in these 'new' systems have already been identified in Queensland (Bell 2005). Brown (2004) formulated these phenomena as "*For every action on a complex, interactive, dynamic system, there are unintended and unexpected consequences. In general, the unintended consequences are recognised later than those that are intended*".
Current practices continue with the use of harsh chemicals and ignore the delicate balance of humus, microbes, trace minerals and nutrients in the soil. Management has resulted in marked losses in soil organic carbon (including humus) and greatly reduced diversity and abundance of microbes (algae, bacteria, fungi, nematodes, protozoa) and larger organisms (eg. mites, ants, beetles, worms) in the soil foodweb (Ingham, this proceedings). This exposes roots to harsh conditions and greatly diminishes the capacity of the soil to feed plants as well as making roots more sensitive to saline and acid condition and the whole plant susceptible to pests and diseases, and requiring plants to be spoon-fed with fertilisers and protected by chemicals (Anderson 2000). Disruption of soil biological and chemical processes usually leads to soil physical problems, such as reduced infiltration, compaction and erosion. Conventional farming is searching for answers to increasing soil organic matter (~1.4 times organic carbon) and microbial biomass (Bell 2005, Fisher 2005, Kirkby *et al.* 2006).

Ecosystem

A sustainable farming system is a complex ecosystem with non-linear dynamics that exist in alternate stable states, each state having their own threshold. When a critical threshold is breached, recovery to a sustainable system will become difficult or impossible. For unstable farming systems to again become sustainable, we have to understand ecosystems before we can take care of them.

Sustainable ecosystems are resilient, having the capacity to absorb disturbance and re-organise over a wide range of conditions before ever reaching a critical threshold. They are characterized by many interactive components within and between scales. Adaptability and transformability are two other characteristics of ecosystem response to change. Adaptability is the capacity of actors in the system to manage its resilience and transformability is the capacity to become a fundamentally different system when existing system remains unsustainable (Resilience Alliance 2006).

The underlying aims towards sustainable farming systems are conservation of soil, water and energy resources to maximise food production. This goes back to the functioning of ecosystems, the interactions between a community and its non-living environment. Agroecology is an approach in agricultural development which draws on modern ecological knowledge and methods. It is defined as the application of ecological concepts and principles to the design and management of sustainable agroecosystems (Gliessman, 2000).

Understanding functioning of ecosystems requires a 'big picture' holistic approach. The knowledge of different groups in the living world and how they interact with other groups is here more important than in-depth knowledge of individual species. Studying the latter, however, and single issues in general, seems to be more popular and advanced. Then again, we can't understand a system by combining available knowledge of component single issues. That is, the holistic 'whole' is not the sum of reductionist 'detail'. This also needs to be realised in simulation modelling of systems.

Symbiosis – the balanced, mutual interdependence of different species – is a protective mechanism in nature which develops in response to compatible needs. Self-organisation keeps natural biological systems in balance. Interactions between organisms are powerful evolutionary forces. Increased complexity and diversity of species and interactions within the soil foodweb promote balance and higher plant productivity. The whole should be considered as an integrated system being resistant and resilient to change through an abundant diversity of organisms.

Plants depend on beneficial soil organisms to protect them from pathogens, to help them obtain nutrients from the soil, and to break down toxic compounds that could inhibit growth. Soil organisms create a living, dynamic system that needs to be understood and managed properly for best plant growth. If the balance of micro-organisms is wrong, fertilisers and pesticides can't help recover plant vigour. Understanding soil health requires knowing which organisms occur, which ones are working, how many are present and whether they are the right kinds for the desired plants (Ingham 2000, 2006).

Soil health thus requires improvement of biodiversity in paddocks and catchment to enhance natural predation in a functional soil foodweb (FAO 2006). This may be achieved by doubling soil organic carbon (the foundation for a living soil) minimising use of chemicals and the establishment of shelterbelts for improvement of soil surface microclimate and home to an important part of the soil foodweb. That paddock soil then becomes resistant to change and, being resilient, is able to recover from disturbances caused by extremes in weather or management. Such soils will remain more productive with climate change as living soil organisms can adapt. It will also help slow climate change by sequestering carbon (Leu this proceedings, Carbon 2006).

Further ecosystems improvement may be achieved by managing natural energies with permaculture (PRI 2006), Yeomans' Keyline Designs (Yeomans 2006) or Natural Sequence Farming (NSF 2006) to fit paddocks in a sustainable landscape. Natural Sequence Farming is a rural landscape management technique aimed at restoring natural water cycles that allow the land to flourish and be less sensitive to drought conditions (Newell 2006). This goes back to the natural balance of water cycles as pioneered by Peter Andrews (NSF 2006) in conjunction with biological farming principles.

Another aim towards sustainability and the protection of ecosystems is reducing the vulnerability of farming to effects of diminishing oil availability by decreasing the reliance on petrochemical products.

Science

Current specialisation in agricultural science has resulted in research within very narrow boundaries. This has ensued linear, mechanistic thinking, which doesn't allow room for synergies, and results in confusion between cause and effect. Soils, for example, have become partitioned in separate isolated fields of chemistry, physics and biology, with specialisation within each of them. Soil degradation and resulting healthy soils issue, therefore, can't be solved with many individual research projects conducted by various specialists. In nature every thing is linked with everything else. These circular, web-of-life phenomena have to guide our applied field research.

Much of the sustainability research is fiddling at the margins of entrenched methods and tends to work on symptoms rather than primary cause of problems, as evidenced by appearance of new problems. It is not simply a matter of doing better what we do. 'Best practice' locks us in status quo which is still not good enough!

If agricultural research is to deliver anything approaching sustainability, therefore, we need to change the science paradigm (Jackson 1985). Or as Dr Albert Einstein said: "*No problem will be solved with the same level of thinking that created it in the first place*". Over generations research has become increasingly "reductionist", that is, reducing and outlining systematically the area of interest and the disciplines to be studied. While this approach has delivered a lot of knowledge about the workings of particular crops, pastures, livestock, insect pests, chemicals, etc, focussing too intensely on closed systems with narrow boundaries– on single, isolated components of the bigger “real-world” system – means we are blind to larger cycles and patterns within which component parts exist (Stapper 2002).

New problems keep emerging as each of them are dealt with as single issues resulting in partial solutions that don’t necessarily solve the problem, for example, acidity (with lime) and salinity (with lowering ground water). Partial solutions tend to equate a single solution with the cause of the problem but lime and ground water, for example, are not always directly related with acidity (Anderson 2000) and dryland salinity (Jones 2001, 2006), respectively. Alternative causes for dryland salinity have been derived from experiences with soil management in New South Wales (Wagner 2005), Victoria (Nathan 1999) and Western Australia (Paulin 2002).

Experimental results of individual components are thus difficult to apply to paddocks, being complex systems in time and space. What does an ‘average’ mean in a paddock? Other management factors are likely to be working against individual research results, thereby inhibiting change. Hence, problems continue to emerge in agricultural production systems. These are now proposed by science to being solvable with genetic engineering. Another oversimplification in our fragmented agricultural science, band-aids over the real cause of our problems – degrading soils.

The standard multi-factorial research methodology seems ill-suited to study complex biological systems where everything is linked with everything else. To obtain functional outcomes, no factors may be considered ‘constant’ in trials while varying a few ‘important’ factors to quantify their impact. Also the boundary conditions of research objects chosen by specialists (*eg* pots & small plots in growth chamber, green house or research station) are often not appropriate and representative of real ecosystems (especially microclimate) and create results not transferable to farming systems level. Comparative analysis is needed on a commercial production scale. Questions arising from such studies then need answers through reductionist science.

New methodologies and directions of research are required in the search for resilience, to achieve reproducible and predictable outcomes in farming systems across agroecological zones. Such research needs to be planned, executed and analysed by a transdisciplinary team working across ecosystems at representative scales, agroecology (Gliessman 2000, Altieri 2006). This is to allow measurement and observation of expressions of the multitude of interacting components within and between different scales of the farming system. Plant health (Anderson 2000) and animal health (Voison 1958), for example, are dependent on availability in the right balance of minerals, but this is still regarded as ‘alternative’.
To reach sustainable agriculture we have to look at the whole system and develop holistic tools with agricultural science that bring together, from across disciplines, the knowledge obtained through analytic reductionism, without getting lost in small component detail of the ‘which single factor? the how? the why?’ Such tools are unlikely to be quantitative, hard systems, as dynamic interactions by soil organisms are too complex and affected by small spatial and temporal changes in management and climate. Therefore, a soft systems approach is required, synthesising knowledge into management guidelines for sustainable land use involving careful monitoring of status.

Australia’s public R&D in this research direction is minimal and seems to be one of the lowest of OECD countries as was evident at the recent International Federation of Organic Agriculture Movements Congress in Adelaide (ISOFAR 2005). However, we need to search for productive agricultural systems with reduced usage of petrochemicals and energy, and not rely on ‘Techno-Fantasy’ to help us out. In an economy without cheap oil, Heij (2006) examined the role of science in the context of this profound socioeconomic change now gathering momentum around us.

Management

As managers using the soils, what do we look at, what do we (want to) see? After decades of regular use of single-super phosphate some farmers and graziers stopped using it when they became aware of the negative impact it had on soils and trees, caused by the acidic nature of the fertiliser, muriate of potash (potassium chloride) being as detrimental to biology.

We can learn to use the power of nature rather than fighting it with synthetic chemicals and unproven new technologies in a war we can't win. Organic Farming is surging and Biological Agriculture (Anderson 2000, Zimmer 2006) is emerging as a sophisticated farming system in transition between current and organic. Both benefit from reintroduction and enhancement of humic and soil biological activity which was already in the foundation of Biodynamic Farming (ATTRA 2006). In contrast to the Organic standard, Biological farming allows minimal use of the most microbe-friendly fertilisers and herbicides with humic additives and molasses or sugar to enhance effectiveness and reduce damage to microbes. This requires ever smaller quantities as the system is balancing and moving towards Organic, a process that occurs much quicker when actively managed with biological inputs.

Management aims to balance chemistry, physics and biology in the soil aided by improved organic carbon content, appropriate mineral balance and a diverse and abundant soil life. Thus stabilising our fragile soils and creating a sponge that stores and makes available required plant foods and facilitates prolific root growth. Soil biology helps building and maintaining soil structure to secure aeration and prevent compaction. A balanced biological soil will have the maximum levels of available minerals coinciding with maximum demand by plants.

The farming system is intended to enhance biological activity in soil and on foliage, enabling a balanced supply of required minerals for effective plant growth, providing energy to plants and grazing animals, and building internal resistance to diseases and insects (Callaghan 1975). Soils are actively remineralised, inoculated with soil microbes and supplied with food for microbes, all required to attaining and maintaining an energetic balance.

Cover

With cropping and in orchards, the soil should be covered most of the time by plants or stubble to protect from high temperature and water loss. A litter layer as cover will be a continuous source of carbon for soil organisms and also provide temperature insulation and water retention. Green manuring provides opportunities to convert rainfall into soil fertility.

Weeds

Weed growth is minimised with soil minerals being in balance and with lowest levels of freely available nitrogen. Mineral availability provides conditions that produce certain weeds, which can be used as an indicator of mineral deficiencies (Walters 1999). The weed spectrum changes immediately when soils are balanced using appropriate materials. For example, from stinging nettle domination (sign of calcium unavailability) one year to no nettles and some shepherd's purse as main weed the next. This is the ecological concept of succession, with different suites of species supported on the same area of land as soil conditions change over time (Ingham, this proceedings).

Variety choice

Most current varieties have been selected to produce well in high-input management systems and therefore expect such treatment. New varieties have to be developed under organic-biological conditions to optimise production with low input on healthy soils. The first step is to evaluate 'old' varieties that were selected before nitrogen availability became a priority for plants.

Rhizosphere

The rhizosphere is the area of intense biological and chemical activity close to the root inhabited by soil microbes feeding off exudates from the root, thus facilitating nutrient supply to the root and protecting it from pathogens. Fertiliser with the seed at sowing decreases root growth, root branching and the number of root hairs. Applying microbes, humic substances and food for microbes with the seed generally results in a vigorous seedling with a thick rhizosphere, prolific branching and many root hairs, without a need for conventional seed-dressing. Such annual plants when pulled out of the ground at flowering still show a vigorous rhizosphere. Microbes keep colonising the roots as they grow thus providing a continuation of that good rhizosphere. It has been demonstrated that an active rhizosphere can be created in degraded, acid or saline soils with that neutral zone around the root allowing vigorous plant growth. Such a carbon pump into the soil will improve that soil and the increasing soil biology will segregate negative compounds. Carbon may thus help stop dryland salinity (Jones 2006, Seis this proceedings).

Inputs

The most important inputs are foods for the soil microbes with the most effective one being carbon exudates from roots of growing plants. Maximising the time of active plant growth therefore is most important. Rotational, cell or planned grazing, for example, facilitates root growth and delivers more carbon to the soil than set-stock grazing. Another example is pasture-cropping where winter crops are sown into summer-active perennial pasture (Bruce 2005, Jones 2006, Seis this proceedings).

Residual stubble and roots are also important sources of carbon. Stubble, however, needs to be broken down to be available for soil organisms. To facilitate this a stubble digest, containing cellulose digesting fungi and some urea to lower the C:N ratio, can be sprayed on a slashed, spread and rolled stubble with or without incorporation. Such decisions depend on the amount and kind of stubble, paddock history and soil biological activity, whether or not such bugs are already present.

Carbon can be applied as molasses, sugar, humates or brown coal, in order of decreasing availability. Humic substances, such as humus, humate, humic acid, fulvic acid and humin, are important forms of carbon for plants, playing a vital role in soil fertility and plant nutrition. Plants grown on soils which contain adequate humin, humic acid and fulvic acid are less subject to stress and are healthier, and the nutritional quality of harvested foods and feeds are said to be superior (Pettit 2006).

Soil microbes and minerals can be applied as required by spreading, down the tube or as foliar or soil spray with possible micronised minerals. Microbes can be applied as compost tea (Ingham 2006) or as commercial mix available on the market, such as EM (Effective Microbes) or 4/20 both internationally renowned products. These mixes may contain free-living nitrogen fixers (Azotobacter species), bacteria that establish in the litter layer and can provide 20 to 70 kg N per ha per year depending on moisture and carbon availability. Phosphorus solubilisers are another bacterial group that may be included to make available the P applied in the past and locked up in the clays. Importance of Biodynamic preparations and application (time and method) does not just rely on its bacteria content, but also stimulate the activity of other soil bacteria and fungi.

Other inputs can be organic in nature, such as seaweed, guano, soft rock phosphate, lime and rock dust, or in biological farming, inorganic microbe-friendly fertilisers in small amounts, such as sulphate of ammonia, calcium nitrate or mono-ammonium phosphate (MAP). Lime is regularly applied (0.4 to 1 t per ha) for calcium to be available, which is a very important mineral and requiring fungi for availability to roots (Ingham, this proceedings).

Compost is an important and effective method to deliver carbon, organic compounds, minerals and microbes to the field as a readily available organic fertiliser. The best compost would contain up to 90% of the carbon in microbial biomass, that is, bacteria, fungi, protozoa and nematodes (Ingham 2006). Compost tea can be extracted from good compost and sprayed in orchards and on broadacre crops and pasture (Ingham this proceedings). Vermicomposting is the process by which worms are used to convert organic materials into a humus-like material known as vermicompost.

Trials

It is good to do trials on your own property to find out what and how things work. It is best to leave test strips on the paddocks, including a nil strip to see what would have happened if you hadn't done something. It is important to keep good records and markers in the field to be able to keep track of a treatment in one season over subsequent years. Current yield monitors are providing grain growers with a good tool to quantify differences.

Monitoring

"*You can't manage what you don't measure*" – Monitoring of soil and plants is important to be able to see improvements when changing management and to allow early detection of required management. It is good to keep track of differences between paddocks and use it to try to quantify different solutions to a problem. Monitoring is a great learning tool. Keeping good records facilitates discussion with other landholders and advisors. A Soil Health Card with recording instructions was developed by a Landcare group in the Northern Rivers region of NSW (NR 2006).

Pulling plants out of the soil is a test to help assess microbial activity. Naked roots usually means a dense soil with little microbial activity. Having a thick soil layer stuck to roots (i.e. the rhizosphere) with prolific branching of the roots is an indication of a well aerated soil with active soil biology.

Smell the soils and discover the sweet smell of a healthy soil. Lab soil tests are the classic tool to get some chemistry numbers of what's in the soil. However, it is important to also assess the biological availability of essential elements and their balance, as provided by special labs. Deficiencies are relative as productivity can be adversely affected by excess. Soil minerals can work together or be antagonistic to each other. An excess of one will create a deficiency of another.

Tools

Descriptions of home-made equipment are given with the Soil Health Card (NR 2006). A wire quadrat is used for soil cover estimates or weed/plant population densities, a penetrometer to monitor hardness of soil and an infiltrometer tube to measure rate of water infiltration.

Plant sap will reflect improvement in mineral availability and sugar content, and can be monitored in the field with a refractometer giving a brix reading, which needs to be above a crop specific minimum to keep insects and diseases away (Anderson 2000).

A pH-meter can provide you with information as to whether plant sap is at the healthy neutral level, meaning the soil is in balance energetically. In Biological Agriculture a pH-meter should also be used to make sure herbicides are applied with a pH as low as 4, and with fulvic acid as additive, to greatly increase effectiveness.

Outcomes

Farms having achieved healthy soils look and smell good with presence of dung beetles on pastures and no slugs or snails in cropping. Plants growing on those farms have less disease and insect damage, less frost damage (high brix, sugar content in plant sap), have great root systems and taste better. Standard successes are crops of canola and lucerne without insect damage and not needing pesticides. Animals show the most extraordinary health (*eg*. lack of foot rot, bloat, pink eye, mastitis), fertility (*eg*. +25% lambing) and longevity. They need less fodder and graze shorter compared with available conventional feed.

The animal health is astounding when you think of what could happen to humans if we ate such food! Biological farming can reduce fertiliser use by up to 70% and eliminate fungicides and insecticides within three years of commencing. Such personal statements about achieved outcomes are available in newsletters and articles in rural magazines but independent quantification is rare (Stapper 2004). Most methods haven’t been proven scientifically, failures are experienced if methods or conditions are not right, and are therefore rubbished by many.

Improved soil biological activity becomes visible through presence of earth worms and many creepy crawlers. Common soil problems have been alleviated such as acidity, salinity, compaction, water logging and wind erosion (no dust behind sheep). Water holding capacity has been improved which shows, for example, on irrigation farms through a 2-3 day extension between irrigations. Water retention seems greatly improved as soils at the surface remaining moist longer. Improved soil organic carbon manifests itself through many factors. A study in the Wagga Wagga, NSW district quantified the value of soil organic carbon as $116 per one percent increase, resulting from better water holding capacity and nitrogen availability (Ringrose-Voase *et al.* 1997).

As in current systems, not all inputs are always effective. Success in biological systems depends on many factors working together. Soil organic carbon formation from roots and stubble, for example, requires important nutrients to be available as the C:N:P:S ratio of organic carbon is stable across the world (Kirkby *et al.* 2006). Something can fail if a catalyst is missing. When everything connects we can get responses beyond expectation as synergies (‘1+1=3’) start to occur. However, we are on the right track. An organic farmer from the UK, a Nuffield Scholar having visited the USA regularly, stated in February 2006: “*I have seen some truly exceptional farmers who are light years ahead of anything I saw in America, particularly where it really counts, in the practical application and making it work on farm*.”

Lal (2006) found that enhancing soil quality and agronomic productivity per unit area through improvement in soil organic carbon pool will increase food production in developing countries, with numerus ancillary benefits. Adoption of recommended management practices on agricultural lands and degraded soils would enhance soil quality including the available water holding capacity, cation exchange capacity, soil aggregation, and susceptibility to crusting and erosion.

Many have studied the impacts of farming methods on environment and food production. For example, studies have shown reduced nitrate leaching and enhanced denitrifier activity and efficiency in organically fertilised soils (Kramer *et al.* 2006). Impacts of herbicides on rhizobium survival and recovery with reductions in nitrogen fixation have been reported by Drew *et al.* (2006). Organic agriculture often is a proven good producer of food with yields comparable to those of conventional agriculture both in poor (Parrott and Marsden 2002) and rich (Mäder *et al*. 2002) countries. Gala (2005) and Leu (2006) provide detailed accounts of studies from many countries.

Organic technologies have been developing for about 6000 years to feed mankind while conserving soil, water, energy and biological resources. We are now able to increase yields for those low-input systems by using our breeding knowledge and methods to select higher yielding varieties adapted to local conditions (*eg*. improve harvest index). Among the benefits of organic technologies are higher soil organic matter and nitrogen, lower fossil fuel energy inputs, yields similar to those of conventional systems, and conservation of soil moisture and water resources, especially advantageous under drought conditions (Pimentel *et al.* 2005).

Cuba is the first country to develop agroecological systems nationwide. This was following the disintegration and collapse of the Socialist Bloc and tightening of the US trade embargo which prevented access to petrochemicals. Cuba successfully turned to self-reliance, organic farming, animal traction, biofertilisers and biological pest-control with retention of productivity, a remarkable paradigm shift (Funes *et al.* 2002).

Road to Sustainability

Sustainable agriculture has been given many definitions. However, it is a process of social learning, not lead by a science with overemphasis on production and neglect of maintenance functions within agroecosystems. Hill (1998) sees this blind spot as one of a number that are indicators of our undeveloped and distressed psychosocial state. Habits, perception and assumptions make what we see and want to see. Correlation is not cause. Another part of the required changes in paradigm or how we learned to see the world.

How do we find the road to sustainable agriculture producing healthy food in a healthy landscape? How do we turn our ‘Clean and Green’ image into a reality? Minerals and microbes are the key in both soil and human health. Mineral density of foods has more than halved last century (Berger 1997, McCance and Widdowson 2000) and we need to increase it again through production and keep it available with proper processing of food. Good nutrition comes back to agriculture and the way our foods are grown, processed and prepared. Real medicine must start with the patient’s diet and ultimately the nutrition on the farm (Anderson 2000, 2004). Worthington (2001) found genuine differences in the nutrient content of organic and conventional crops which improvement could be greater if all organic crops are actively managed with microbes and minerals. Farmers and graziers are to be paid for such quality.

Active management of the soil foodweb, remineralisation and greatly increasing the required soil organic carbon is essential to reaching ecological sustainable production systems and a (less-un)sustainable agriculture. Such a system produces healthy food with good taste, structure (*i.e.* calcium and silica availability) and extended shelf-life.

Trees are important as shelterbelts in a dry, wind-swept continent. There are examples in many districts where farms converted say 10 percent (often from 0.5) of their property to trees and wetlands, and resulting in improved productivity by being less sensitive to droughts. This will especially be the case when appropriately combined with Natural Sequence Farming (NSF 2006).

Organic-biological farming methods also seem promising on a landscape and catchment scale as they result in farming systems which stimulate biodiversity, minimize use of synthetic chemicals, stabilise the soil, and balance hydrology thereby reducing off-farm impacts. It is important to mix and match such systems with landscape changing factors such as permaculture (PRI 2006), Keyline Design (Yeomans 2006) and Natural Sequence Farming (Newell 2006).

Most districts have a property with sustainable practices as outlined above. These practices were achieved with persistence by the manager through trial and error under the financial pressures on fragile soils in our highly variable climate. It is the task of science with participatory research to connect these dot points in the landscape using appropriate concepts and principles. A typical agricultural manager is time poor and cash poor thereby easily following advise from (trusted) outsiders. Action research is needed to visualise farmer knowledge of natural resource management with indicators and feed the required information-exchange networks. Thus allowing knowledge to be transferred in time and space to achieve and maintain soil health, optimise production and minimise risk to achieving profitable farms in sustainable rural communities.

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Organic carbon dynamics in agriculture

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Abstract

Soil organic matter is a complex and heterogeneous mixture of materials. These materials vary in their physical size, chemical composition, degree of interaction with soil minerals and extent of decomposition. We must know the composition of soil organic matter (what types of organic matter are present and how biologically active they are) to be able to predict the impacts of management and changes in organic carbon content on soil productivity.

The amount of organic matter in a soil results from the balance of inputs (plant residues) and outputs (microbial decomposition). Inputs are controlled by the type of plants and the environmental factors governing production. Losses result from decomposition of plant residues and various organic materials incorporated into the soil and are controlled by the biological stability of the inputs and three basic SOM pools. The final organic matter content of a soil therefore results from a balance of these two processes over many years.

Organic matter contributes to a variety of functions in soils. These functions can be broadly classified into three types: biological, chemical and physical. Strong interactions often exist between these different functions. For example, the biological function of providing energy that drives microbial activity also results in improved structural stability and creates organic materials that can contribute to cation exchange and pH buffering.

In this paper, we describe these processes and functions in more detail.

Soil Organic Matter in agricultural systems

What is Soil Organic Matter?

Soil organic matter makes up a small but vital part of all soils. It includes carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulphur. Because of variations in the component elements of soil organic matter, it is difficult to measure directly. Most laboratories measure and report the content of organic carbon in a soil test report. To estimate soil organic matter, multiply soil organic carbon by 1.72.

Soil organic matter is a complex and heterogeneous mixture of materials. These materials vary in size, chemical composition, degree of interaction with soil minerals, and extent of decomposition. To predict how management and changes in organic carbon content will affect soil productivity, we must know the composition of soil organic matter (what types of organic matter are present and how biologically active they are).

We now recognise four different types of soil organic matter:
Crop residues – shoot and root residues larger than 2 mm, on and in soil;
Particulate organic matter – individual pieces of plant debris that are smaller than 2 mm but larger than 0.053 mm;
Humus – decomposed materials less than 0.053 mm that are dominated by molecules stuck to soil minerals; and
Recalcitrant organic matter – dominated by pieces of charcoal

The amount of each of these different types of organic matter in Australian agricultural soils has been found to vary significantly and can be changed by management practices.

How can we change Soil Organic Matter content?

The amount of organic matter in a soil results from the balance of inputs (plant residues) and outputs (microbial decomposition). Inputs are controlled by the type of plants and the environmental factors governing production. Losses result from decomposition of plant residues and various organic materials incorporated into the soil and are controlled by the biological stability of the inputs and the three soil organic matter pools described above. The final organic matter content of a soil therefore is the result of the balance of these two processes over many years.

Fire can contribute by converting biomass to charcoal, which is recalcitrant organic matter and can survive in the soil for thousands of years. Results obtained for a wide range of soils have indicated that charcoal, the major component of the recalcitrant fraction, can account for between 0 and 60% of the organic carbon present in a soil. Given the relatively inert nature of charcoal, it is important to identify soils with high charcoal contents to understand what fraction of the soil organic carbon is available to microorganisms.

As stated earlier, inputs are determined by plant production, how much of the residues are retained in the soil and any organic amendments that a farmer may add. Without irrigation, inputs are restricted by climate and management. For example, if a farmer burns his stubble, about half of the input is lost; if good fertiliser practices are used, inputs (stubble) could be substantially increased through higher yields. Addition of amendments such as compost and manure will also substantially increase carbon inputs.

Losses, on the other hand, are linked to how quickly the residues and the soil organic matter decompose through the impact of micro-organisms. Factors that affect decomposition are the chemistry of the residues, the presence of a microbial community that can effectively deal with the organic matter, soil factors such as clay content that can protect organic matter from decomposition, and again climate, which will dictate how quickly these processes may proceed. Of these, only the chemistry (quality) of the residues is readily modified by management, but in agriculture even this can be manipulated to only a relatively small degree.

The resultant soil organic matter level attained is the balance between these processes. It might take centuries to reach a final equilibrium, although most change occurs within the first 50 years.

Functions of organic matter in soil

Organic matter contributes to a variety of functions in soils. These functions can be broadly classified into three types: biological, chemical and physical. Strong interactions often exist between these different functions. For example, the biological function of providing energy that drives microbial activity also results in improved structural stability and creates organic materials that can contribute to cation exchange and pH buffering (Baldock and Skjemstad 1999)..

Mineralisation of N from organic materials

An important property of organic materials that influences nitrogen mineralisation is its C/N ratio. During the decomposition of organic materials, nitrogen can either be released (mineralised) or tied up (immobilised). Organic matter with a high C:N ratio (e.g. wheat stubble - C:N>75) will immobilise N and reduce the amount of plant-available N present in a soil during decomposition. Conversely, materials with a low C:N ratio (e.g. humus fractions of soil organic matter – C:N<15) will mineralise N and increase plant-available N content as they are decomposed.

Estimates of the effect of a crop residue on the plant-available N status of a soil can be calculated using a simple N balance approach. Examples are the addition of wheat or legume (medic) residues. Decomposition of the wheat residues (C/N=100) will result in a removal (immobilisation) of N, while that of a medic residue (C/N=25) will release (mineralise) N.

Mineralisation of N from soil organic matter

The mineralisation of nitrogen from soil organic matter during the growing season is more difficult to predict than that from residues. Two types of factors are important: 1) those that define whether or not the nitrogen is in a form that can be mineralised and 2) those that influence the rate of mineralisation. Factors that define the availability of N to mineralisation include:
* The chemical composition of N contained in soil organic matter and residues of crops and pastures. (Does the organic N exist in a form that can be used by microorganisms?).
* The position of organic N in the soil matrix and its extent of interaction with soil minerals (Is the N located in a position in the soil where biological and chemical processes can operate?).
* The presence of a biological capacity to mineralise N (Are the organisms responsible for mineralising N present and active in the soil?).

Although these factors control the potential delivery of N to the plant-available pool, they do not define the rates and magnitude of N delivery. They each interact with a range of agronomic practices (e.g. cropping history, residue management, tillage regimes, and previous fertiliser usage) and environmental properties (e.g. temperature, soil water content and pH) to define the rate of N mineralisation.

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Ecological engineering: pest management solutions for organic agriculture

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Abstract

Ecological engineering is about the design of human systems, such as agriculture, to work effectively with the minimum of inputs. This presentation will explore ecological engineering in the context of pest management. Though most research worldwide into ecological engineering has taken place in non-organic systems, these approaches have great utility in organics. A four-phase approach to the design of pest management systems will be used to illustrate the place of ecological engineering in contemporary organic agriculture.

Key Words

Organic Farming, Low Input Agriculture, Integrated Pest Management, Biological Control, Habitat Manipulation.

Ecological Engineering

Ecological engineering is about the design of human systems, such as agriculture, to work effectively with the minimum of inputs (Odum, 1962). This is achieved by following ecological principals to 'work-with-nature' but success demands an understanding of the mechanisms that operate in fields such as community ecology. Ecological engineering's utility in the context of pest management has been covered extensively by Gurr et al. (2004). Despite the fact that such approaches have received growing research attention over the last 15 years, most research has taken place in conventional agricultural systems rather than under organic production (Zehnder et al., 2007).

Organic Pest Management

Insect pest management for organic agriculture has been extensively reviewed by Zender et al. (2007). The structure of that review used the four-phase classification system proposed by Wyss et al. (2005) for pest management approaches suitable for use in organic agriculture. First phase approaches involve optimal selection of site and crop variety as well as considerations such as trellis and training design for perennial crops and plant spacing. These are all approaches implemented in the lead-up to and at establishment and contribute to the crop's subsequent resilience to pest attack. Second phase approaches manipulate the vegetation in and around a crop and effect pest suppression (i) directly, by disrupting pests' ability to locate host plants and (ii) indirectly, by enhancing the activity of the predators and parasitoids of pests. These approaches can be implemented after first phase strategies and this is especially important when perennial systems need additional protection. Third phase approaches are inundative and inoculative biological control (Eilenberg et al. 2001) that involve releasing mass-reared live agents to control pests for a brief or extended period. Fourth phase strategies involve the application of allowable inputs of biological or mineral origin that may act directly against pests in a toxic manner, disrupt mating or inhibit their colonisation of the crop.

Approaches in the last two phases, especially the fourth, tend to be used in a reactive manner to treat pest populations when first and second phase approaches have failed to prevent an outbreak. In the above four-phase scheme, ecological engineering approaches make up the second phase.

Looking Ahead

Second phase methods such as various forms of poly-culture (growing more than one crop species together) can suppress pest activity. Ecological engineering is, however, more complex than a naive belief that diversity is a panacea for pest problems. Many research questions remain to be resolved and practitioners need to be aware of potential pitfalls that can exacerbate pest damage (Landis et al., 2000). This presentation will consider prospects for the use of ecological engineering pest management approaches in organic agriculture using examples from a range of crop types.

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Building natural soil fertility

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Abstract

Mara Seeds & Mara Organics are family companies located in the Northern Rivers region of the North Coast of New South Wales. SOFT (Sustainable Organic Farming Techniques) is the use of natural resources combined with an on-farm composting and biological input system. The paper demonstrates the integration of commercial organic farming and value-adding business.

Activities addressed will be the production under a SOFT system of:
* cattle breeding and fattening
* crop production of soybean and winter wheat
* sub-tropical grass seed production
* commercial composting
* value-adding of organic products

Presentation

Welcome to

SOFT

Sustainable Organic Farming Techniques ™

www.maraseeds.com

Who are we and what do we do?

- Located in the foothills of the Richmond Ranges in Northern Rivers of NSW
- Primary Producers/Processors/Exporters
- Farming Area 2040 ha (5000 acres)
- Family Business employing 9 staff

Typical Landscapes

2006

What are our Business Activities?

- Organic Soybean Production
- Organic Winter Cereals
- Grass Seed Production
- Organic Beef Cattle Breeding
- Organic Silage & Grain Assisted Fattening
- Organic Hay Production
- Seeds Cleaning Plant
- Processing Soybean Wholegrain, Meal & Grits
- Compost Production (Bulk & Bagged)

Why did we become 'SOFT' farmers?

- 11 years ago at the peak use of conventional practices there were obvious signs of over use of chemicals and fertilizers
- Costs became prohibitive as more and more fertilizer and chemicals appeared to be required
- Crop and plant residues were not breaking down from year to year
- Yields plateaued or declined
- Plants had flat roots and no drought tolerance and soils were getting harder
- Weeds became a problem (due to imbalance of soil nutrients and biology)

1993 Soil / 2003 Soil

Typical Soils in 2006

Conventional V Compost 1997

Composted Paddocks 2004

How?

- We grew 40 ha of soybean using an imported biological/mineral based system
- Bio-dynamics (small scale)
- Purchased composts
- Finally resorting to developing our own system

Activities & Inputs: Cereals / Soybean

- Soil and Biological analysis
- Custom-made compost preparation (incorporated prior to planting at 2.5T/ha)
- Compost extract applied to soil prior to planting 190 litres/ha
- Over-row cultivation (Yetter) used for in-row weeds
- Cultivation between rows
- Harvest April/May
- Soybean markets as whole grain for soymilk & tofu with balance used as protein meals supplied to animal industries

Wheat

2005

Healthy Soybean Crops

2005

2004

Activities & Inputs: Livestock

- Run 800 breeders (2000 head)
- 50% Hereford, 50% Hereford Crossed with Brahman Bulls
- Yearlings are fattened as Organic Beef
- Winter cereal/ryegrass background weaners
- Fattening Silage / full-fat soybean /grain ration for domestic and Korean market

Activities & Inputs: Grass Seed

- Rhodes Grass & Setaria
- Soil & biological analysis
- Pastures are slashed with compost extract applied @ 190 L/ha or custom-made compost applied after Ground Hog @ 2.5 T/ha in spring
- Harvest April - May

Harvesting Narok Setaria

Activities & Inputs: Hay Production

- After harvest of seed crops quality hay for feeding and balance of windrow tailings is used as a carbon source for compost

Activities & Inputs: Compost Production

BFA
Certified Organic

Inputs:

- Hay as a carbon source from our pastures
- Chicken Litter, Cow manure, pig manure
- Hardwood & softwood sawdusts (composted),Ground timber
- Crops grown for green material (sorghum / soybean)
- Fine metal dust
- Fine agri-lime
- Water – dam / lagoon
- Biology manufactured as compost tea reapplied as inoculant

Compost 2006

Compost Inputs

Spreading Compost

Markets for Compost

- Soybean growers
- Beef & Dairy Industries
- Potato farmers
- Macadamia farmers
- Home gardens
- Bagged product into wholesale & retail outlets

Compost Tea

Inputs:

- Custom-made compost
- Plant material from forest
- Molasses
- Kelp
- Fish hydrolysis
- Malt
- Full-fat soybean
- Guano

Ground Hog for soil aeration

Compost Tea applied to pastures

Management Systems

- P.A.M.
- MYOB
- GP Mapper
- My Scale Pro

- MAX Machinery Management
- MCMS (Mara Compost Management System)

Benefits

- Sustainable long-term future in farming
- Better bottom line
- Niche Marketing
- No nasty inputs
- Strong export and domestic demand

Intensive organic production systems and issues of sustainability

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Abstract

Sustainability, variously described as a 'journey rather than a destination' to a 'composite quality' defies exact definition. Differentiation of sustainability into component indicators is somewhat easier to grapple with; sustained productivity, economic viability and guaranteed product quality are a few of the obvious parameters that may be easily quantified.

Indeed, organic productions systems (OPS) are recognised as providing produce quantitatively free of agrochemicals, and with high nutritive value, but their impact (ideally positive) on landscapes, ecosystems and environmental quality, the substance of Environmental Management Systems, are less quantifiable. For better or worse, the expected environmental outcomes of OPS are wide-ranging, and possibly not achievable.

A recent survey of organic customers (Meldrum 2006) shows that > 75% believe OPS are better for the environment; and it is up to the scientific community to substantiate these beliefs and to develop guidelines to ensure that OPS are better for the environment.

With a focus on intensive horticulture in the tropics and subtropics, I consider the contributions to OPS and environmental sustainability of live mulching and organic amendments. Their primary roles as nutrient sources, as conditioners of soil physical quality, as determinants of cation exchange capacity, and as major contributors to the maintenance of soil organic matter are discussed, as too are interactions between these, and their relationships to the topical issues of sequestration of atmospheric carbon. I argue that well-defined criteria with respect to expectations for each of these roles must be adhered to in order to 'journey towards the composite quality of sustainability'.

Key Words

Relay cropping, cover cropping, composts, manures, starter solutions

Introduction/Problem

Sustainable agriculture and organic agriculture are both based upon the same premise that their impacts on the natural environment are either neutral or positive. Indeed, for many sustainable agriculture and organic agriculture are synonymous (Rigby and Caceres 2001), and according to a recent survey of organic customers (Meldrum 2006), > 75% believe that organic production systems are better (than conventional practices) for the environment.

While consumers may be guaranteed that organic produce is quantitatively free of agrochemicals, and that it is fresher (for herbs, fruits and vegetables) and more nutritious than produce from conventional practices (and the evidence for this increases over time e.g. see Poudel and Wildman, 2001 and Lumpkin, 2005), and that it is solely based upon organic inputs (as regulated by organic certification schemes), it is much more difficult to ensure that consumers of organic produce are indeed paying for meaningful maintenance or improvement in environmental quality. The preface to a very recent RIRDC publication speaks of "... promot[ing] the utilisation of organic farming systems as a means of enhancing the sustainability of Australian agricultural systems' (McKinna *et al.* 2006), and it is the generation and application of scientific knowledge, leading to an understanding of fundamental principles as has occurred in the past using the scientific method, that will allow credence to such claims.

Context

Within this presentation I shall be drawing upon a number of sources of information, largely my own and of my co-operators, focusing on intensive horticultural systems within the warm tropics. The content will analyse some of the issues relating to organic inputs and water management, to the exclusion of pest and disease management (which we cover in other recent publications e.g. Qureshi and Midmore 2006). The information provided is not necessarily specific to organic production systems. Recent calls for consideration of the ‘middle ground’, to foster the adoption of the most favourable of organic and conventional technologies that have minimal environmental impact (Elliot and Mumford 2001), may indeed be one way to go, but that debate will for sure last for a number of decades.

Pragmatic assessment should be favoured over ideological principles when proposing production practices for organic growers. What follows are some thoughts that are offered as potential lines of research to enhance the environmental sustainability of organic systems, and although some initial expectations could be predicted, any practice must be underpinned by good science leading to quantifiable improvements in environmental sustainability. There is always opportunity to improve upon the *status quo*. The topics discussed are grouped loosely under the titles of ‘organic inputs’ and less exhaustively ‘water’

Organic inputs

Organic sources of nutrients, whether from green manure crops or manures/compost, contain a significant amount of carbon (C), and arguments have been put forward to capture carbon credits for that rich source of carbon (see this volume), once it is ‘fixed’ in the soil. It is a well-documented fact that organic farming systems are conducive to aggregation of soil organic carbon (SOC), a good indicator of soil health if only for its positive benefit for soil water holding capacity. The subject is admirably reviewed by Hanlon (2006) showing the importance of soil organic matter (SOM) in terms of C storage, and for enhancing soil water holding capacity

Organic and conventional vegetable growers are well-known for their high use of manures and composts, with annual rates of organic inputs easily reaching up to 70 t/ha (Midmore and Jansen 2003). With a conservative 0.5% nitrogen (N), and anticipating that only 30% of the N is released in one year, over 100 kg N ha^{-1} will be released – and to that must be added the release of N from previous years’ applications, plus that of the much slower background mineralisation from soil organic matter. Superimposed upon this must be the realisation that up to 50% of N in manures rich in the NH_4 form may be released and made available for crop uptake (or volatilisation) immediately upon application.

Organic composts and manures vary widely in their C and N contents and in order to ensure that supply of N from compost matches demand, decay models specific to the compost or manure composition must be determined. Data for a long term composting trial at AVRDC (AVRDC 1993) with three crops per year using sugar cane compost at 50 t ha^{-1} $crop^{-1}$ with 50% water content and 9.5% N on a dry weight basis, show a doubling of SOC over 10 years (from 0.7 to 1.4%) and of soil N (from 0.08% to 0.16%). Three years after initial application of compost a balance was achieved between applied and released nitrogen (*c.* 300 kg N ha^{-1} $crop^{-1}$ applied as organic matter and 300 kg N ha^{-1} $crop^{-1}$ released as mineralised N). The 300 kg N ha^{-1} $crop^{-1}$ is released in a steady manner, with no regard for the temporal demands by vegetable crops. This opens the possibility for leaching and pollution of ground water. Indeed, intensive horticulture, whether organic or conventional, is often regarded as being that most polluting to ground water.

One of the major concerns for optimal crop growth, whether organic or conventional, is how to ensure that necessary nutrients are available at the right time, place and quantity to satisfy plant demand, without leading to excesses, perhaps toxicities and almost certainly leaching of the more mobile ions. Over the past three decades, for horticulture that depends upon inorganic, and, therefore, more readily available and quantifiable sources of nutrients, matching demand and supply according to quantification of mineral nutrients in the soil has been widely adopted. Although traditional practice has been to apply most fertiliser (often referred to as a ‘slug’) at sowing/transplanting, an easily combined practice by putting the fertilizer in an offset band and the rate depending upon estimates of yield to be achieved by the end of the season, more recently splitting fertilizer into basal and side dressing improves the efficiency of use. The Nmin practice – application of nitrogen based upon plant available nitrogen, the site, growth stage and demand –is an added improvement, as is the use of starter solutions (direct application of low quantity, high concentration nutrient solutions containing N, P and /or K to the root zone of young transplants) at the time of transplanting. The benefits of these practices in reducing overall nutrient input is shown in Tables 1 and 2, data generated while I was at the AVRDC in Taiwan. Note in Table 1 that similar yields were achieved over a five-crop sequence with less than one half of the mineral N application if application rate was based upon the difference between anticipated demand and the mineral nutrients in the soil (i.e. the Nmin procedure), rather than on a blanket institutional recommendation per crop.

Table 1. Nitrogen application and vegetable cumulative yields[a] in relation to two N-fertilizer treatments

N-fertilizer treatment	Total cumulative (ha^{-1})	
	N application (kg)	Yield (t)
Recommended	620	60.3
		not significant
N min	250	53.9

[a] Crop sequence: Chinese cabbage, Chilli, Carrot, Vegetable soybean, Chinese cabbage.

In Table 2, it is apparent that with a simple starter solution providing 7 kg N ha^{-1} a basal application of 40 kg N ha^{-1} could be obviated.

Table 2. Chinese cabbage head yield (t ha^{-1}) as affected by starter solution and basal N rate

		Head yield		
		Basal N application (kg/ha)		
		0	40	80
Starter solution	with	29.5	31.9	32.5
	without	22.3	30.6	28.8
SED (24 df) between means within a table			1.38	

Measures of mineral nutrients in soils can be quite accurate, cheap (using ion electrodes) and provide a sound basis for initial availability of nutrients for crop growth, but additions of organic manures requires knowledge of their component nutrients, and of mineralisation rates, as are those of native organic matter in the soil, in order to match demand with supply. A recent development from AVRDC (Ma *et al.* 2005) is that of a farm-based expert system for predicting the initial composition of composts necessary to achieve desired input levels to crops of known nutrient demands. Accessing data bases with 300 records of waste materials (e.g., agricultural wastes, food processing wastes), 70 methods of composting, 200 records of organic fertilizer, 1000 records of organic fertilizer, and a database of vegetable species’ major nutrient requirement, outputs, conditioned for soil texture and fertility, can guide growers as to recommendation for the quantity of organic fertilizers to be applied. This must form the basis for a more quantitative and environmentally benign use of organic manures and composts in horticulture. Nevertheless, the continuous supply of mineral N from soils with high OM content presents a problem to intensive horticulture, if NO_3 and NH_4 are not readily utilised by vegetable crops.

The critical periods are those when root to total soil volume is low and leaching and/or volatilisation of readily soluble nutrients occurs. In annual cropping in horticulture these periods correspond to the time of sowing/transplanting and just after harvest. Young plants established from seed or seedlings exploit a small root volume compared to that available, yet their specific demand for nutrients (i.e. mg/g dry weight of plant) is as great as that of plants whose root systems fully exploit all the root volume (to a specified depth) and based upon computations of plant population and soil volume. At the other end of the cropping season for annual vegetable crops, in contrast to annual crops that senesce before harvest (e.g. grain and root crops) and can run down most of the mineral nutrients in the soil, horticultural produce is harvested before physiological maturity, and plants therefore have to be supplied with substantial quantities of nutrient to continue to sustain their growth and development right to the point of harvest. Following harvest, supplies of available nutrients build up rapidly again through mineralization.

A number of practices may be implemented to overcome these potential leaching and volatilisation losses of nutrients:
1) transplanting into an existing cover or horticultural crop, thereby minimising the time that the soil is free of nutrient-absorbing roots,
2) harvesting and/or incorporating green manure crops prior to sowing/transplanting to immobilise (essentially to tie up in microorganisms) available and soluble nitrogen, followed by,
3) applying starter solutions to a soil to which organic manure has or is yet to receive organic manure,
4) sowing or transplanting another crop or ‘catch’ crop into the existing vegetable crop before its final harvest.

Diagrammatic representations of the effects of these practices on soil mineral N are presented in Figure 1, where the supply of N to the soil from mineralisation of SOM, and that from manure application to soil with no crop, are presented. In the diagram with a crop, as the root system develops following transplanting, the available soil N is taken up such that before harvest there is a synchrony between release and uptake. Once the crop is harvested, soil mineralization releases N to the soil, predisposing it to leaching.

Option 1, transplanting into an existing crop, is designed to ensure that there is only little mineralised N in the soil at transplanting time, for the relay/cover crop utilises that that is mineralised. Complementarity between crops for competition for light and water/nutrients is difficult to manage (but not impossible – see Midmore, 1993) and inter-specific competition, if not minimised, significantly reduces vegetable crop yields.

Option 2, inducing immobilisation of soil mineral N through incorporation of green manure with a high C:N ratio, is commonplace. Our data (Figure 2) show how this may be achieved. Experience has shown, (Kleinhenz *et al.* 1997; Thoennissen *et al.* 2000ab) that the incorporation of leguminous green manures and subsequent immobilisation/release of mineral N is dependent upon a series of factors, including:

Chemical components of green manure
Inherent soil fertility
Placement of the green manure (surface or incorporated)
Soil temperature, moisture and aeration.

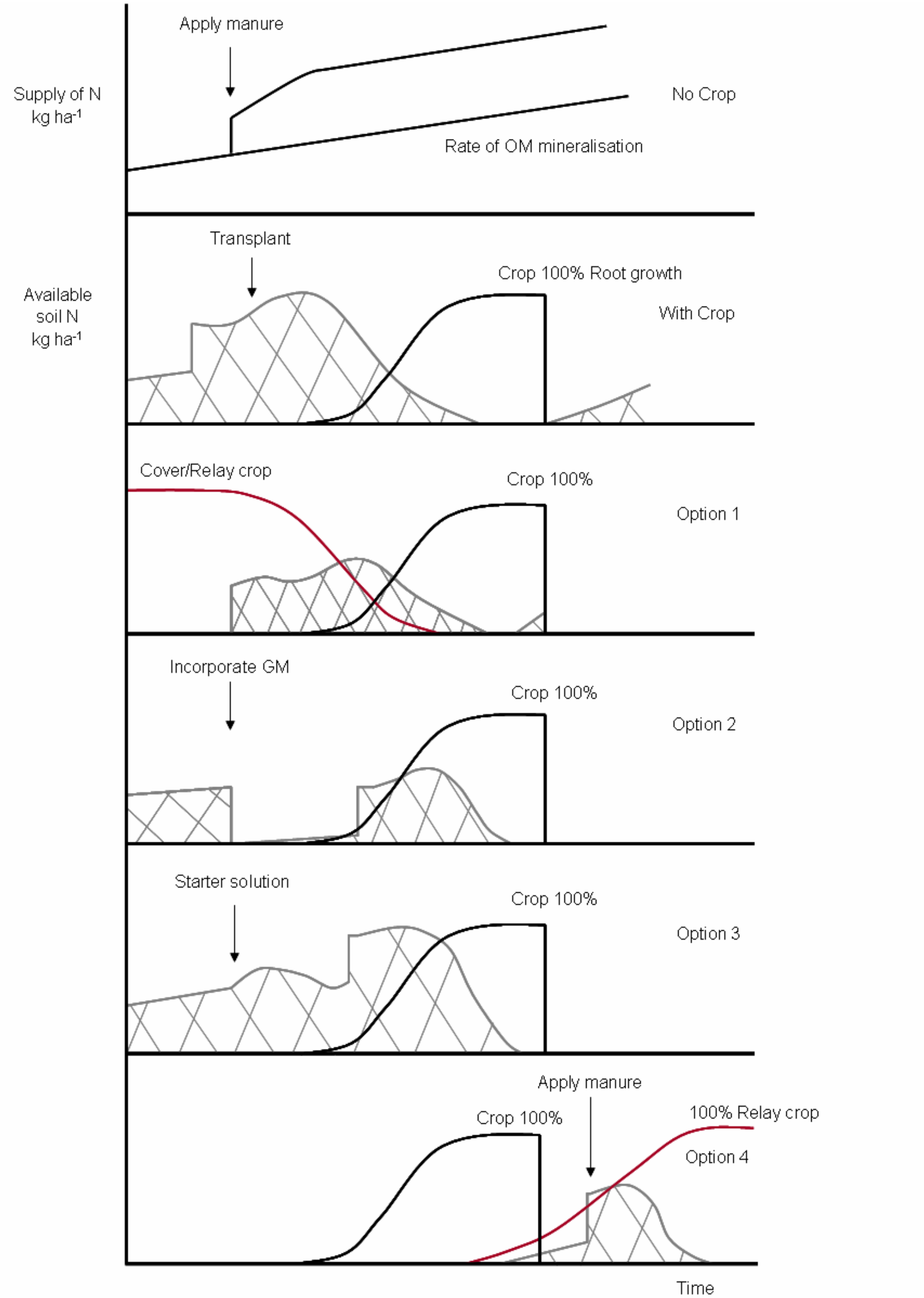

Figure 1. Supply of N in a non-crop situation, from mineralisation of SOM and from manure application, and available soil nitrogen in relation to supply and demand (root uptake) for four management options. Details of the options can be found in the text.

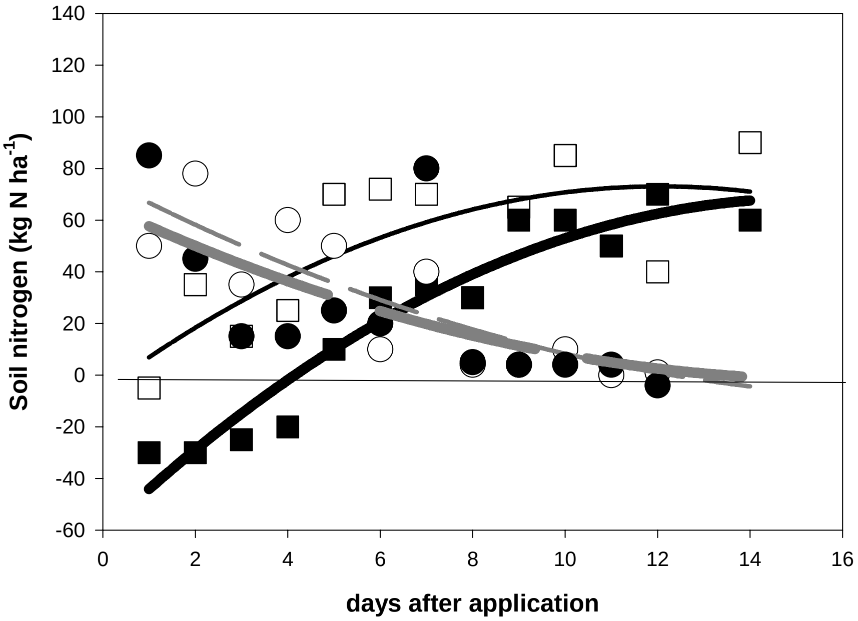

Figure 2. Influence of live mulch application (60 kg N ha-1 as siratro) in combination with mineral N-fertilizer (60 kg N ha-1) on soil mineralised N. Solid lines represent soil nitrate-N, dotted represent soil ammonium-N. Thin lines are without live mulch, thick lines are with live mulch. Modified from Kleinhenz et al. (1997).

Lower temperature and poorer soil aeration favoured immobilisation of NO_3. Contributions of leguminous green manures to soil N decline after 8 weeks, (by which time 30-70% of green manure was 'lost'), corresponding to the time of early fruit development in tomato, and even then only 9-15% of legume N was recovered by the tomato plant (Thoennison *et al.* 2000b). Of interest, there was no difference in tomato yields between incorporation and surface mulching with green manures, although the former decomposed faster. Incorporated leguminous green manures could, therefore, reduce soil nitrate at planting, yet result in peak release of nitrate, up to 120 kg ha^{-1} at any time from 2-8 weeks after application, depending upon location (Thoennissen *et al.* 2000b).

Maintenance of high soil temperature (20-30 ^{o}C) and near optimal soil moisture (-0.01 to -0.05 MPa) were responsible for fast release of nitrate following green manure application in tropical locations, yet Thoennissen *et al.* (2000b) concluded that a single application of green manure shortly before vegetable transplanting is considered less successful, from a yield and environmental perspective, than split applications of inorganic N.

Option 3, that of using starter solutions, is an option for organic growers for recent research at AVRDC (Palada *et al* 2005) has shown that organic starter solutions applied at transplanting to chilli plants with basal chicken or pig manure composts boosted early growth above that of plants with either compost alone, or granular inorganic fertiliser. When inorganic starter solution was applied at 7 kg ha^{-1} at transplanting and then again at 12, 25, 36 and 50 days after transplanting, to chilli receiving chicken manure compost, yields were increased by 25%. Using fermented fish waste and molasses a concentration of c. 2000 ppm of available N may be achieved (Ma, Pers. comm., 2006) but this may drop to c. 200 ppm within a few days. Starter solutions have their best effects on soils of lower fertility, possibly in those in which mineral N has been immobilised as in option 2 above, but the positive response to starter solution N in Table 2 was on a silty loam with 1.8% SOM.

Option 4 is directed at 'mopping up' the nitrogen that is released through mineralisation once a vegetable crop is harvested. By planting a relay crop into the existing vegetable crop, before the latter is harvested, the root system of the relay crop is established and can utilise nutrients not utilised by the vegetable crop after harvest. As for option 1, complementarity between demands for water, nutrients and light must be accommodated for successful implementation of this approach.

Water

Besides the well-established benefits of improved water holding capacity with high levels of SOM, some new developments in irrigated horticulture deserve mention for the organic industry.

With subsurface drip irrigation, with tapes buried within the soil, and with minimal tillage (another important tool in managing soil N mineralisation, but not discussed here), there is a likelihood of compaction around the tapes, resulting in reduced soil aeration and root growth. We have recently developed a system of what we refer to as oxygation: the aeration of the drip supply such that the irrigation water flow is aerated to *c.*12% by volume (Bhattarai *et al.* 2005). In this manner, yields of crops that are deprived of oxygen, notably flooded crops but also those receiving 'normal' supply of irrigation water, gain access to additional quantities of soil air and oxygen that result in remarkable increases in yield. It is quite logical that even in crops that are grown on quite porous soils, as drip emitters push water out into the root zone, the water purges the soil pores of air, even if only for a short period, and it is the supply of air in the irrigation stream with oxygation that relieves the roots of the otherwise anoxic conditions. Horticultural examples are given in Bhattarai *et al.* (2006).

Some final points

Quite evidently the practice of managing soil nutrients, and herein we only refer to soil N, is a complex issue, and one that requires detailed research if we are to ensure that organic vegetable production is to be labelled as sustainable. Some simple practices, that will require trial and error in their implementation, may be of use to growers who wish to enhance their nutrient use efficiency. If successful, they may well improve the economic viability of growers' enterprises. To these we add the option of oxygation.

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Establishing perennial pastures in dry-land organic farming systems: developing resilience for climate variability

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Abstract

Climate variability is one of many factors influencing the potential of dry-land pastoral production systems in south-eastern Australia. There is general agreement amongst scientists that Australia's climate has changed since the beginning of the 20th century. In the 1970s it was thought that the global climate was becoming cooler with failures in the Indian monsoon, crop failures in Russia and droughts in Africa. In 2006 it is now recognised that temperature has increased by about 0.8°C over the last century. In Australia, there have been changes in regional rainfall patterns suggesting a more variable climate for many of the agricultural production zones. So how can primary producers weather the increased risks from a variable climate and changing rainfall patterns? Making use of rainfall where and when it falls is the best insurance against climate variability. Incorporating combinations of perennial pasture species that have active growing periods in either summer or winter provides the opportunity to capture rainfall and grow productive pastures for livestock feed, ensure groundcover, compete against weed species and address water imbalance. Establishing perennial pastures in dry-land farming systems has been traditionally reliant on herbicides for effective annual weed management. This paper reports recent results from a project that is investigating the status of perennial pastures on organic farms and their establishment within the limits of an organic farming system.

Key Words

Organic farming, climate variability, perennial pastures, establishment

Introduction

Climate variability has long been a factor affecting agricultural production in Australia. Australia is known for its erratic rainfall events that often culminate in disastrous floods, or extended periods of little or no rain resulting in drought (CSIRO, 1960). In the 1970s it was thought that the global climate was becoming cooler with failures in the Indian monsoon, crop failures in Russia and droughts in Africa (Australian Academy of Science, 1976). In the past two decades however, scientists have formed general agreement that Australia's climate is changing such that an increased level of variability now exists, due to global warming.

Increased climate variability can result in a range of different impacts that may affect agricultural production. Generally, a reduction in average annual rainfall and an increase in mean annual temperature and atmospheric CO_2 concentrations are predicted over much of Australia. There is also agreement that an increased frequency of extreme weather events, such as floods and droughts, will occur. This may affect pasture, crop and animal production, but also have an effect on the distribution and survival of weeds and pests, which also affect agricultural production. For existing issues such as salinity and soil erosion, increased climate variability may result in significant changes to water tables with the potential to exacerbate salinisation, and extreme weather events may result in more dramatic soil loss through erosion from floods and droughts (www.greenhouse.gov.au/agriculture/impacts).

What do these broader changes in climate mean for the producer in the south-eastern dry-land pastoral zone? There may be increased pasture growth from higher CO_2 levels in the atmosphere but this is likely to be offset by decreased rainfall and higher temperatures. Increased rainfall variability generally results in a reduced livestock carrying capacity from less overall pasture growth and reductions in forage quality. There may be increased risk of salinisation in some areas, and increased problems with weeds, pests and diseases as they adapt to new areas and local conditions.

What can producers do to manage the effects of increased climate variability on their farms? Mixed enterprise farms producing both crops and pastures for livestock are dependent on pasture systems for livestock feed, but also nitrogen from legumes in pastures for crop growth. Ensuring that pasture systems are perennial with both winter and summer active grass and legume species, provides the best insurance for climate variability, as it is these pastures that can make the best use of rainfall where and when it falls.

Broadacre farming systems require perennial species in order to be environmentally and economically sustainable. Perennial pasture species, such as lucerne and phalaris, have the potential to address the water imbalance in current agricultural systems. Their deep roots are able to extract water to depths of 3-4 metres and dry the soil profile during spring, summer and autumn (Angus *et al.*, 2001, Ridley *et al.*, 2003). This slows down the movement of rainfall through the profile thereby reducing the risk of leakage to ground water and the possible onset of salinity. Perennial species can also be effective in reducing nitrate leaching that contributes to soil acidification (Ridley *et al.*, 1990). Once established, perennial pastures are competitive and with appropriate management, can reduce annual species invasion thereby assisting in chemical-free weed management.

A research project jointly funded by the Victorian Department of Primary Industries (DPI) and the Rural Industries Research and Development Corporation (RIRDC) commenced in 2004 to investigate the status of perennial pastures on certified organic farms and to investigate methods of establishing perennial pastures within an organic farming system. Establishment of perennial pastures is heavily reliant on the use of herbicides to manage annual plant species but there is insufficient information available on how perennial plants can be established in systems where herbicides are not used. This paper reports preliminary survey information on the status of perennial pastures on certified organic farms in south-east Australia and data from an experiment located at DPI Rutherglen in north-east Victoria investigating establishment methods for different perennial mixes.

Materials and methods

Survey of perennial pastures on organic farms

A survey of certified organic producers was undertaken during 2005 and early 2006 to determine the status of perennial pastures on farm. Producers were identified from organic certification agency websites and selected based on their main enterprises of livestock and/or grain production. The methodology used to select the sub-sample of producers to be surveyed consisted of disproportionate allocation of six sub populations. The sub populations consisted of producers from Victoria, New South Wales and South Australia, and from two certification agencies, Australian Certified Organic (ACO) or National Association for Sustainable Agriculture Australia (NASAA). The total population of producers was 291 and the sample surveyed was 166 allocated as shown in Table 1. Producers were interviewed by telephone and the average response rate was 77%. Information sought included an estimation of the percentage of pasture area under perennial species, whether producers had tried to establish perennial pastures in the last five years, what they thought were the major barriers to perennial pasture establishment in organic systems and whether they had observed native perennial grass species on their farms.

Field experiment

The field experiment was established at Rutherglen in north-east Victoria during 2005 and consisted of a factorial design of three establishment methods (row sown, broadcast or undersown) and two sowing rates (conventional or double [organic]). Three perennial mixes were investigated including a control mix of phalaris (Phalaris acquatica cv. Sirosa) and subterranean clover (Trifolium subterranean cvs. Goulburn and Riverina), an all year feed mix of fescue (Festuca arundinacea cv. Flecha Max P) and lucerne (Medicago sativa cv. Genesis), and a novel mix of lucerne and plantain (Plantago lanceolata cv. Tonic). Sowing rates of the pasture species were: phalaris 3 and 6 kg/ha, lucerne 7 and 14 kg/ha, plantain 3 and 6 kg/ha, and fescue 10 and 20 kg/ha. Oats were sown at 30 kg/ha in the undersown treatments. The perennial species were sown in June 2005 and measured for plant emergence, spring dry matter production and autumn plant density (2006).

Table 1. Number of organic producers by state and agency and the relevant sample size in brackets.

State	BFA	NASAA	Total
NSW	141 (57)	22 (18)	163 (75)
SA	16 (13)	25 (20)	41 (33)
VIC	25 (20)	62 (38)	87 (58)
Total	182 (90)	109 (76)	291 (166)

Results

Survey of perennial pastures on organic farms

An average response rate of 77% was achieved with NSW having 68%, SA having 79% and Victoria having 83% response rates. Producers were asked to estimate the proportion of their farm under pasture in 2005, and to provide an indication of the perennial component of that pasture. In NSW, approximately 50% of the pasture area on surveyed organic farms comprised perennial species whereas in SA and Victoria, there was slightly less under perennial species, at 47% and 45% respectively. An average of 42% of producers surveyed indicated that they had attempted to establish a perennial pasture within the last 5 years (Table 2).

Table 2. Preliminary survey results on the status of perennial pastures on certified organic farms in south-east Australia

State	No. of producers surveyed (%)	% perennial pasture of total pasture area	No. of producers sowing perennial pasture in last 5 years (%)
NSW	51 (68)	50	20 (39)
SA	26 (79)	47	12 (46)
VIC	48 (83)	45	19 (40)

Producers were also asked what they thought were the major barriers to perennial pasture establishment within an organic system. Overwhelmingly, the majority of producers cited available moisture at the right time to be the most limiting factor. This was followed by the management of weeds and pests during the establishment period. Preliminary observations from the data indicate that producers were willing to establish perennial pastures, even if they had experienced an establishment failure in the past. There was a high level of awareness amongst producers of native perennial grass species and the majority of producers had observed native grass species on their farms.

Field experiment

Sowing phalaris, lucerne and plantain in rows resulted in greater emergence than sowing it under an oat crop or broadcasting the seed on the soil surface (Table 3). There was no difference in sowing method with fescue establishment. As expected, increasing the sowing rate resulted in higher plant densities at emergence (Table 3).

Dry matter (DM) production of each perennial pasture mix was assessed during spring of the establishment year (2005). Broadcasting phalaris and subterranean clover resulted in higher DM production than either row sown or undersown (Table 4). There was no difference in sowing method in DM production with the lucerne/plantain mix whilst row sown was significantly better in DM production with the fescue/lucerne mix (Table 4). Only with the phalaris/subterranean clover mix was there an effect of sowing rate on DM production with the organic rate exceeding the conventional rate as expected (Table 4).

Table 3. Emergence (plants/m^2) of perennial species sown in June 2005

Perennial mixes/ treatment	Phalaris	Lucerne	Plantain	Lucerne	Fescue
Row sown	160	315	181	258	338
Broadcast	103	185	159	176	256
Undersown	90	183	146	204	305
l.s.d. (P=0.05)	49	41	14	49	ns
Conventional	88	169	117	176	193
Organic	147	287	207	245	406
l.s.d. (P=0.05)	40	33	12	40	92

Table 4. Dry matter production (kg/ha) of perennial species measured in October 2005

Perennial mixes/ treatment	Phalaris Subterranean clover	Lucerne Plantain	Lucerne Fescue
Row sown	4470	2974	5000
Broadcast	7026	3968	2972
Undersown	3195	3439	2045
l.s.d. (P=0.05)	2444	3903	2528
Conventional	3504	3152	2595
Organic	6290	3768	4083
l.s.d. (P=0.05)	1996	3186	2064

Pastures were assessed 12 months after establishment for plant density as this is a more accurate measurement of pasture persistence over the longer term. Plant densities, irrespective of the pasture mix, had declined significantly one year after establishment. The row sown treatment in the phalaris mix was still superior to the other treatments whilst there was no difference between sowing methods after one year with the lucerne/plantain mix (Table 5). In the lucerne/fescue mix, the row sown treatment had a lower lucerne plant density than either broadcast or undersown, whilst the fescue in this mix was higher when sown in rows than broadcast (Table 5). There was no difference in plant density after one year with different sowing rates in any of the mixes (Table 5).

Table 5. Perennial plant density (plants/m^2) 12 months after establishment

Perennial mixes/ treatment	Phalaris	Lucerne	Plantain	Lucerne	Fescue
Row sown	56.9	7.6	58.6	24.8	97.0
Broadcast	31.4	6.6	57.1	42.0	73.9
Undersown	28.4	7.3	61.2	43.5	83.4
l.s.d. (P=0.05)	17.0	6.7	14.6	15.9	22.8
Conventional	33.5	8.7	54.2	38.1	76.5
Organic	44.2	5.7	63.8	35.4	93.0
l.s.d. (P=0.05)	13.9	5.4	11.9	13.0	18.6

Discussion

The preliminary survey information indicates that perennial pastures are present on organic farms and generally constitute about half of the area under pasture. This means that those producers can take advantage of variable rainfall events with pasture species that can make better use of rainfall throughout the year than annual species. The preliminary data does not indicate the condition of those pastures and further survey analysis will demonstrate knowledge of grazing management of perennial pastures amongst producers. The survey information has also shown that organic producers are aware of the presence of native grass species on their farms. This is a very positive result as these species are highly adapted to the variable Australian climate and are not expected to be as seriously affected by climate change as many introduced species. As pasture species for livestock production, native perennial grass species can play an important role in providing feed at critical times of the year, but also as groundcover on non-arable areas and as habitat. The survey results will be fully published by the end of 2006.

The results from the establishment experiment provide some evidence that it is feasible to establish perennial pastures without the use of herbicides, providing there is adequate prior weed management. The experimental plots were established into cultivated soil that had received some prior weed management to prevent annual grass seed production. Perennial plant densities achieved in the experiment after one year are comparable with conventional systems in north east Victoria however, maintaining these densities is dependent on appropriate grazing management and rest periods for pasture recovery. The treatments were sown into soil that had a high background weed density, with 1,910 plants/m^2 of loosestrife (*Lythrum hyssopifolia*), 28,323 plants/m^2 of silver grass (*Vulpia* ssp.) and 212 plants/m^2 of chickweed (*Stellaria media*). Not all these seeds would have germinated at the same time as the perennial species but the numbers provide an indication of the potential competition that may affect a successful establishment. The experiment is being repeated in 2006 to confirm the trends demonstrated in 2005.

The project information reported in this paper is providing field based information for primary producers to assist in their decision making for increasing the perennial component of their pasture systems. Perennial pastures are essential for long term sustainability of dryland farming systems in south east Australia and are critically important in this era of increasing climate variability.

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Feeding above the line: strategic feeding to reduce inputs and increase efficiency of grazing ruminants

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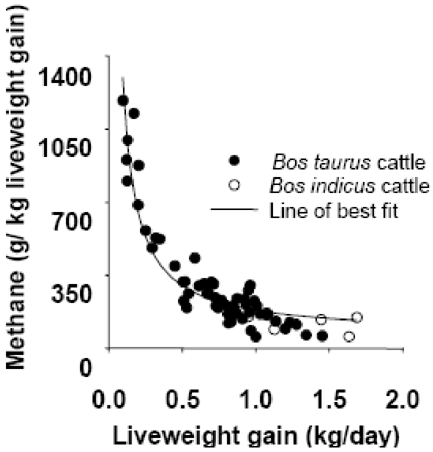
A suggested means of reducing emissions per unit of product is to increase livestock performance. When plotted against productivity, methane emissions per unit of product has a curvilinear relationship.



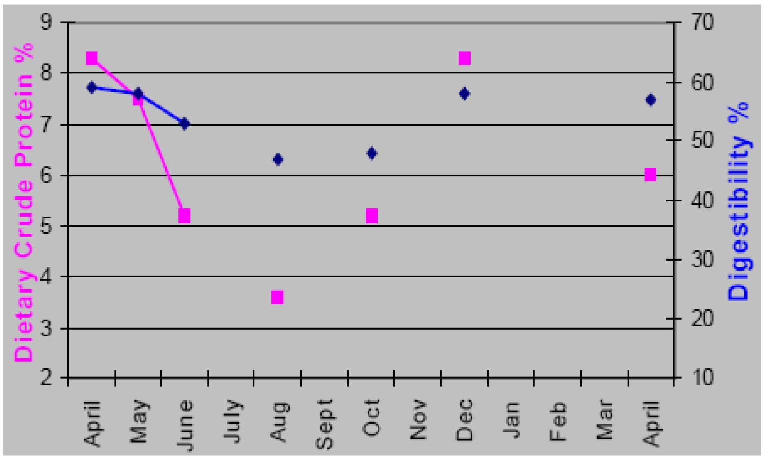
This relationship is due to the existence of a maintenance requirement for food intake. Hence strategic supplementation will ultimately reduce the amount of greenhouse gas emissions produced per kg of LWG.

As graziers, our cheapest feed source is our pasture; hence the key to minimising cost of production is through maximising pasture growth and utilisation. This is achieved primarily through grazing management and strategic supplementation. By maximising pasture utilisation, we minimise the amount and cost of additional feed required. This is where most graziers can make substantial improvements in profitability. In order to do this we need to move away from a heavy reliance on grain feeding through the "free range feedlot", the approach currently adopted by the majority of organic beef producers.

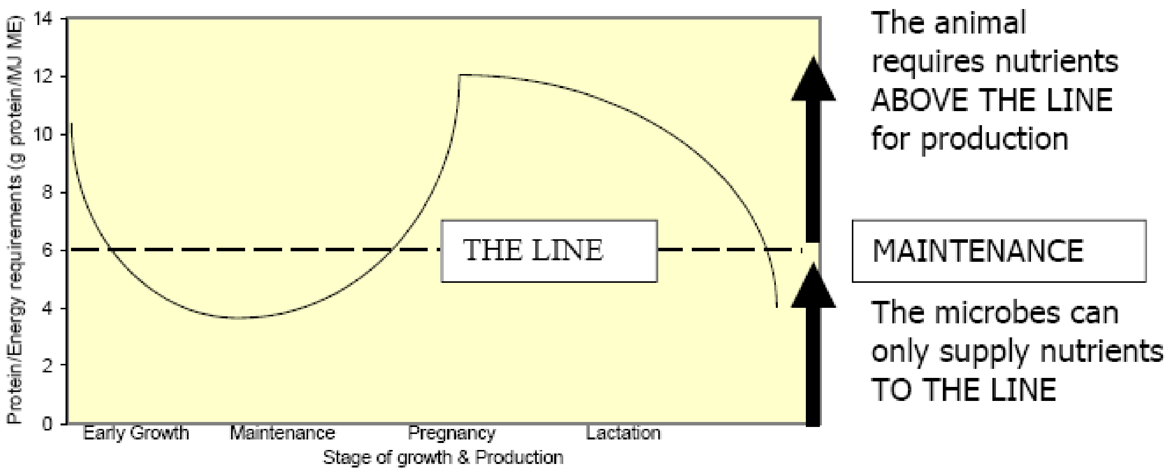
To understand what should be fed in the paddock, we need to understand what is actually limiting production. NIRS dung sampling is a practical tool that allows us to monitor changes in digestibility and crude protein.

Digestibility is directly related to energy. The more digestible a feed is, the more nutrients a beast can extract from it, hence the more energy it obtains. A decline in crude protein means less protein for the animal, but also results in a decline in the number of rumen microbes present. This decline in microbes leads to reduced feed intake and hence lower energy intake. To lift the number of microbes, a rumen degradable protein (RDP) is required.

This has a two-fold effect in that it increases protein to the animal, but also results in higher feed intakes, which is crucial as digestibility declines. RDP sources include lupins, whole cottonseed and grain by products (i.e. millrun, bran, hominy, pollard).



The level of production achieved is directly related to the level of metabolisable energy (ME) intake and the efficiency of utilisation. The animal requires different levels of ME and protein at the various stages of physiological growth.



By feeding a rumen degradable protein source we are feeding the microbes. These supplements 'Feed to the Line'©.

The LINE is:
* The maximum amount of nitrogen the microbes can use;
* The maximum amount of protein the microbes can produce and supply to the animal; and
* The breakpoint between maintenance and production.

Ruminants therefore require additional nutrients such as bypass protein to allow them to produce 'Above the Line'©, (i.e. to produce meat, fibre, milk and for reproduction). Once the microbes are working as hard as they can a rumen by-pass protein (BPP) should then be fed. BPP sources include meals (i.e. copra meal, cottonseed meal, palm kernel extract, soybean meal). Most of the protein in these feeds is not digested by the rumen microbes and is therefore absorbed directly by the animal.

This is the correct approach to paddock supplementation. Feeding amounts of grain greater than 0.4% of liveweight will result in decreased pasture intake due to a shift in the rumen microbes from cellulose digesters to starch digesters. Once this occurs, animals are no longer equipped to efficiently digest pasture and become more and more reliant on grain, in effect substituting available pasture with grain. This in turn increases farm inputs – the scenario we, as organic graziers, seek to avoid.

Pasture cropping: a land management technique

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Abstract

Pasture cropping is a technique of sowing crops into living perennial (usually native) pastures and having these crops grow symbiotically with the existing pastures.

This idea was initiated over 14 years ago and since that time Colin Seis has spent much of his time perfecting this technique. It is now possible to grow many different types of winter and summer growing crops without destroying the perennial pasture base.

It may appear that pasture cropping is simply a cropping technique. It is much more than that. Pasture cropping is the combining of cropping and grazing into one land management system where each one benefits the other. The potential for profit and environmental health in being able to do this are enormous and a lot of landholders in many regions of Australia are showing this to be the case.

Introduction

The original concept of sowing crops into a dormant stand of summer growing (C4) native grass, like red grass (*Bothriochloa macra*) was thought to be a very inexpensive method of sowing oats for stock feed. This certainly turned out to be true; we quickly learnt that there were many side benefits and that we were only touching the surface of a land management technique that is proving to be revolutionary. The grazing crops performed so well (Figure 1) that it was obvious that we could expect to harvest good grain yields as well.

Figure 1. Successful example of pasture cropping showing red grass growing amongst oats.

The year 2003 saw more advances with the technique where cereal crops in NSW, South Australia and Victoria were sown a into winter growing (C3) native perennial grass with good results such as oat crops yielding over 3 tonne/ha. Additionally, there have been good results in Victoria and NSW, sowing summer forage crops into winter dominant native perennial pastures.

It was also learnt that sowing a crop in this manner stimulated perennial grass seedlings to grow in numbers and bulk. This produces more stock feed after the crop is harvested and totally eliminates the need to re-sow pastures. Conventional cropping methods require that all vegetation is killed prior to sowing the crop and while the crop is growing.

Pasture cropping in practice

From a farm economic point of view the potential for good profit is excellent because the cost of growing crops in this manner is a fraction of conventional cropping. The added benefit in a mixed farm situation is that up to six months extra grazing is achieved with this method compared with the loss of grazing due to ground preparation and weed control required in traditional cropping methods (Figure 2Figure).

Figure 2. Harvesting oats at Winona, Gulgong. Note perennial grass growing between crop rows.

To illustrate this, below (Table 1) are the details of a 20 ha crop of Echidna oats that was sown and harvested in 2003 on Colin Seis' property Winona. Although this crop's yield was 4.3 tonne/ha (31 bags/acre) the total area of 100 ha of echidna oats averaged 3.4 tonne/ha (25 bags/acre). This profit does not include the value of the extra grazing. On Winona it is between $50 - $60/ha because the pasture is grazed up to the point of sowing. When using traditional cropping practices where ground preparation and weed control methods are utilised for periods of up to four to six months before the crop is sown then no quality grazing can be achieved.

Table 1. Partial budget for Echidna oats sown and harvested on Winona in 2003.

Costs	**$/ha**	**Income**	
Spraying	5.00	Yield	4.3 tonne/ha
Herbicide	14.00	Value	$150/tonne
Sowing	7.19	**Total income**	**$645/ha**
Fertilizer	35.00		
Harvest	28.00		
Total costs	**89.19**		
		Profit	**$555.81/ha**

Other benefits are more difficult to quantify. These are the vast improvement in perennial plant numbers and diversity of the pasture following the crop. This means that there is no need to re-sow pastures, which can cost between $100 - $150 per hectare. Even more difficult to calculate are the environmental benefits of leaving a grassland intact by maintaining 100 % ground cover 100% of the time.

Conclusions

There is growing evidence, anecdotal and scientific, to support improvement in soil health, improved water use efficiency and general improvement in ecosystem function.

History has shown us that many new or different techniques are scoffed at when an idea is first presented. Pasture cropping was no different, with criticism coming from many fields, and in particular, from traditional agronomy experts. Many farmers and graziers from all over Australia have adopted pasture cropping with serious interest being expressed in the USA.

Independent studies at Winona on pasture cropping by department of land and water have found that pasture cropping is 27% more profitable than conventional agriculture this is coupled with great environment benefits that will improve the soil and regenerate our landscapes.

The CSIRO have also taken pasture cropping seriously investing in a three-year trial project that was conducted by Dr Sarah Bruce on Winona. The project looked at the many things that pasture cropping can achieve. Water use efficiency and improved soil health are just two positive outcomes.

Until this point in time pasture cropping has been practiced with the use of chemicals to control weeds and conventional fertilizers are used to manage soil chemistry, but some crops are being now sown without these inputs. The pasture cropping technique can be used to grow organic crops. This can be done without using a plough or destroying existing perennial pasture.

The benefits of pasture cropping are enormous, way beyond the short-term crop yields. They contribute to the development of vitally needed topsoil, water management, stabilising the many forms of soil erosion, controlling weeds as well as many other benefits. It gives farmers and graziers a tool to effectively manage their properties whilst individually contributing to a healthier environment.

Note

Because of a ground swell of interest in pasture cropping, Colin Seis has been helping landholders in many parts of Australia advising them with workshops and private consultancy on the best methods to use for their particular area, rainfall and pasture type. This consultancy-type advice can also be extended to any interested party.

Is agricultural education heading in the right direction and what direction might that be?

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Abstract

The focus of the paper is the new degree in ecological agriculture at Charles Sturt University, Orange where students are able to study organic agriculture & horticulture, permaculture, and biodynamics. The course offer more than this though and represents an approach to developing a mindset in its graduates that is more holistic than reductionist, that involves self-knowledge as a pathway to self-development, and introduces students to the role of critical thinking and intuitive ways of knowing in management. Importantly, the course challenges students to think systemically and to understand the consequences of action/inaction. The paper challenges the capacity of university courses in agricultural education to meet the future needs of Australian agriculture where ever the curriculum remains 100% science focused.

Introduction

The title of this talk poses an interesting dilemma and it is one that I shall address in the next 20 minutes. But first let me play my role as an educator and start with a quiz. Keep the answers in your head and I'll correct them at the end of my talk:

Q1: Where does the sky begin!
Q2: How many times is the sun bigger than the earth!
Q3: Are humans the only species to reflect deeply.

In this session I will be outlining the degree in ecological agriculture which is offered through CSU Orange campus. This degree was first offered in 2001 and produced its first graduates last year. But before I do that I would like to address the issue of climate change and weave that into an explanation of our educational program.

My starting point is Tuesday 16 May 2006 and the front page of the SMH. The page comprised the bold headline *A Disaster Waiting to Happen*. At first glance I thought they were highlighting, at last, the dangers associated with climate change. They weren't. The Herald felt the Beaconsfield mine disaster deserved that heading. The next heading on the front page was about half the size of the former and stated *CO_2 Consuming the Planet*. At long last that fact had reached the front page of the Herald. It didn't rate as a disaster waiting to happen – not yet – and hopefully it won't, however, trends suggest otherwise. I read recently that in 1999 a heading such as this would be most unlikely to get coverage in the paper let along on front page so you could say we have made some progress.

The interesting point is this: Why wasn't the Disaster Waiting to Happen Headline used on the CO_2 consuming the planet story? Why is it that despite out knowledge of what causes climate change that we seem incapable of making decisions to ensure that there is a reduction in CO_2 output or worse still why is that it is business as usual at the political level despite dire warning of a grim future if we don't make some big decisions soon? I would like to address this "head in the sand" response to this issue by addressing the need to change our approach to education and the way we educate people to think and relate.

Professor Peter Senge is well known in the academic world for his writings on organizational change. In his latest book *Presence: Exploring profound change in People, Organisations and Society*. Senge and co-authors make a number of salient points about life in the 21st century. I list four arguments from his book that seem to resonate with me:

1. That people tend to shift the burden: what he means by this is that people look for symptomatic fixes for problems rather than fundamental ones. You have a headache so you take a tablet rather than looking for the cause. You have lower wheat yields so you pile on the fertilizer. You have a concern about CO2 emissions so you build a nuclear power station.

2. Secondly people think in fragments not wholes. Senge quotes physicist David Bohm who maintained that science fragments creating false divisions where there are actually tight connections. The capacity for reductionist thinking is fundamental to modern day science, and the capacity to create reductionist thinking is the hallmark of a 21 Century university. The danger of this type of thinking, of course, is that there is an absence of capacity to seeing decisions in the context of the whole and how other entities may be affected by that decision.

3. The third point is somewhat related to this and that is the over reliance on measurement which dooms modern society to continue to see things rather than relationships. This is an important issue that I would like to return to latter.

4. The fourth point concerns the growing gap between technological power and wisdom partly because we have found our solutions in technology. Senge believes that with increasing complexity of life we need greater wisdom to manage it. He says we have two pathways: to reduce our reliance on technology or to enhance human wisdom. The pathway Senge is urging is the latter – that is, greater wisdom through **a more integral approach to science**.

Senge's ideas as stated in his 2005 book resonated with me since they formed much of the backdrop to our decision to introduce an undergraduate degree in ecological agriculture back in 2001. At that time a group of five academics from the Orange campus of the then Faculty of Rural Management, The University of Sydney met to reflect on the absence of a course in Australia on ecological agriculture at the tertiary level of education. It was our observation that Australia was well supplied with traditional technical science based approaches to agricultural education but lacked any centre for educating in a more ecological way. We felt our students didn't understand themselves well, had low self esteem, saw the bits but not the whole, looked at things in monetary terms as though there was no alternative, and lacked any sense of empathy or connection with a wider world.

In arriving at what needed to change, and how, we drew on several models, and I would like to quickly mention these since they help to explain our decisions.

In terms of building a stronger element of social ecology into the course we took comfort from Ken Wilber's model of reality which highlighted that human beings for the past couple of hundred years have been engaged in studying the external objective world (Figure 1). What was missing from this approach he maintained was a focus on the subjective world of an individual and how they think about themselves and how they view reality. There was also an absence of any appreciation of how individuals work together in what he refers to as intersubjective.

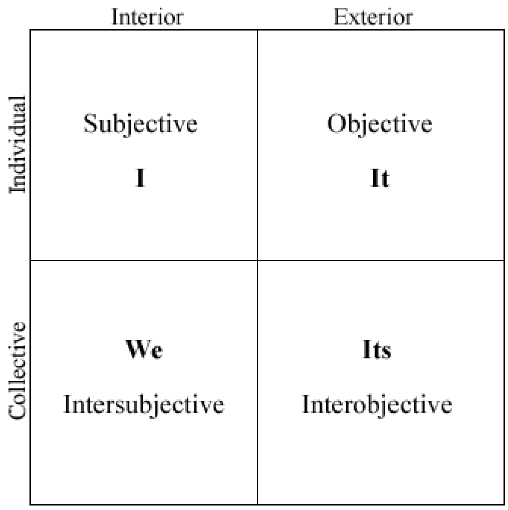

Figure 1. Wilber's validity model (modified). (Wilber, 1996)

Wilber labelled this as the **It, Its** world for the objective frames and **I** and **We** for the subjective frames as outlined in Figure 1. What Wilber has portrayed is what we new – that if you study agriculture at virtually any Australian university the focus is virtually 100 % on the **It** and **Its** quadrants, that is, about the external world. At Orange we wanted our students to study that area but in addition to understand themselves and other people as well.

Our next challenge was to introduce processes which might balance the overriding emphasis placed on segmented or atomistic thinking. Students have been trained to break things down into their constituent parts but have great difficulty in connecting the part to the whole. What we were training them to do was the very antitheses of what prevails in nature according to holistic educator, John Miller (O'Sullivan, 1999). Miller said and I quote:

"Holistic education attempts to bring education into alignment with the fundamental realities of nature. Nature at its core is interrelated and dynamic. We can see this dynamism and connectedness in the atom, organic systems, the biosphere, and the universe itself. Unfortunately, the human world since the Industrial Revolution has stressed compartmentalization and standardization. The result has been the fragmentation of life."

In other words there is an important ingredient in life that cannot be captured through reductionism or through the normal traditional processes of education. Traditional science based education follows a reductionist tradition where subjects are taught in separate entities and where a graduate's thinking skills are, therefore, tram lined into analysing life from this reductionist perspective. What we sought in the design of the curriculum in ecological agriculture was a graduate who could think both analytically and holistically and who knew the distinction between the two. Part of our limitation was having to work within the confines of an existing undergraduate degree program in farm management with which ecological agriculture shares a number of subjects. Despite this limitation we have put in place certain techniques to make the program address the issue of holism. I'll refer to these shortly.

Our next challenge was to introduce the notion that our capacity to see the world is a function of our consciousness. Some people are highly sensitive to nature and see and feel things that others don't. This capacity to see the world in a particular way is a function of many influences but I would put imagination and empathy skills as top of the list. Our discussions around this issue were influenced by the writings of United States philosopher Gregory Bateson and his categories of learning. In brief Bateson discerned four types of learning. I won't go into these levels other than to say that level 1 is about no learning, learning 2 is concerned about operational learning particularly in relation to the objective world, Learning 3 is about learning about self, and learning 4 is concerned with seeing the connections in a more unified and holistic way. What we needed to do was to give our students experience at all levels of Bateson's hierarchy and not have them stuck in the default mode that applies at all other Australian Universities and that happens to be Level 2 – learning about the external world. To be an ecological operator, to be ecologically literate, we needed our students to know about the world around them and how to manage it financially, socially, and environmentally, but also to know about themselves and what makes them tick. But more than this we wanted an ecological agriculturalist to have a sense of connection with the wider world in ways that can only be accessed through the functions of imagination and empathy and which might draw on the skills of art, drawing, poetry or music. An ecological agriculturist in my language must be able to talk many languages and not just one. Dexter Dunphy Australia’s foremost academic on change management, put it nicely at last years graduation ceremony at Orange. He said: “*Inner consciousness and outer reality are intimately related and co-create each other. To transform the world about us we must also transform our inner consciousness. The most important change agenda is internal and intensely personal.*

This was music to my ears because it debunks the paradigm of classical science as influenced by the Newtonian Cartesian concepts of reality. These concepts have led to enormous technical advances in standard of living and of our understanding of reality but it is a science that believes that there is no such thing as consciousness. It represents a highly rational linear view of the world; a world that remains distant from humanity and to be used by it. However if we are to educate students into a new paradigm of thinking, what is that paradigm and how might it work in reality?

The new world of education concerns balancing the opposites that prevail in a traditional system of learning. If traditional is learning about the world out there then ecological is about learning about that plus the world in here, that is, the inner self...so subjects such as *Managing Self & Others* or *Managing Change* are important. If traditional is learning about science and things, ecological is about science and relationships and by relationship I mean the relationship of one self or humanity as a whole to the rest of living or non-living forms. In this context the subject *Human Ecology* is important. In that subject students study cosmology, they study ecophilosphy and ecopsychology, and they seek to explore what I call a second person relationship with the environment through some form of artistic expression. If traditional education is about breaking things to down into their constituent parts to interpret them then ecological is about this and more. We seek that our students explore the notion of holism that is best expressed by the poet/scientist Wolfgang Goethe. In effect we ask that our students see reductionist thinking as a servant of holistic thought. Only then do we know we have developed a way of thinking that is both broad in its coverage of the total system but focused in its capacity to analyse what is happening. If traditional education is about bringing the student into the classroom and asking them to pass assessment items in order to qualify them as a worthy graduate the approach in ecological agriculture is this and more. We ask our internal students at least to keep a portfolio of evidence of their development in relation to the seven graduate attributes we expect in our graduates. Students collect evidence from all subjects studied and all experiences experienced and these are written up and ultimately presented to an industry representative in the final month of their studies. The 30 minute student evaluation is a pass or fail exercise. To graduate they must convince industry that they have the qualities expected of a graduate.

I believe agriculture needs to change. We need to produce graduates who are more rounded in their thinking who know about their sense of place in evolutionary and geographical terms. We need graduates who see themselves as just one cog in the wheel of life rather than THE cog. There is a need for a level of humility in humankind as well as a capacity to think broadly and sensitively about issues. There is a need, as Peter Senge’s suggest, to introduce a fresh new wisdom to the way we manage technology and also to being honest in our preparedness to identify the fundamental problems rather than play with symptoms. We cannot afford to ‘fiddle as Rome burns’ as the saying goes and as one looks at the figures and predictions surrounding global warming one gets the impression that that is exactly what is happening. If the present grew out of the past in terms of how we view reality then surely the future cannot continue with the same set of values. In order to produce graduates who are wise, as Senge suggests we need to do, is it acceptable that the curriculum of most university agricultural courses are filled to the brim with science and technical oriented subjects. Where are the subjects that challenge out understanding of knowledge such as philosophy? Where are the subjects that enable student to develop an understanding of who they are as people and how they might relate to others? And indeed where are the subjects that challenge student to consider ethical issues and the principles surrounding that important topic. **Science as a component of agricultural education at the university level is important but not to the extent that it commands as much as 100% of the curriculum.**

The 2006 autumn edition of The Australian Organic Journal stated that agriculture is responsible for 30% of global warming. However on the brighter side of this figure is the indication that for organic farming CO2 emission is 40-60% lower than conventional agriculture. Given this figure and given the trend towards lower levels of oil reserves throughout the world leading to their ultimate demise sometime this century, one can only see a bright future for an approach to agriculture production that is ecological in focus. Conventional agriculture is an emergent quality of a technocentric world fuelled with petroleum. The next phase will be ecological which will require a far greater knowledge of natural systems and their operations. In this sense the degree in ecological agriculture with its emphasis on social ecology, applied ecology, and business studies, represents the future. It is a pity that this approach is dependant on demise in oil reserves. I would like to think that ecological agriculture and the tenants of ecological thinking represent the default expectation of all people who operate in agriculture but hitherto this has not been the case. In the subject Human Ecology I ask student to devise exercises which enable them to develop five qualities of ecological agriculture according to North American educator Laura Sewell. This qualities are (1) Learning to attend or observe (2) Perceiving relationships with other entities (3) Developing perceptual flexibility (4) Understanding depth, i.e. our place in evolutionary history, and (5) Developing the imaginal self i.e. developing imagination. This is a challenging exercise and one that awakes students to other ways of seeing their world. I have taken two extracts from the current bunch of students as read only last week and they commented as follows:

Student 1: *This has been a wonderful journey to date, challenging, and very slow to unfold, but wonderful nonetheless. Some facets of my ecological thinking have developed more obviously than others but I feel I have changed, and am continuing to change, and will do so as I explore this new thinking, and apply it to myself and my thoughts, and then put them into practice – a practice that involves strengthening my connections with the non-human world, and also with providing opportunities for others to take this journey as well.*

Student 2*: I feel as though I have grown on another level during this semester. There was a path I was heading down before starting Ecological Agriculture and that path changed when I started studying and that path has changed dramatically in the last three months while completing Human Ecology. I did not 'see' the landscape at all, and then learning of the practical side of environmental studies made me see the landscape in a practical way, in its parts. Since Human Ecology opened my eyes I how 'see' the landscape as though it is alive with energy.*

The title of this paper has been: Is agricultural education heading in the right direction and what direction might that be? At Orange, we have found a direction that appears to answer many of the problems that exist as created through prevailing mindsets. We (western world) have to change our way of thinking and I think Orange is demonstrating how that might happen. We don't profess to have all the answers but we are making some progress and we are open to suggestions from you. I invite your evaluation of what we do.

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The importance of climate change to agriculture and landscape

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Abstract

The debate about global warming is over and most people accept that if effective action is not taken to reduce greenhouse emissions there will be significant impacts on landscape and agriculture by 2100. Agriculture generates 16% of Australia's greenhouse gas, mainly methane and nitrous oxide which are more potent greenhouse gasses than CO_2 . Adopting more sustainable agricultural practices reduces the greenhouse gasses and can improve profitability. Soil has the potential to store significant levels of carbon depending on soil type and management practices. Land use change to more revegetation has the potential to provide substantial carbon credits to offset emissions from the power, transport and manufacturing industries.

Landcare Australia is investigating the feasibility of establishing a voluntary carbon pool of biodiversity plantings in NSW to provide an income stream to landholders and drive revegetation on a landscape scale for land degradation and greenhouse reduction benefits.

The importance of climate change to agriculture and landscape

It is clear that the debate is over and global warming is a reality. The evidence is mounting that the effects of global warming are being recorded, particularly over the last five years. Global warming is the result of increasing CO_2 concentrations in the earth's atmosphere that acts like a greenhouse trapping more heat and increasing the earth's surface temperature. Figure 1 shows this increasing concentration dramatically over time.

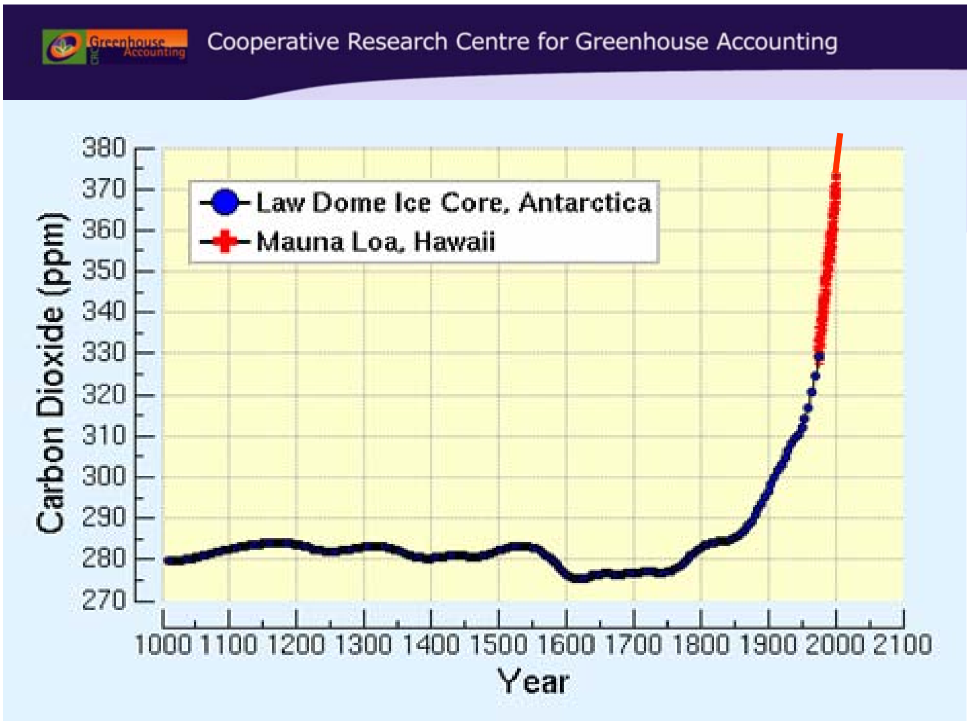

Figure 1. Historical CO_2 changes.

The increasing CO_2 concentration is resulting in gradual increases in the surface temperatures of the globe (Figure 2).

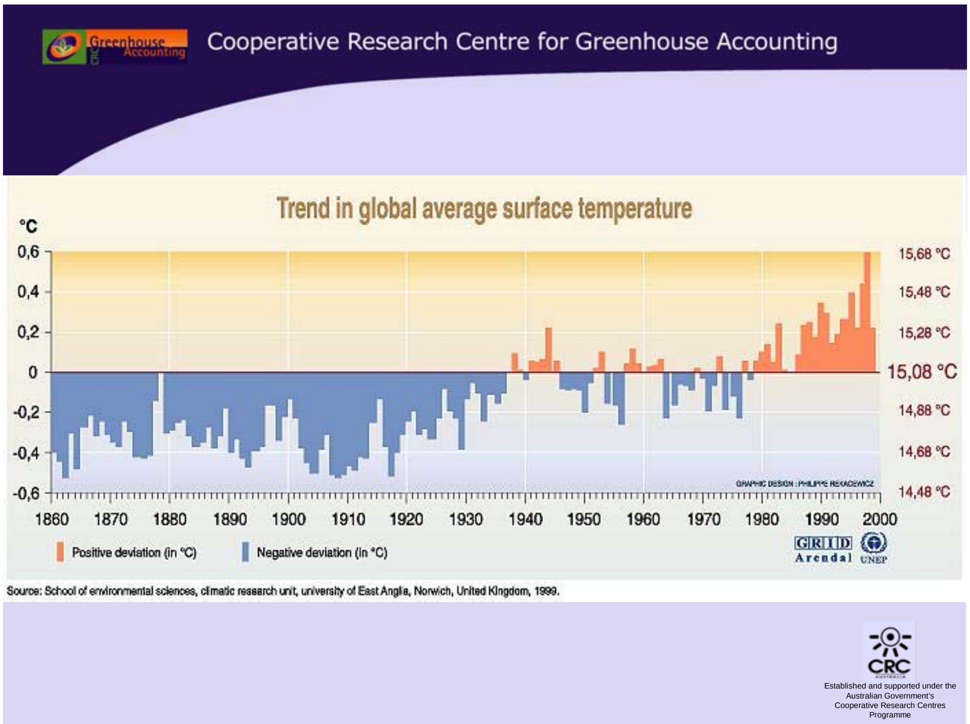

Figure 2. Historical changes in global surface temperatures.

We are now seeing increased observable impacts of climate change over the last five years.

A number of recent reports indicate that predictions of global warming of 3-4°c increase in average surface temperature by 2100 are likely.

The Business Case for Early Action Report (April 2006) indicates the potential impact that 3-4-fold increase in average global surface temperature could have on landscape and agriculture are

95% decrease in distribution of Great Barrier Reef species
20-85% shrinkage in total snow covered area in the Australian alps
45% chance of wheat crop value below current level
128% loss in tick related losses in net cattle production weight
55% of core habitat lost for eucalyptus
16-48% decrease in flow in the Murray Darling Basin

The relative emission contribution of agriculture and landscape change

It is important to appreciate the relative contribution that agriculture and landscape change makes to Australia's emission inventory and the impact that landscape change can have on net emissions (Figure 3).

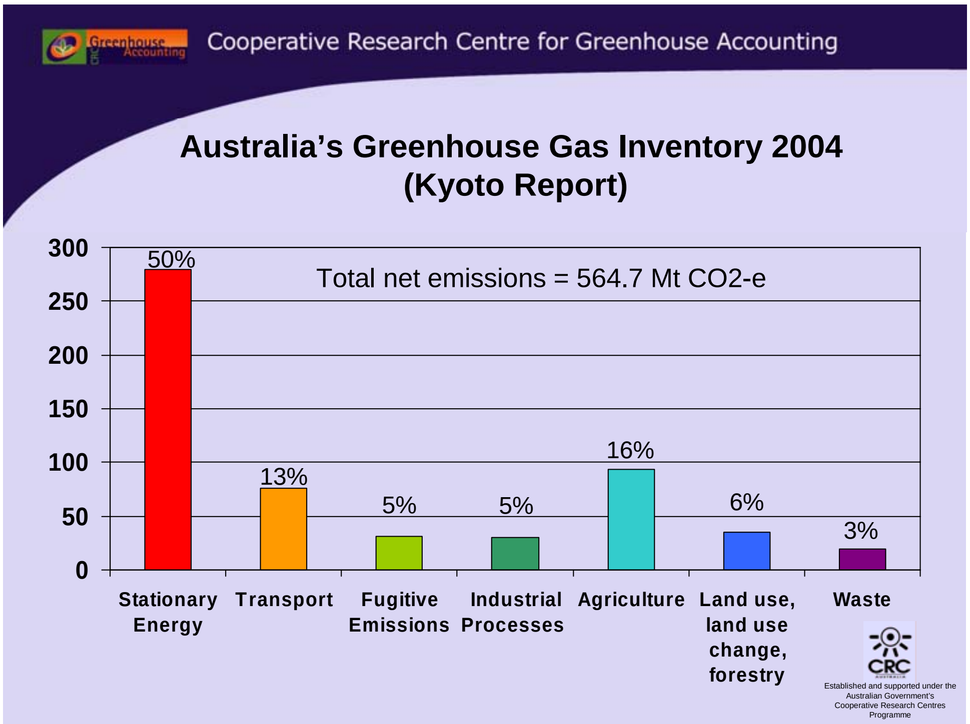

Figure 3. Greenhouse gas inventory for Australia in 2004.

It can be seen that agriculture contributes about 16% of the emissions, mainly as the loss of methane (livestock) and nitrous oxide (nitrogen fertiliser loss).

Land use/land use change contributes around 6% of emissions. However, it is the relative impact of land use change that can be seen in the next table on Australia's net emission change since 1990 (Figure 4).

Cooperative Research Centre for Greenhouse Accounting

	Emissions CO2-e Mt		change	% change
	1990	2004	1990-2004	
Australia's net emissions	**551.9**	**564.7**	**12.8**	**2.3**
Energy	**287.5**	**387.2**	**99.7**	**34.7**
Stationary Energy	195.7	279.9	84.2	43.0
Transport	61.7	76.2	14.5	23.4
Fugitive Emissions	30.0	31.0	1.0	3.4
Industrial Processes	**25.3**	**29.8**	**4.5**	**18.0**
Agriculture	**91.1**	**93.1**	**2.0**	**2.2**
Land Use, Land Use Change and Forestry	**128.9**	**35.5**	**-93.4**	**-72.5**
Waste	**19.2**	**19.1**	**-0.1**	**-0.7**

CRC
Established and supported under the Australian Government's Cooperative Research Centres Programme

Figure 4. Changes in carbon emissions in Australia.

From the above it can be seen that the stationary energy sector has increased by 34% since 1990. However, this has been offset by the reduction in land clearing which has reduced those emissions by 72%. Australia's target of 108% increase on 1990 emissions by 2008 is on track. But a reduction in land clearing is a once off contribution.

However, revegetation can clearly help to offset inevitable increases in stationary energy and other emissions.

Clearly more has to be done by the energy sector and industry, but landscape change through afforestation and reafforestation can have a significant impact by providing offsets if implemented effectively.

Increasing biodiversity plantings in particular has the multiplier effect of reduced erosion, salinity and the beneficial effect of more ecological stability while sequestering CO_2 from the air.

Potential Emission Reductions in Agriculture

Of the 16% of emissions generated by agriculture, an estimated 66% is from methane (NH_3) from enteric fermentation for livestock respiration and 19% from nitrous oxide (N_2O). However, nitrous oxide is 310 times and methane 21 times more potent than CO_2 as a greenhouse gas.

The good news is that more sustainable agricultural practices have been shown to reduce the loss of both these gases. In particular, the loss of nitrous oxide from fertilisers under a grazing regime can be as high as 40% - 60% while under cropping 20% - 50% loss is common.

Action can be taken to reduce these losses substantially by adopting best management practices that also increase profitability.

Soil organic matter and CO_2 storage as carbon

The biomass of trees can be 30% - 50% below ground as roots etc.
With 50% of the biomass of trees being carbon, soils are an important store of carbon particularly under a forest situation.

The soil organic matter is made up of

- Crop residues
- Particulate organic matter
- Humus
- Recalcitrant organic matter – charcoal

Typically, a cleared agricultural soil can hold significant carbon stores depending on soil type, climate and management regime.

The following is a typical example of soils in Wagga NSW, under wheat cropping –

- Sandy soil (2.7%c) 70 tonnes c/ha
- Loam soil (3.7%c) 90 tonnes c/ha
- Clay soil (4.2%c) 100 tonnes c/ha

Management of the soil can play an important role in maintaining and increasing the soil carbon. The amount of crop residue of compost that is returned to the soil is the most important factor in the amount stored. From a farming point of view the following diagram demonstrates the effect of management on the amount of CO_2 stored in the soil and the changes to carbon equilibrium content over time.

Figure 5. Changes in soil carbon over time (Skjemstad, Baldock & Wright). a = return all crop residue, including grain, to soil; b = harvest grain, return residue – no till; c = harvest grain, burn stubble; d = harvest, burn stubble, long fallow; e = application of manure, mulch, compost from external source

Clearly management has a substantial effect on the carbon stored in soils but change is long term and has limited potential to generate carbon offsets. Measuring change in the carbon stored in the soil is difficult and expensive.

Landcare Australia undertook a greenhouse emissions audit of 110 properties from 40 landcare groups. The audit revealed that there was a wide diversity of emissions from the properties ranging from net sinks where the properties had planted out substantially biodiversity areas and were on heavy soils, to substantial emitters on light soils dominated by cropping.

The study clearly indicated that where sustainable agricultural practices had been adopted, such as no till, stubble mulching and revegetation of degraded areas coincided with a reduction in greenhouse gas emissions.

In fact, it became clear that the carbon atom could be used as a measure of how sustainable a farming system had become. Where best management practices were used greenhouse gas emissions were reduced substantially.

Land use, land use change and forestry

The substantial effect that reduced clearing of land had on net emissions, i.e. a 72% reduction in emissions which helped to offset a substantial increase in the other sectors can be seen in the Greenhouse Gas Inventory (Fig 4).

Similarly, increasing the rate of revegetation of the landscape can help offset some of the unavoidable increases in emissions. Industry and the community must do more to reduce CO_2 emissions with new technology, green energy alternatives etc but encouraging offset trading schemes is important if Australia is going to meet its greenhouse gas emissions target into the future.

Landcare and carbon offsets

Since 1990 landcare groups across Australia have been revegetating degraded landscape for conservation/sustainable productivity purposes.

Opportunities are now emerging in NSW for landholders to potentially receive an income from carbon offsets associated with these plantings. Landcare Australia's close association with corporate Australia through its sponsorship activities is ideally placed to create a voluntary carbon pool of these biodiversity plantings and act as a broker to help facilitate the trading in carbon offsets to the power industry and other sectors.

Vegetation has the ability to 'lock up' or sequester carbon dioxide from the atmosphere and deliver broader environmental benefits to improve such problems as soil salinity, erosion and habitat loss. The 4,500 Landcare groups across Australia have revegetated approximately 100,000 ha (ABARE 2003) per annum since 1990 with 40,000 ha planted per annum in NSW. Figure 6 shows how much carbon dioxide a typical conservation planting will absorb per annum over 100 years.

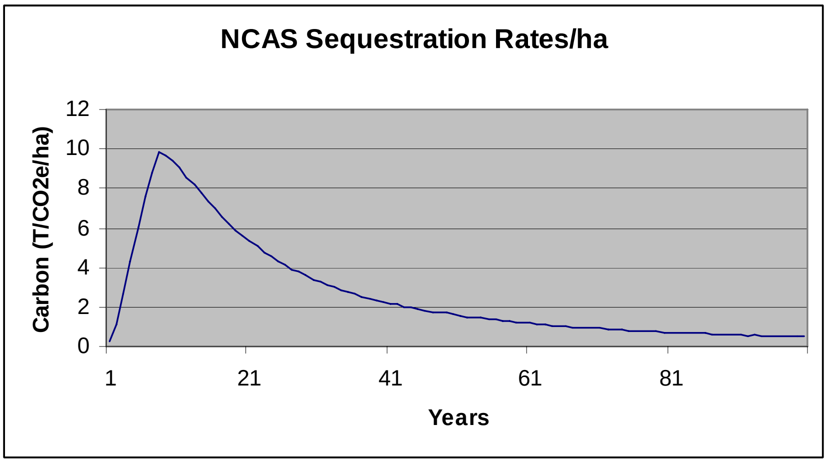

Figure 6. Rates of carbon sequestration by conservation plantings (per hectare per year over 100 years), a typical Australian profile.

Pooling Carbon

Carbon pooling is the grouping of disparate carbon sequestration projects into a larger aggregated 'pool'. A carbon pool manager administers the carbon rights from the bundled carbon sequestration projects by entering into legal agreements with the landholder(s) to acquire their rights to the sequestered carbon, and then on-selling the aggregated carbon rights to investors or to companies needing to purchase carbon credits.

Geographical diversification through carbon pooling offers a range of potential benefits to all participants including significant risk reduction, greater stimulus to undertake conservation plantings, broader environmental benefits and greater market access for small scale operators, particularly non-commercial.

Carbon Trading

Each ton of carbon dioxide sequestered has a market value. Currently, one ton of carbon dioxide has a market value of around $13-$15 in NSW under the first legislated trading scheme administered by IPART (Independent Pricing and Regulatory Tribunal). Under this scheme 1 ton of CO_2 is equal to 1 NGAC (NSW Greenhouse Gas Abatement Certificate).

Demand for NGACs comes from benchmark signatories (power companies) who must purchase one NGAC for each ton of carbon dioxide emitted above the benchmark. The cap and trade regime in NSW offers potential to provide landholders who have planted areas back to native vegetation to gain an income stream from those plantings. This will encourage more plantings on a landscape scale to provide carbon offsets to corporate Australia.

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The bio-based economy – hydrocarbons to carbohydrates

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"The bio-based economy can and should be to the 21st century what the fossil-based economy was to the 20th century". (Ralph W.F Hardy)

The Bio-based economy is the term used worldwide to describe the platform for the collective conversion from a hydrocarbon fossil based economy to a biologically based economy using "bio-products" derived from recycled and renewable organic materials such as organic waste and purpose grown crops.

The existing hydrocarbon fossil fuel-based economy currently provides much of the fuel, fabric, industrial chemicals and energy requirements for today's world. Excessive use of hydrocarbons has led to harmful consequences such as environmental degradation, climate change and human health problems. In addition to these environmental impacts, fossil-based, non renewable resources such as oil and coal are finite and oil resources in particular are quickly diminishing. With the rapid industrialisation of economies such as China and India putting additional upward pressure on oil reserves progression to alternative renewable commodities such as those offered by the conversion of biomass into bio products is urgently required.

Many of the technologies and processes in the Bio-Based Economy are not new. The Diesel engine was initially designed to operate on a vegetable oil derivative (Bio-Diesel) and Henry Ford thought the automobile would run on ethanol and built many of his early car bodies from soybean derivatives (Ralph W.F Hardy, internet, 2005).

The bio technologies, bio processes and bio products that will underpin the bio conversion are in various stages of development. For example biomass such as compost is widely used, but the alternative, hydrocarbon based fertilisers, is likely more dominant at present. On the other hand the extraction of green chemicals from renewable organics is in its infancy. Newer technologies such as bio diesel and ethanol are now rapidly expanding in North America and Europe with a new ethanol plant being opened in North America every ten days (Alan Jones, pers comm., 2006). Table 1 identifies the targets set by the National Research Council USA for Bio-Based inputs to industry in the USA.

Table 1 - targets for a national bio-based industry, percent derived from bio-based feedstock (NRC, 2000).

		Future target	
Bio-based product	Current level	Intermediate (2020)	Ultimate (2090)
Liquid fuels	1-2%	10%	up to 50%
Organic chemicals	10%	25%	90+%
Materials	90%	95%	99%

The following flow diagram (Figure 1) conceptualises the categories of bio sources, bio processes and bio products involved in the Bio-Based Economy.

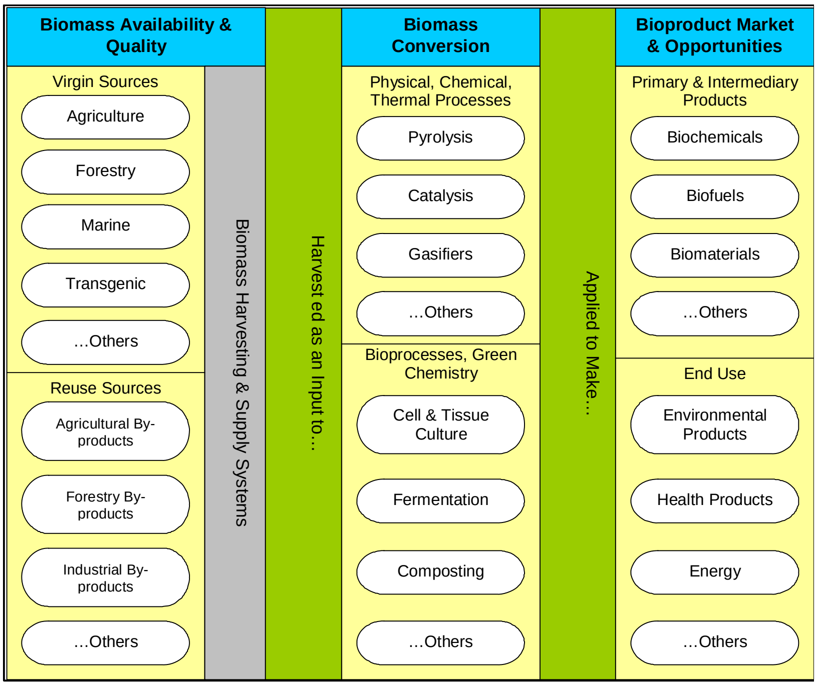

Figure 1. BBE basis and structure

The bio-based economy will provide significant answers to major environmental concerns of the twenty-first century. Because it is based on the natural carbon cycle, it is inherently sustainable whereas the fossil-based economy in inherently unsustainable. Conversion to a bio-based economy will mitigate global climate change by reducing major greenhouse gas emissions. There will be reduced local, regional, and global environmental pollution. For example, 85% of atmospheric pollutants (O_3, CO_2, SO_2, NO_x) - result from fossil fuel based products.

The bio-based economy will not produce slowly degradable spills of oil on land and water. Most “bio-based” crops will be perennial with low inputs, will be harvested annually, will produce minimum environmental impact and conserve wildlife, and will not be grown on prime food-producing crop land.

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Cost benefit of recycled organics in agriculture. A Partnership Project with Department of Primary Industries (funded by NSW Department of Environment and Conservation)

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Abstract

I have divided today’s presentation into two parts, firstly I will talk to you about commercial compost and its role in resource recovery, and secondly I will be discussing the ‘compost-application’ cost benefit project which the NSW Department of Environment and Conservation has commissioned. The Department of Primary Industry’s Centre for Recycled Organics in Agriculture is undertaking the research, headed by Dr Yin Chan.

Firstly, a word about the terms “Organics” and “Recycled Organics”. These are terms which appears to have been adopted world-wide to describe organic residues and composts– so we have, for instance,

- ‘garden organics’ which primarily comprises of grass, leaves, and prunings;
- we have ‘food organics’, which are residues from food processing and consumption, and
- ‘recycled organics’ – which are the final products, usually mulches and soil conditioners, most of which have gone through a composting process.

These are comparatively new terms. And this terminology does lead to confusion with your industry and with all the other uses of ‘organic’ that are out there. The term ‘recycled organics’ is the one that you are most likely to become familiar with.

1. Commercial Composting Overview

The average person, when talking of composting, thinks of small scale home or farm based heaps of food and garden scraps, or manures and straws. Mushroom compost, and ‘spent mushroom compost’ are also familiar to most people because the products have been available at a retail level. However, few people are aware of the contemporary compost processing industry, and this is not surprising because it is a relatively new industry. But this industry is a rapidly growing industry and we are now composting annually, Australia-wide, some 3 million tonnes plus of organic material. In NSW alone, commercial composters sold 830,000 cubic metres of compost products.

Collection services

A variety of collection and recycling services are available to householders and businesses (e.g. landscapers, lawn mowing services, developers etc) for recycling organic materials. Many councils offer kerbside collection services for garden organics, kerbside chipping and annual clean ups. Numerous councils and facilities now offer drop off locations where garden organics can be taken for recycling.

In 2004, 71 councils operated a regular kerbside collection service for garden organics, with some offering expanded services, such as combined garden and food organics collections. Many of these collections are based on a container, such as a dedicated 240 litre wheelie bin. Over 1.1 million households in Sydney, Illawarra and the Hunter receive a regular collection service for garden organics. Material is delivered to a central facility, often adjacent to a landfill site, where the material is processed, or it is delivered to a transfer station, where it is size-reduced for transporting to a processing site.

Processing

Material is taken to a central facility where it is usually manually sorted to take out contaminants such as plastic bags, and then the material is size reduced.
After size reduction, the material is piled into long rows, called windrows, which are turned mechanically on a regular basis. This part of the process is the phase where compost reaches the high temperatures (55^{O} +) and the thermophilic bacteria kill pathogens and weed propagules. The turning ensures that all parts of the heap is subjected to these temperatures and also ensures continued good aeration, a good supply of oxygen. This is the heart of the composting process.

After having spent time in the piles, the composted material is screened, to separate into different sized products and to remove contamination. The products that are produced at this stage are most often blended to produce a range of commercial products. Products include potting mixes, top dressings, soil replacements, soil conditioners and mulches.

Product Standards

A number of voluntary industry standards published by Standards Australia have been produced to give surety to customers and to provide guidance to manufacturers.

Products that comply with standards minimise risk to human health, animal health and the environment. Products that have been through a managed composting process will not have pathogens present, nor will they contain active weed propagules.

Australian Standards relevant to recycled organics or compost are:

- Australian Standard AS 4454 (2003). Composts, Soil Conditioners and Mulches.
- Australian Standard AS 3743 (2003). Potting Mixes.
- Australian Standard AS 4419 (2003). Soils for Landscaping and Garden Use.
- Australian Standard AS/NZS 4422 (1996). Playground Surfacing.

Professional Sector

The industry is rapidly developing into a professional sector, as well as Australian Standards having been developed for a range of compost containing products, most States now regulate for minimum environmental standards in composting facilities. Professional State-based organisations have been formed and also a national organisation, Compost Australia. Compost Australia was recently the recipient of a Federal grant which enabled the industry to develop a nation-wide blueprint for progress – the Compost Road Map.

The contemporary commercial composting industry was born from the waste minimisation industry, and to some extent contemporary composting has suffered bad press because of this parentage. There is an association with 'waste', which the industry is endeavouring to escape. Far from being a second rate product, research has proven that compost is a unique and valuable resource.

Environmental Benefits

There have been a number of studies that have demonstrated the environmental benefits of recycling organics are conservatively in the order of $114 per tonne of garden organics – this includes the environmental benefits from diverting this material from landfill and the benefit of applying this material as compost in an agricultural setting.

The primary application benefits are to be found in water savings and soil structural improvement. Irrigation, for example, has been found to be reduced by up to 70% through using composted mulches and an average of 10 tonnes per hectare of soil loss due to erosion can be prevented.

Generally speaking, environmental benefits broadly relate to:

Increased water retention capacity of soils
Fertilizer replacement (N, P, K,) and associated avoided emissions,
Reduced pesticide use, and associated avoided emissions,
Reduced nitrous oxide emissions,
Soil carbon sequestration, and
Reduced acidification and salinity.

Organic material is responsible for the main Climate Change impacts which are generated from landfills. Methane generation from landfills is a greenhouse gas problem, methane being 21 times more significant than carbon dioxide in global warming potential. Methane generation is one of the main reasons that landfills are undergoing such close scrutiny today, and why many attempts are being made to find alternative solutions.

State governments have set targets to reduce material going to landfill and have thus set waste reduction goals. Garden and food comprise some 50% of material going to landfill and garden organics have become a focus for recycling efforts and education.

However, as a result of the success of organics diversion, compost has been produced in quantities that have outstripped the markets. Supply has built up over the years, despite an increasing focus on marketing by both industry and government. Industry now maintains that there is a ‘stockpile’ in the Sydney basin of (Fifty thousand?) cubic metres of compost, and there have been suggestions that some of the smaller processors will fail because of the pressure of over supply.

The NSW State Government has thus invested in market development programs. The Department is involved in research trials such as erosion control in catchment management applications, salinity trials, mine site rehabilitation, parks and sporting ground maintenance and stormwater infiltration to provide validated evidence of the benefits of using recycled organic products. One research project, being conducted over four years, is examining the cost benefit of using recycled organics in horticulture and viticulture.

2. Quantifying the benefit of recycled organics in agricultural cropping systems

The DEC has been pursuing environmental outcomes by investing in trials which will assist the agricultural market have sufficient information and confidence to invest in the purchase of composts. Less than 17% of recycled organic products are applied into agricultural markets. This is not a simple exercise, because we know from research to date that composts have different efficacies in different crops, different soil types and different weather regimes. And the effects of compost are inter-dependent and multi-faceted which always presents scientific research dilemmas.

In this project, DEC initially commissioned an agricultural market analysis, which was undertaken by the Department of Primary Industry. Based on a number of criteria, including crop area, total production, gross margins, soil fertility and environmental considerations, vegetable production in the Sydney basin and viticulture were identified as potential markets for RO products. These two crop types became the basis for the field trials undertaken to assess the cost benefit of applying compost in agricultural cropping systems.

Vegetables

From the analyses, the strengths of vegetable production as a market for RO include high gross margin and proximity to Sydney. environmental concerns (off-site impacts on water quality) of existing vegetable production practices relating to fertiliser and poultry manure are identified.

The vegetable field trial is located on the Department of Primary Industry’s Centre for Recycled Organics site at Belgenney Farm in Camden. The area chosen had a relatively typical Sydney basin profile and a rotation of vegetables has been chosen to replicate normal farming practice in the Sydney basin. The site has a long history of dryland cropping and so soil carbon is low, comparable to the average of vegetable soils, particularly those of similar soil types.

A survey of 42 vegetable farms including the major soil types used in vegetable production in the Sydney region revealed significant losses of total nitrogen and organic carbon but accumulation of very high levels of extractable P.

Trial Set Up

The trial compares growing vegetables with compost against farmers' conventional practice (using a mixture of poultry manure and inorganic fertilizers) under both high and low soil phosphorus regimes. Only one application of composted soil conditioner has been made, whilst there have been several applications of the fertilizer regimes needed in the trial to date. The first two vegetable crops have been planted and harvested, broccoli and eggplant and the third crop, cabbages, have just been planted.

The first crop, broccoli, was planted in May 2005. Several re-plantings were needed, the result of undue interest from the local sulphur crested cockatoos.

Yield data has yet to be released, but preliminary examination of results suggests:

- yields of compost treatments were similar to the conventional treatment (inorganic fertilisers + chicken manure)
- similar yield between high and low rates of compost
- similar yield between high and low phosphorous treatments

The second crop was eggplant (variety Black Bell) and was planted in December 2005. Soil samples from the different treatments were also collected in December.

Harvesting commenced out on January 2006 and altogether 6 harvestings were carried out, the last on 31st March 2006. Eggplant samples from the compost and conventional treatments were sent to the Sydney Market for assessment and both were similar and regarded as excellent grade. Preliminary results indicated similar yield of eggplant fruits between farmers' practice and compost treatments, with an average total yield of 71.6 t/ha. The latter is regarded as very high yield for eggplants in New South Wales.

Preliminary Environmental Findings

Analyses of soil samples at sowing of the second crop revealed significantly higher soil organic carbon level in the compost treatments compared to the conventional farmers' practice. Higher extractable Phosphorous level was found in the conventional treatment compared to the compost treatment in the high Phosphorous treatments, indicating accumulation of labile Phosphorous under farmers' practice. Both these findings have implications for long term soil health and nutrient run-off problems.

Viticulture

Based on a number of criteria, including crop area, total production, gross margins, soil fertility and environmental considerations, viticulture was also identified as one of the potential markets for RO products in NSW. From the analyses, the strengths of viticulture as a market for RO included high gross margin and proximity to Sydney.

A potential threat of using RO in viticulture is Phylloxera which has the potential to infest and decimate vines in Phylloxera free areas. Sydney is a Phylloxera infested area and so compost producers need a compliance agreement with NSW DPI to move composted materials derived from Sydney to other parts of New South Wales.

Other weaknesses identified include

- Vines take a long time to establish and respond to treatments, making it difficult to conduct research into quantifying the benefits of composted garden organics and detect crop response in these production systems.
- Little research has been done to characterise soil carbon status in these production systems, which makes it difficult to identify responsive soils.

Trial set up

Six vineyards in the Cowra, Canowindra and Canberra areas were selected for the mulch trial which commenced in September 2005, included were two organic vineyards, Rosnay and Gardners in Canowindra. The sites were selected based on the results of a preliminary soil investigation and advice from Industry stakeholders.

There was extensive discussions with industry and the researchers, and the trial variables were reached as a compromise between what the academic researchers were interested in and what the compost industry maintained were practical (i.e. affordable) parameters.

The trial was designed to compare two mulch treatments against farmer’s current practice in a replicated field experiment. At each site both a high yielding area and low yielding area have been included for comparison. The high application rate for mulch was 7.5cm thick by 60cm wide; the low rate 7.5 cm thick by 30cm wide in addition there are the control rows, farmer’s current practice of managing under vine area

In each area, each treatment is represented by a whole row to facilitate irrigation water monitoring.

First season monitoring

During the season, regular visits were made to inspect vine growth, collect soil water and temperature data, measure weed control and liaise with owners/managers of the vineyard regarding irrigation. Ten vines from each treatment row (subplots) have been tagged at all the sites for agronomic and yield measurements. Soil moisture and temperature sensors and data logging devices which measure and record soil water potential and soil temperature at 4 hour intervals were installed at all sites.

Weed control

High rate of mulch was found to have more marked effect in reducing weed growth in the under vine area compared to the control. During the season there was a tendency for weed growth to accumulate in the edge areas between the mulch and the bare soil inter-row area where chemical spraying is difficult. Therefore, weed growth remained a problem in the under vine area for the low mulch treatment

Temperature and soil water regimes

The mulch treatments, particularly that of the high rate, were found to have significant effect on soil temperature at 10 cm depth, both in lowering the actual temperature as well as in buffering the soil diurnal temperature fluctuation. Furthermore, the mulch treatment helped to keep the soil profile moister and hence help to delay the drying out the soil profile early in the season.

First season harvest

Harvest commenced with the Chardonnay on 13th Feb 2006 and the last harvest was the Cabernet Sauvignon in late April. At each site, 200 berry samples are stored frozen and will be analysed for a range of quality parameters, namely pH, titratable acidity, colour, sugar and berry size.

Results are still to be compiled from the harvest. The results will be tallied with remote sensing observations that are being systematically recorded. In the form of aerial photographs, these observations provide a wealth of detailed plant health information to viticulturists.

3. Importance of the Trials.

This is the first time that any Government in Australia has dedicated such a significant investment to long term trials in horticulture and agriculture. Compost's contribution to soil and water health accrues over a longer time frame, so this trial will afford us the opportunity to look at cost benefits more realistically, encompassing several years worth of data.

Initial findings are suggesting that the use of recycled organics will prove of particular environmental and economic benefit in precision agriculture. If application of recycled organics is targeted to poorly performing areas in cropping systems, evening out total crop performance and management regimes, then cost benefits are likely to be very positively in favour of targeted compost application.

For more information

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Certification: coping with climate change flexibly

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Introduction

Organic certification rests upon standards that have inherently addressed climate change from their inception. Whilst there is no overt reference to climate change in standards , they have been shaped by and have shaped practices that address climate change significantly with regard to sequestration of carbon and a variety of greenhouse gases.
Recent studies, discussions and workshops aimed at broadening the environmental scope of organic standards make the first overt references to gas exchange. Certification bodies will do well to brief themselves and provide further guidance to the organic sector and the organic industry through the OFA will need to further develop its cognizance and treatment of climate change related practices if it is to remain a leader in sustainable systems.

Flexibility is defined as suppleness, give and elasticity, all characteristics of a resilient system able to respond to changing circumstances. Certification frequently has less flexibility than the systems of organic production that it certifies, although in the area of soil and vegetation management it has been characteristically adaptable to multiple sectors and systems of production. The issues of carbon sequestration exemplify this approach and it might be argued has been too flexible in certain cases

It is worth remembering some of the principles of organic agriculture which appear in the introduction to organic standards:

1) To foster local and regional production and distribution;
2) To use renewable resources as much as possible;
4) To maintain and increase long-term fertility and biological activity of soils using locally adapted cultural, biological and mechanical methods as opposed to input reliance;
5) To provide balanced nutrients, optimise opportunities to cycle nutrients within the farm, to recycle nutrients and energy that leave the farm or other farms in food and fibre products that are not consumed (i.e. organic waste containing energy and nutrients), with the aim of feeding the soil ecosystem;
6) To promote wise use of land, water and vegetation and minimise off farm effects of agriculture on aquatic and terrestrial systems;

The principle of reducing non renewable energy use through transport and distribution, the reduction of fossil energy based inputs and ultimately the building of soils and vegetation with their inherent sequestration characteristics are backed up with a variety of standards, (from NASAA) in some ways more flexibly than others.

General land management

No stubble burning shall take place.

From 1st June 2005, each farm shall contain an area consisting of no less than 5% of total area that is set aside from intensive production and includes at least perennial grasses and or trees/shrubs.

No natural wetlands may be drained

Crop production and rotations

Except where fertility and structural characteristics are entirely met by the importation of composted manures or other permitted varieties of Organic Matter (OM), in any three year period, at least one year shall be used to grow one of the following:

- A green manure crop either volunteer or planted which is mulched or incorporated at a time and in a state considered appropriate to render fertility and structural improvement to that portion of land;
-An annual legume which has demonstrably modulated which may be permitted to mature and seed if required; or
- A pasture ley phase which remains intact for a period of at least 12 months and includes the use of at least one legume.

The measurement of levels of fertility and the percentage of OM in a given field shall be measured with sufficient frequency to demonstrate that, even under the above rotational program, there is ongoing maintenance and improvement of OM. In the event of soil testing revealing a negative long-term trend, a modified rotational program shall be developed by the operator for NASAA approval.

The use of fallowing as a moisture and weed management tool is restricted. Given the high levels of oxidisation of OM under summer conditions, a pasture phase or crop residues must be maintained to compensate any fallow periods which span a period of more than 6 months. Other requirements remain as above.

The use of long fallows as the principal basis for weed control is not permitted.

Fertility inputs

Material of microbial, plant or animal origin shall form the basis of the fertility program.

Mineral fertilisers shall only be used in a program addressing long-term fertility needs together with other techniques such as organic matter additions, green manures, rotations and nitrogen fixation by plants.

Livestock

Landless animal husbandry systems are prohibited. Animals must be allowed free movement and access to pasture at least on a daily basis.

Over 50% of the feed shall come from the farm unit itself, or be produced in cooperation with other certified farms in the region.

Clearance of native vegetation including native grasslands that has taken place during the last 5 years will be subject to consideration by NASAA before certification is determined.

General

Crop production, processing and handling systems shall return nutrients, organic matter and other resources removed from the soil through harvesting by the recycling, regeneration and addition of organic materials and nutrients.

Revising the standards

Some new draft standards under consideration which more overtly address climate change issues include

Operators shall have a non renewable energy resource conservation system in place, appropriate to their type and scale of operation.

Crop production, livestock production, processing and handling systems shall reduce, reuse or recycle residual materials generated through crop production, livestock production, processing and handling respectively.

Identify where areas of energy efficiency and greenhouse gas reduction can take place,

Operators must demonstrate that soil and vegetation carbon sequestration trends are positive

The questions the organic industry needs to ask itself, is how flexible does it wish to be and what levels of application, monitoring and documentation of climatic related standards does it wish to address.

Biodynamic options to address climate change

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The possibility to create humus and increase the water holding capacity of our soil was my doorway into biodynamics. Drought tolerant soil is an attractive concept for Australia.

Soil and climate are the farmers’ raw materials from which they produce the food and fibre we need. Humus holds water, carbon and fertility. It also holds our soil together.

Scientists are becoming more skilled at identifying and measuring the particles and life forms that comprise our soils. Economists are skilled at exploiting this noble resource without consideration of the climatic effect of their calculations. Economists are now also becoming interested in how we can trade carbon use with carbon sequestration.

We know from the Australia State of the Environment Report 2001 that Australia loses 6.97 tonnes of soil per hectare per year across the country (www.deh.gov.au/soe/2001/land/land01-5.html).

The question is: how can farmers most effectively respond to this growing body of expert opinion about the resource they are responsible for and which in many cases they are more knowledgeable about?

Biodynamic farmers increase soil life, depth and humus content using a number of preparations which can be produced on farm or acquired through local or national biodynamic associations. They are cost effective and simple to apply.

The two field sprays are the horn manure 500 and the horn silica 501. The horn manure 500, applied to the ground, stimulates an abundant soil microbial life producing deeper soils rich in humus. The horn silica 501, applied as an atmospheric spray, stimulates photosynthesis and the production of carbohydrates in the plant. When sufficient sugars are produced the plant has more to release into the soil as exudates to feed the soil life, furthering the production of humus.

In addition, biodynamic farmers use the biodynamic compost preparations for all composting and breakdown processes of organic matter. These ensure minimal organic carbon or nitrogen are lost from the farm to the atmosphere or the waterways. It is all held in the composting process. When the compost, solid or liquid, is mature and stable it is applied back onto the soil where it is available plant food and not subject to leaching or vaporising.

Biodynamics is an art as well as a science, it is holistic in approach allowing farmers to achieve positive agricultural, financial and environmental outcomes as well the satisfaction of leaving better soil for the next generation.

The farmers are only one side of the equation. Consumers are the key to climate change. It is consumer choice that can drive the world environment. Deciding to purchase organic and biodynamic food and fibre across the globe will harvest carbon for the soil, contributing to a more stable climate and better nutrition.

Climate change is ultimately a social question. We create the world we consume.

Biodynamic Agriculture: adaptability and sustainability for farmers around the world - case studies from Northeast India

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Abstract

Recently returning from two years in Northeast India, having trained and worked with hundreds of farmers from different states growing diverse crops in wide-ranging conditions, I am very excited about Biodynamics adaptability and sustainability and, by its very nature, its ability to reduce carbon emissions when compared with fossil fuel driven conventional agriculture. This paper looks at the wider Indian and the more localised Northeastern Indian agrarian contexts. Two case studies of different farming situations illustrate the possibilities of using Biodynamics and organics to secure sustainable livelihoods in this complex region of India.

Indian context

Agricultural development in the majority world (also known as developing countries, Third World, the South) over the past fifty years faced a very similar attitude to that of other forms of Western driven development i.e. majority world cultures, in this instance, farmers, and their methods were seen by the West as backward and obsolete and not very good for a market economy. With approximately 600 million, predominantly small scale, traditional farmers, India faced the brunt of this Western agricultural development known as the Green Revolution. The rhetoric of the day that this package would "feed the world" is the same slogan used for Genetically Modified crops of today. Yet, at a global level, it is still not about supply but rather the way in which that supply is distributed which causes food insecurity around the world.

The Green Revolution packages included high yielding varieties (HYVs) of seeds grown under irrigation, with synthetic fertilisers and pesticides. Initially these 'packages' were quite responsive to the fertile, irrigated soils of certain parts of India e.g. Punjab. However, within a couple decades yields declined and higher inputs were required.

It is noteworthy to observe the way in which Western agribusiness gained access into Indian markets. In 1965-66 India was in the grip of a famine and receiving food aid from the United States. However, when India refused to allow US involvement in its fertiliser industry, food aid stopped. Eventually, India surrendered to US and World Bank demands to manage its fertiliser industry and to allow more liberal access to its markets. Between the late 1960s and 1980s fertiliser price increased by 600% (George 1977; Lappe, Collins et al. 1998). Many larger farmers quickly exploited the Green Revolution packages and substantially raised production but by the time the small farmers obtained the 'packages', commodity prices had reduced dramatically. By 1980-81 in India, real rural per capita income and its distribution returned to its 1960-61 level (Binswanger and Quizon 1989; Alamgir and Poonam Arora 1991). Whilst consumers benefited by lower prices, food security did not improve for the hundreds of millions of poor Indians. More than 80 percent of over three hundred research reports written on the Green Revolution over a thirty-year period concluded that inequality increased as a result (Lappe, Collins et al. 1998).

Whilst the production of wheat and rice rose to self-sufficient levels, this came at the expense of other very valuable and nutritious crops. Pulses, millets and oil seed crops, which ensured food security, were replaced by rice or wheat. In addition many groups, especially those who relied upon rainfed crops, were excluded.

The impacts of the Green Revolution are still felt severely across India today. Declining yields, lower commodity prices, increased input prices, failed crops and farmer indebtedness, mass people displacement by large dam projects (e.g. Sardar Sarovar dam on the Narmada river), water contamination and lowering water tables, loss of agro-diversity and ultimately, farmer suicide not to mention the effect of fossil fuel derived inputs and their impact on climate change. For example, the Centre for Science and Environment in Delhi tested 12 common soft drink manufacturers revealing up to 87 times the allowable EEC levels for some agricultural chemicals due to water contamination (http://www.cseindia.org). Food sovereignty and food security has been carefully and systematically taken out of the hands of the farmers and sits firmly in the grasp of the multinational corporations that produce these Green Revolution packages.

Northeast Indian context

One of the regions that predominantly missed out on the Green Revolution was Northeast India, and especially the hill areas. States of the Northeast historically include: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Sikkim is also occasionally included as a state of the Northeast. Farming there is often labelled "organic by default" due to the relatively small usage of Green Revolution packages. The hill areas primarily practice *jhum* farming, also known as "shifting cultivation", or "slash and burn". This is not to say that chemicals fertilizers, pesticides and HYV and hybrid seeds are not used, because they are – but nowhere near to the same extent as the rest of India. For example, NPK fertiliser usage in Nagaland state in 2003 was around 2.2 kg/ha compared to 90.1 kg/ha for the rest of India (Ghosh 2003).

The Northeast region is complex and historically problematic due to its remote and hilly terrain, its socio-economical and political situation, and its culturally diverse and very numerous tribal groups. Approximately 2% of the external border of the states joins India; the rest join Nepal, Tibet, China, Burma and Bangladesh. The region continues to encounter insurgency, drug, weapon and human trafficking, drug use, HIV/AIDS, it lacks infrastructure and any substantive development, not to mention the levels of corruption that exist. Soils tend to be shallow, infertile and acidic with little irrigation infrastructure. Average annual rainfall for the area is around 280cm with a range of between 132cm and 1200cm; the region has approximately 1% of India's population and 5% of its land (Ghosh 2003).
It is of little surprise that seed and chemical companies and agricultural extension did not tackle this frontier in search of extending its Green Revolution veil. However, currently there is a great deal of interest in and discussion of the Northeast as a source of organic products due its "organic by default" status. Cash crops are predominantly the focus – there is little attention given to food security type crops such as rice, the staple of the region, or vegetables (Figure 1). Spices such as ginger, black pepper, turmeric, cardamom and aromatic oil such as patchouli are favoured by various government and government/private ventures with all these products looking at the export market.

Figure 1. A road side market in Nagaland driving from Dimapur up the mountain to Kohima

Case study 1: Biodynamics, organics and rice and vegetable cultivation in the plains of Nagaland

In collaboration with a Nagaland non government organisation (NGO), with funding from an Australian agency, an initial key informant focus group discussion was conducted in several villages in lowland Nagaland to establish the local needs and perspectives. These small and marginal farmers are predominantly wet rice farmers who also grow insignificant amounts of vegetables – they are not self-sufficient in either needing to obtain these from the local market. Nutrition in their households was less than adequate. These tribal farmers usually left the fertilizing process up to nature to deposit silt. However, several years without decent rains and no silt deposits has resulted in decreasing yields. Some villages use small amounts of HYVs and have in the past used urea, although one village had banned it because the farmers believed it had hardened the soil. Insecticide and fungicides are used.

The focus group discussions resulted in trialling the System of Rice Intensification (SRI) and a vegetable project in Nagaland utilising Biodynamics, organics and various Permaculture design principles. The main development outcome of this pilot project was to determine if a system of organic kitchen gardening and the System of Rice Intensification (SRI) are appropriate methods though which to improve food security, nutrition and livelihoods. Given we had never worked with these farmers and the techniques were new to them, we needed to get early positive results to engage and sustain their motivation and interest. Maintaining a close and regular working relationship was very important (Figure 2).


Figure 2. (L) Staff with members of one women's groups; (R) Using a digital projector to show farmers a DVD about the SRI technique in Indonesia

Over a 12 month period nearly 200 farmers and NGO staff were trained in various Biodynamic, organic and Permaculture design principles (Figure 3), including making and using:

- Biodynamic compost and other hot compost
- Cow pat pit (CPP) or manure concentrate
- BD 500 and BD501
- Liquid manures
- Vermiwash and vermi-composting

Figure 3. A Biodynamic compost making training in the plains of Nagaland.

Other soil improving techniques such as green manuring, liming, and some Indian indigenous knowledge was included such as:

- Panchagavya: a fermented preparation of five (*panch*) products of a cow: dung, urine, milk, curd (yoghurt) and ghee (clarified butter) as well as molasses, cane juice and BD compost preparations if desired. It is used as a plant growth promotant and is often used during flowering to improve fruit set.
- Cows' urine: used to reduce the impact of various fungal attacks. It was used the night before applying BD501 for rice blast with good results.
- Use of neem as an insecticide and fertiliser.

System of Rice Intensification

The rice farmers were also trained in the System of Rice Intensification (SRI) which aimed to improve yields with fewer pest problems and up to 50% less water. Developed in Madagascar in the 1980s, it has spread to many parts of India and the rest of the non-Western rice growing world including Indonesia, Thailand, Burma, Bangladesh, Cambodia, Nepal and China. It had not been used with farmers before in Nagaland.

It differs to conventional wet rice (paddy) cultivation in our project area in that:

- plants are transplanted at 2-leaf stage after about 8-12 days (usually transplanted at around 30 days)
- single plants are transplanted at 25cm distance in grid formation (usually plants are transplanted in a group of 6-10 plants)
- water is applied periodically to maintain soil moisture but is never flooded prior to panicle initiation (usually remains flooded until about 20 days prior to harvest)
- weeds and oxygen are incorporated into the soil using a weeding machine (usually weeded by hand but fewer weeds usually grow in flooded fields).

The advantages of such a system include increased tillering, stronger plants due to larger root systems, less water usage and higher yields. A great example of the improved root structure (Figure 4, right) in all of our trial plots was that all surrounding conventional crops had lodged (fallen over) whilst the SRI crop remained standing (Figure 4, left).

Figure 4. (L) Standing in SRI crop; lodged conventional to right. (R) single SRI plant (top), 6 conventional (bottom).

An important element of this system is good soil fertility which allows for the higher yields. The best and most sustained yield increases in other trials around the world were in plots with a good history of compost and with plant spacing of 50cm.

Those farmers in our trial who followed the basic outline of the management methodology obtained increases of up to 25% in the first year. This was without any compost or BD preparations prior to sowing. Most farmers applied BD500, CPP and BD501 sequentially based on the Planting calendar as well as foliar applications of CPP, cows' urine and Panchagavya. Several farmers involved in the trial didn't apply the techniques properly and didn't get good results.

The successful farmers aim to double their area under SRI in the following season. With relatively few inputs, such large increases in yields in the first year were not predicted. It is envisaged that yields will continue to improve.

Community vegetable gardens

The second part of the project involved working with women's groups to improve the production of vegetables at the village level. The women's groups and the "rice" groups often shared the same training especially with regards to the making of the various composts and Biodynamic preparations. The women were also trained in and frequently assisted with:

- garden plot design and location
- nursery preparation
- intercropping and companion planting
- mulching & minimum tillage to reduce moisture loss
- no-dig gardens
- Integrated pest management (IPM) including:
  - crop rotation
  - making and applying various low cost organic "pesticides" e.g. neem, chilli, garlic, Bordeaux
  - traps including trap crops
- seed conservation.

After a slow start, the women's groups were the highlight of the project. Initially, they did not enjoy or seek information. However, in less than 12 months they were training nearby villages in many of the things they learnt. They have given produce away to neighbours, or sold it for a premium due to the taste and quality. A common practice of burning biomass has ceased – now it is all used for composting. One garden in particular was in the best possible position in terms of self-promotion – next to the church in the market town. No one remembered anything growing on this rock hard ground; the villagers never thought it possible to cultivate such hard soil. The transformation resulted from some, but not a lot of compost, lime, regular applications of BD500, CPP and BD501 with the occasional foliar applications of vermi-wash and Panchagavya. By the end of the dry season with the second crop under cultivation, the well dried up for a couple of weeks but the plants lasted much longer than they would have under normal cultivation and managed to survive the stint without water until the rains arrived (Figures 5 and 6).


Figure 5. Making progress with improving the land: (L) before, hard, concrete soil; (R) ... and the same patch seven months later.


Figure 6. (L) Use of cowpea as green manure; (R) BD500 & CPP applied to cut green pigeon pea green manure

The outstanding positives have been the way in which the women worked together to not only maintain the community gardens but to feverishly develop their own and others' personal gardens. The groups have experienced success working together in this project empowering them to take on new initiatives. They have since received training from another organisation about value-adding their produce (eg. making chilli pickle). The local NGO is now, with the cooperation and support of the women's groups, seeking funding for a watershed development project to improve the water situation. In an area that has such high levels of rain it seems ridiculous that wells simply dry up. They are also attempting to expand their acreage under cultivation.

Recently I received news that another group of NGO staff from a different state who I had trained in a separate program had taken the 12 hour bus journey to visit the project villages in Nagaland to observe the results and to discuss with the women's groups about the lessons they had learnt. The visiting NGO will return after the monsoon with farmers to utilise the expertise of the women's groups to train their own project farmers in Biodynamics and vegetable cultivation - a better result I couldn't have wished for. As Paul Kelly sang, "...from little things, big things grow".

Case study 2: Using Biodynamics & other organic practices to improve the sustainability of jhumming

In my first few months in the Northeast, I assumed that *jhum* farming was not sustainable and was most likely a major factor in the widespread flooding and landslides experienced regularly in the hills. *Jhumming*, or *jhum* farming, is also known as "shifting cultivation", or "slash and burn". I was not alone: many non-hill people blame environmental problems in the NE, such as severe flooding, landslides and lower rainfall, on *jhumming*. Many outside groups were pressing for transformation to permanent, terraced fields. Looking more closely, it is the declining rotation period rather than the system itself which is making it unsustainable (not to mention the amount of illegal logging that occurs).

Historically, rotations were around 20 years or more. In a very systematic and planned way, farmers slash the forest removing any valuable products (timber, non-timber products, medicines, herbs; usually leaving many coppiced trees), burn the remaining biomass, crop for one or two years, after which the plot is returned to the management of nature and its diversity of green manures for humus production. After the fertility is restored the community returns in 20 years or so to do it again. Currently, in many areas of the Northeast, rotations have shortened to as little as 5 years. Due to population pressures, what was once a sustainable, stable and very diverse system is becoming unstable with soil erosion, landslides, downstream siltation, diminishing yields, less diversity and as a result, is unsustainable.

Considering the diversity and equitable distribution of products, community ownership of the *jhumming* system and its cultural significance, and its longevity over thousands of years (compared to say, Australia's European style agriculture which has caused severe environmental problems such as salinity in only a couple of hundred years), changing to a more permanent terraced system, was not a very likely alternative. Terraced systems require a lot of labour to establish them and can lead to a reduction in diversity of crops i.e. monoculture, and an increased use of chemical fertilisers and pesticides.

Jhum rotations need to be lengthened to return the system to its former sustainable and stable level. One way of lengthening the rotation considerably was if farmers could utilise a plot for more than the current one or two years. To do this, a quick increase in soil fertility is required, remembering that due to its remoteness and its difficult terrain, large amounts of inputs, such as compost, are not a sustainable or appropriate response.

Having already experienced success with Biodynamics with other tribal groups in the Northeast and small and marginal farmers in other parts of India, I consulted with various key people and tribal farmers in the hills in remote Nagaland on the Burmese border to discuss its suitability. Several factors indicated the potential for introducing Biodynamics to these farmers - prior to Christian missionaries arriving, they had also used the moon as a guide for various farming practices, they could readily access cow dung and horns – it excited the groups to realise that Biodynamics was appropriate in this context.

Farmers and NGO staff were trained about soil formation whereby biomass is converted to rich humus. Information needed to be culturally specific – comparing their diet to that of soil organisms worked well. For example, rice was compared to carbonaceous materials (e.g. rice straw, dry leaves, sawdust); meat, pulses and vegetables to proteinaceous (animals and dungs, green waste). The importance of converting biomass into soil organic matter rather than burning it was discussed.

Having made Biodynamic compost, Cow Pat Pit (CPP, or manure concentrate), and put down BD500, these farmers from nearly 20 villages were up way past their normal bedtime watching a DVD about beneficial versus pathogenic soil organisms, as seen under an electron microscope. The DVD illustrated the importance of a source of food i.e. organic matter, for these helpful creatures. These farmers know healthy, fertile soil – it is the one the forest delivers to them prior to the slash and burn – and they also know how quickly it disappears after one or two years of their cropping system and therefore the importance of retaining what they now knew to be humus.

Figure 7. (Above L) BD 500; (Above R) beginning BD compost with steep terrain in background; (R) BD compost making with *jhum* fields in background.

Burning of biomass is undertaken in *jhumming* to reduce the amount of biomass and competition from weeds. Between cropping years, it is used to reduce crop residues and weeds to enable good seed germination. The focus of the work currently being undertaken is to increase the soil biota to such an extent that these residues can be transformed into to healthy humus in a short space of time by using Biodynamic preparations. Farmers from nearly 20 villages have all made BD500 and CPP and are trialling it for the first time.

Farmers in this remote part of Nagaland had not heard about climate change or global warming. As part of the training we went through the carbon cycle and the various ways in which carbon dioxide is created and used (carbon sequestration) and what impact rising emissions are having on global weather systems. We discussed the weather changes that they had witnessed in recent times and they were interested to discuss how other farmers around the world are also facing drier times. From this perspective, we discussed the mutual value of reducing burning and utilising humus forming techniques such as BD500, CPP and green manures, i.e. by increasing humus one also reduces carbon emissions.

Biodynamics and climate change

The farmers that I worked with in the Northeast had not heard about climate change nor global warming but they had noticed a reduction in rainfall. Whilst reducing carbon emissions is of interest, it is merely an added bonus for these farmers that if they undertake Biodynamics and a more agro-ecological organics to improve soil fertility, they also reduce atmospheric carbon dioxide through carbon sequestration. In addition, by not using fossil fuel derived chemicals and synthetic fertilisers they are also reducing global carbon emissions.

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The Biodynamic preparations – solutions for climate change

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Introduction

Rudolf Steiner first described biodynamics in 1924, after requests from farmers, who were experiencing an increasing degeneration in seed strains, cultivated plants and animal health. Steiner gave the farmers indications for nine special "preparations" (500-508), which form the foundation of Biodynamic practice. Horn Manure Preparation (500) is a specially prepared manure, Horn Silica Preparation (501), a silica-rich rock powder; 502-508 are herbs and other materials all with their own beneficial qualities for soil and plant health. Each preparation in conjunction with natural forces stimulates and enhances biological activity in a specific way to achieve optimum results on the farm.

So how do the Biodynamic Preparations work? This is a huge subject and could take us on a whole amazing trip of discovery, which is what actually happens once you get involved. The questions keep arising and answers lead to the next question, and life becomes most interesting. So lets just start with the soil and we can move on upwards.

Recognising vital forces in nature

In the past few years new discoveries have been made in the areas of soil microbiology. David W. Wolfe, in his book *Tales From The Underground –a Natural History of Subterranean Life* describes this time of discovery as "*reminiscent of where marine biology was 50 years ago, when Jacques Cousteau was first perfecting his Aqua–lung for exploration of another hidden realm – the oceans. Such explorations have verified the existence independent ecosystems at all levels below the surface*".
Biodynamic practice has at its very foundation an acknowledgment of working with many levels of activity in both the earth and atmosphere to bring health to the whole farm enterprise. You may remember from our previous article that the Biodynamic farmer develops a greater awareness of nature and the utmost respect for both the visible and invisible forces that shape life. The recognition of some of these vital forces in the soil is now readily understood thanks to Dr Elaine Ingham's pioneering work on the Soil Food Web.

Dr Elaine Ingham, a Soil Microbiologist from Oregon, USA has found that she can tell how the soil has been treated by the soil bio-life found in a soil sample. The healthiest soils are in the old growth forests, where fungi outnumber the bacteria and the whole system works in a symbiotic way to support each other.

> ***How the soil can feed the plants***
> *It is the activity of beneficial soil bacteria that attach with glue to the soil particles together and then the beneficial soil fungi that wrap around the particles and bacteria that gradually form soil aggregates. Water pores and air spaces are created and then protozoa and nematodes and arthropods are attracted by the food source of the increasing bacteria. The bacteria feed off the root exudates and organic matter that the earthworms digest and bring into the soils. Some of the bacteria (azotobacter) are able to make nitrogen from the root exudates and they accumulate it. When the protozoa eat them, this excess nitrogen is released in to the soil and becomes available for the plants roots to absorb for growth. This is how the plant is fed by the soil – water soluble fertilisers are not necessary and are actually detrimental to*

Soils that have been compacted, treated with water soluble fertilisers, herbicides and pesticides have very little bacteria, no fungi and poor oxygen levels and very low if any soil arthropods. In other words it is nearly dead! And this is the reason many have been turning to Biodynamics. How can I help my soil? It used to be alive and now it is dying. What practices can bring the soil back to life?

In Biodynamics we work to keep life in the soil, to attract specific bacteria and fungi that help absorb trace elements and nitrogen in the soil. Biodynamics brings structure and tilth in the soil. Humus is made and the capacity for the soil to hold water is improved. More oxygen becomes available and soil life multiplies incredibly. To achieve this the Biodynamic farmer utilises a range of Biodynamic Preparations.

Horn Manure Preparation (500)

You have probably heard of "Horn Manure Preparation (500)" the most famous of Biodynamic Preparations which is made from cow manure placed in a cow horn, buried in fertile soil over winter, producing a sweet smelling humus-like colloidal substance, when retrieved in the spring. It is applied at 30g-75g per Ha, stirred in water for one hour and spread in droplet form to the soil after 3pm (when the earth is breathing in). Used to build soil structure and tilth, it works with calcium and helps make humus, attracts earthworms and the soil bacteria Azotobacter. The Azotobacter are 15 times more potent at making Nitrogen out of the soil than any other bacteria. It also attracts rhizobia, which helps nodulation on plant roots especially supporting increased clover growth. Soil depth increases, roots go deeper and grow more luxuriantly and the most importantly water is held, like in a sponge in the humus materials created, when regularly using the Horn Manure Preparation (500).

Here is an effective solution for Australia's water and salinity problems! Biodynamic farms use 25%-50% less water than their neighbours working conventionally! We recently heard of the water authorities ringing to see if the Biodynamic farmers were cheating, as they came in with much lower water use than their neighbours in a recent Irrigation audit.

Horn Silica Preparation (501)

The Horn Silica Preparation (501) works in the atmosphere and with the silica and light forces as the opposite to earthly forces of the Horn manure Preparation (500). It is made from ground quartz crystal and is buried in the horns in the soil for the summer months. Only the smallest amount – 1-2g per Ha is used and it is stirred for one hour and sprayed as a fine mist into the air at first light. Used later in the day around midday it can burn – so it is important to only spray out at sunrise (when the earth is breathing out).

This amazing preparation works with photosynthesis. It helps the plant keep up its sugar sap levels and the excess sugar saps are sent to the roots as root exudates to feed the bacteria and fungi that are forming a symbiotic relationship around them. In turn, the increased activity and nitrogen formation helps the plant grow – so we have the complete circle.

By keeping the sugar sap levels high, then plants are resistant to insect attack and disease. If the conditions are extremely wet and prone to fungal disease, then the Horn silica can help restore the balance. The Horn Silica preparation also helps with the dry matter content of the fruit, increasing flavour, colour, weight and keeping qualities. This is borne out in the number of Biodynamic growers who consistently receive medals or prizes for their wines, fruits and grains. Organic wholesalers know that Biodynamic produce has the best flavours and their customers keep coming back for more. Several Biodynamic Herb growers are now topping the list for the highest quality and smell of oils in distillation.

Most exciting is the discovery by grape and fruit growers that use of the Horn Silica Preparation (501) can lift the Baume or Brix sugar levels at least one full point within a few hours – critical at harvest time.

Summer & Winter Horn clay

This is a fairly new addition to the Biodynamic repertoire. It is a clay mixed to a slurry and placed in a cow horn over Summer (Summer Horn Clay) and over Winter (Winter Horn Clay). It works to restore a balance between the atmosphere and the earth, acting as a meditator between the Horn Manure Preparation (500) and the Horn Silica Preparation (501). It creates a boundary around the area sprayed to keep the farm integrity intact and help the soil hold moisture and give back more over the dry periods. It can be used even if the soil is highly clayed.

The Winter Horn Clay is typically used as part of the soil spray to assist in holding nutrients in the soil’s digestive and nutritive processes. The Summer Horn Clay is used in the atmosphere spray and assists in vegetative processes of the plants.

Manure Concentrate

This is also known in Australasia as “Cow Pat Pit” and in Europe and the USA as “Barrel Compost”. Made from cow manure, basalt rock dust and ground eggshells and 3 sets of the Biodynamic compost Preparations 502-507 – it is mixed and then fermented for 2 months in a pit. It can be used as a general soil spray to get the benefits of the compost preparations over large areas. It is especially useful when used for any organic matter breakdown, such as mulches, stubble, sheet composting, turning in green manures, dairy shed effluent and piggery effluent. It is usually recommended for use with the Soils spray – Horn Manure Preparation (500) and Winter Horn Clay.

The Biodynamic Compost Preparations (502-507)

These are made up of various flowers and animal parts treated in special ways. Their purpose is to infuse the compost heap or fermenting brew with living forces. They help the breakdown of organic matter take place in the right way so that the life is not lost, but recycled for the use of the soil. “When used on manure they help it become vitalised so it can transmit this vitality to the soil where the plants will grow.” When the compost or other tea or fermented product made with the Biodynamic Compost preparations is added or sprayed on the soil, it has the capacity to make the soil more sensitive and reconnect to the Planetary movements within our cosmos. This is what has been happening to our earth over thousands of years as it loses it’s immense vitality and ages - we have lost our connections – just like we get a little deaf and blind as we grow older. The Biodynamic Compost Preparations are able to help restore the vitality of the soils again.

The Compost Preparations also appear to work as a stimulant to attract specific bacteria and fungi and trace elements in the soil. It is not a case of putting in microbes and hoping they will survive, it is more a case of make the soil attractive and the soil bio life will appear – rather like the smell of brewing coffee makes us attracted to the coffee shop. Then the increased root exudates from the plant (through use of the Horn Silica Preparation (501) will support their life and increase their activity and thus the plants growth in the right way.

The Compost Preparations (502-507)

These are sold as a set and used in any product being recycled and fermented such as compost, manure concentrate, (Cow Pat Pit), seaweed tea, fish emulsion, fuzzy brew, weed teas, blood and bone brews etc.

A brief summary of the biodynamic compost preparations	
Yarrow *Achillea millefolium* PREPARATION 502	Yarrow flowers placed in a stags bladder. Stimulates the **potassium, silica and selenium** activating bacteria and helps combine sulphur with other substances. Remedies weaknesses in flowering and fruiting and strengthens the plant against insect attack.

Chamomile *Chamomilla officinalis* PREPARATION 503	Chamomile flowers placed in the small intestines of the cow. Helps retain **nitrogen, calcium and sulphur**. Also stimulates **manganese and boron**, as well as **azotobacter** activity – the best bacteria for making nitrogen in the soil.
Stinging Nettle Urtica dioca *PREPARATION 504*	Nettle is buried without an animal sheath. Conveys intelligence to the soil helps proper decomposition, aids chlorophyll formation and stimulates **iron, potassium, calcium, magnesium** and **sulphur** bacteria activity in the soil.
Oak Bark *Quercus robur* PREPARATION 505	Oak Bark placed in a cow skull and in water over winter. Helps restore balance when water activity is working too strongly, such as after lots of rain or at full moon. It also helps protect against fungal diseases. Helps **calcium and phosphorus** work into the earth in a living form.
Dandelion *Taraxacum officinale* PREPARATION 506	Dandelion placed in a cow's mesentery. Stimulates the **potassium /silica** bacteria and fungi in the soil to enable it to work more effectively. Silica makes the plants more inwardly sensitive. Can help increase flowering and filling of fruit out to tips. Also stimulates the **magnesium, boron and selenium** soil activity.
Valerian *Valeriana officinalis* PREPARATION 507	A Tincture made of valerian flowers. Stimulates the **phosphorus** process and mobilises the phosphorus-activating bacteria in the soil, as well as **selenium** and **magnesium**. Prevents the flowering process becoming excessive. Forms a warmth blanket around compost heap. If sprayed onto blossoms in spring can provide protection against late frost.
Equisetum/ Casuarina *Equisetum arvense* I *Casuarina* spp. PREPARATION 508	As Equisetum is seen as a noxious weed in Australia, we have found Casuarina to be a good substitute. **Fresh Casuarina Preparation** works with the water balance in the atmosphere as a **fresh tea** and is used to prevent and stop fungal growth, sooty mould and tightens plants against becoming soft and open to mildew infection. **Fermented Casuarina tea** works in the soil to stimulate the growth of beneficial fungi and large hyphae & is applied with the afternoon soil sprays. All Casuarina seems to be effective, especially the *Casuarina equisetifolia* from eastern Australia.

Biodynamic Plant Tonics

In addition to the soil and atmosphere preparations, the Biodynamic Farmer also uses a number of plant tonics to support the biological and dynamic processes of plant growth. These plant tonics can be made on farm. Plant and animal materials such as seaweed, comfrey, nettle, tree lucerne, casuarina, chamomile, cow manure and fish can all be brewed in 200 litre drums with the Compost preparations (502-507) to make very beneficial foliar sprays. The distinguishing feature of these plant tonics from those used in an organic system is that the Biodynamic Compost Preparations have been added to enhance the availability of nutrients and bio-stimulants.

Biodynamic Tree Paste

A paste applied to the trunk of trees that nourishes, stimulates growth and protects the bark and cambium of the trees and vines, sealing over crevices in which pests may settle in winter. Made from equal parts of cow manure, silica sand or diatomaceous earth and clay or bentonite it is mixed to a thin paste, stirred with the Horn Manure Preparation (500). For a small number of trees it can be painted on with a whitewash brush or in a commercial situation the paste should be thin enough to be sprayed out and only made with the diatomaceous earth instead of sand.

Moving into Biodynamics

If these descriptions of the Biodynamic Preparations sound too daunting as a method of farming, you can relax in the knowledge that all the Biodynamic Preparations and some of the plant tonics can be purchased through Biodynamic AgriCulture Australia in commercial quantities. The association provides the convenience of ready-made preparations as a service to their members who consist of growers from across Australia. So once you have completed two days at a Basics workshop on how to work with Biodynamics, acquired some basic equipment for stirring and spraying out, you can place your order and get underway.

For those that are keen to learn the whole process, once a year the Association has a Preparation Making weekend and also run’s Master Preparation Making workshops to assist local regions in making their own Biodynamic Preparations.

In the Summer issue, we will look at the different types of equipment used for stirring and applying the Biodynamic Preparations, Equipment Calibration and timings for putting the preparations on.

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The UK organic market: key drivers and recent mistakes

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Abstract

Over recent years and as organic food has become less of a niche market the majority of organic food production and distribution in the UK has simply developed along the same lines as the conventional market. In this market environment, medium-sized non-specialist operations struggle to compete with larger specialist units on a price basis. Yet even the large specialist units are finding it harder to obtain a return on their product that covers production costs, and allows for re-investment. So how can the Australian organic sector learn from the UK market and avoid the same issues?

Key Words

Organic food, consumer attitudes, industrialisation, specialist units, direct sales

Introduction/Problem

The ongoing growth in sales of Australian produced organic food is something to celebrate. But developing a ‘sustainable’ organic food market within the confines of a global economy is not going to be easy. Relatively speaking the Australian organic market is very much in its embryonic stage compared to Europe and the U.S. This gives it the tremendous advantage of being able to avoid some of the problems that have occurred in the overseas organics markets.

Organic farming is synonymous with sustainability. The principles of sustainable production are encompassed within organic standards, organic philosophy, and hopefully the mind set of nearly every organic producer in the country. But we cannot achieve sustainability by simply changing our farming systems. We must also change our market structures and trading relationships. There are already some early signs of emerging problems in the Australian organic market that many overseas organic producers have already experienced first hand – let’s ensure that we do not make the same mistakes.

As the organic market developed in the UK, so did the level of competition between producers – both domestically and in Europe. To remain as supermarket suppliers, many producers began to cut costs and returns. The result? Organic food production and distribution has simply developed along the same lines as the conventional market. In this market environment, medium-sized non-specialist operations struggle to compete with larger specialist units on a price basis. Yet even the large specialist units are finding it harder to obtain a return on their product that covers production costs, and allows for re-investment.

The Australian supermarkets account for a significant amount of all organic food sales and clearly have a very important role to play in getting more organic food onto consumers’ plates. However we must remember that supermarkets only sell what the consumer demands and have shareholders to keep happy. One of the larger global supermarkets slogans is: Every Day Low Costs (EDLC) equals Every Day Low Prices (EDLP) simply put, the less money they can pay the farmer the better. Is it therefore not inevitable that down the line, many Australian organic producers will get into this trap of not receiving a fair price for their product?

Conclusions

The future of organic agriculture is likely to be a mix of globalisation and localisation. Consumers in the UK are starting to think more about buying organic food for environmental reasons due to the recognition of not only the traditional perceived environmental benefits (more birds, less water pollution etc.) but for the wider environmental benefits of reducing global warming through carbon sequestration and the reduction in fossil fuel use through the use of fertilisers. The reduction of food miles is becoming the next big thing in the eye of the consumer and is already forcing the hand of some supermarkets in the UK. For example Marks & Spencers have a policy whereby they only source organic food within 30 miles of it’s store. The Australian organic movement needs to do more to educate consumers, encourage farmers to work together, form producer groups and look at ways of encouraging others to come on board and meet the growing domestic demand for organic produce.

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Peak oil and the future of food– a Western Australian perspective

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Introduction

The development of internal-combustion engine at the end of the 19th century had a profound affect on agriculture. Combined with large immense lands of the 'new' agricultural production countries, North America, Australia and New Zealand, the potential to mechanize food production to increase food supply became a driving force that has developed modern agriculture as we know it today. Combine that with the hydrogen based manufacturing of nitrogen rich fertilizers to supplement the expansion into large scale cropping techniques that mechanism provided, you have a new, emerging, technology based industry. Thus began the dependence of agriculture on oil.

Such technology within agriculture has dramatically changed how we do farming. On a positive note there has been a sense of security in a more stable and abundant food supply; yet, technological advances have dramatically increased environmental degradation, dependence on oil, and reduced efficiencies in energy. Understanding these changes requires looking at the relationship between population and consumers, global trade and environmental sustainability.

Agriculture today is a global trading commodity with a net value in the billions of dollars. Consumer demand expects that the global supply chain will provide wheat from Australia, apples from Chile and carrots from China. Flown in overnight, overseas, transported and distributed through huge, multinational grocery chains, oil continues to support this massive web of commodity supply infrastructure.

So what happens when there's a disruption in oil supply? Peak oil is here- and it's not about the world running out of oil. It's about the world coming to the end of cheap oil. The down flow effects on agriculture when there are concerns over oil supply are massive. The end of cheap oil means the end of cheap food as we know it.

The ethics that support organic agriculture may provide an alternative – but it's going to take a change that begins with consumer perception.

Snapshot - population, consumption and the microwave lifestyle

In mid 2006, the Western Australian Environmental Protection Authority released the draft State of the Environment Report, looking at the condition of the WA environment for decision makers and the community to determine the impact development, agriculture and society has had on the WA environment. The findings are not positive.

Population and consumption have become a WA priority up there with climate change, as the two of them are intrinsically linked. WA is experiencing a 1.5 % increase in population per annum and this trend is unlikely to change. In addition, the lifestyle that WA offers gives the state a high ecological footprint, meaning that the consumption rates per capita are amongst the highest in the world (SOE draft 2006). The high standard of living, economically, means the amount of goods and services that a family or individual views as necessary- aside from owning the home, cars and accoutrements that round out a specific comfort level, there is also an increasing drive for convenience in the supply and packaging of food.

Food consumed per capita by each Australian per year averages to about 695kg of food and 227 litres of beverages (Australian Food and Grocery Council 2003). The desire to have 'food on demand' means that a large portion of the food supply is increasingly coming from overseas suppliers. Exotic and staple foods supplied year round increases dependency on overseas imports which leads to competitive price variations between suppliers. The decline of several sectors within the WA horticulture arena highlights this trend- with increases of imported cauliflower, broccoli and carrots from China at a better price, many state based farms suffered significant losses to the point of having to shut down.

On the other hand, WA supplies a large portion of wheat and other products to the global economy. 46% of WA's ecological footprint was attributed to land use for food production with 70% of that production was for products for exports in other countries (SOE draft 2006). The effect of this agricultural export powerhouse has been the leading cause of land clearing which has lead to salinisation, reductions in biodiversity, and the reduction of WA's ability to sequester carbon through its natural forests, all contributing to climate change. Cereal exports now come from a few countries that provide 81 percent of net cereal export on world market (M. Giampietro and D. Pimentel 1994 http://www.dieoff.com/page69.htm).

What we are seeing is an emerging trend in global food supply monocultures. Countries are amassing large tracts of land towards less than a handful of food commodities- Spain produces olives, Australia produces wheat, Chile produces apples. This trend not only has an impact on a country's ability to supply a diverse range of food domestically, but also has a significant impact on the country of origin's native biodiversity assets.

The issue isn't about whether or not we will have enough food to feed the world. There are adequate supplies of production available that are regulated by the trade markets. Peak oil has us questioning the affordability of sustaining those markets and current productions systems within a global context. Intensive monoculture production methods have a demand on a country's natural resources of land and water, impacting changes in climate. With food being shipped around the world utilizing fossil fuels to do so, we place our national food security at risk in light of the cost of oil while also additionally contributing to increases in greenhouse gasses. The global market and free trade ideology that the high standard of living of the Western world has embraced so readily may just become our undoing, especially in light of countries such as India and China desiring to catch up with the living standard of current industrialized nations - China, uses more fertilizer per hectare than the U. S. What will a future slowdown of fossil fuel supply mean to both developed and developing countries? (M. Giampietro and D. Pimentel 1994 http://www.dieoff.com/page69.htm).

State and regional food security assessment

Perth is considered one of the most isolated cities in the world.

Looking again at the population trends in Western Australia, we have increases in population on a thin strip of land known as the Swan Coastal Plain, which lies west of the Darling Scarp and extends north and south from Perth to Cape Naturaliste. WA's population reached 2 million in January 2005 and is expected to increase by 41% by 2031. The combination of the population increase and the narrow strip of land available will put pressure on current land use changes.

The land that sits over the Darling Scarp is primarily low rainfall area and currently being used for dryland broadacre production such as wheat and canola. Much of the horticultural production in Western Australia sits along the coastal strip fringe and the Swan Coastal Plain, where water resources are adequately available. Changes in climate are already having impact on stream flows in these production areas and there is already discussions taking place on how WA is going to meet its future water resources. Land use is also coming to the forefront, as competition for urban and industrial land is impacting on land currently under production for food.

In light of the population trends and demands for urban/industrial land, pockets of agricultural land around the Perth metropolitan are being squeezed out to the fringes of settlement and in some cases disappearing altogether. Out on the other side of the Darling

Scarp where the monoculture of broadacre crops are produced, affects in rainfall from climate change will have impact on the export production cycle. Crop ecologists agree that for each temperature rise of 1 degree Celsius above the historical average during the growing season, we can expect a 10 percent decline in grain yields (L.R. Brown 2006 http://www.earth-policy.org/Indicators/Grain/2006.htm) In 2006, broad acre crops have fallen behind 6 weeks and CBH is estimating that the grain harvest for the 2006-07 season will drop from 11 million tons to 7 million tons (A. Charles, per. comm.)

Risk assessment has been studied and compiled in terms of business, insurance, health and safety and terrorism. Very little has been done in terms of food security in the event of a global shift of events, either politically or naturally- and threats do exist, based on the dependency of global food markets. Mad cow disease, avian bird flu and other health scares have the potential to shut borders and affect the global inter dependency of food trade. The biggest threat is oil. The cost of a gallon of jet fuel soared from US 78 cents per gallon in 2000, to $US 1.81 per gallon at the start of 2006, according to the U.S. Department of Energy (http://www.azcentral.com/). Already, news stories are reporting on increases in food costs with the rise in oil prices - milk, cheese, yoghurt and fruit juice rose between 4 and 8 per cent in WA in 2005 (http://www.abc.net.au/news/newsitems/200509/s1471509.htm). This trend is likely to continue as oil prices escalate.

Taking into account the population growth, loss of land for agricultural uses, drops in water resources, increases in oil prices and the dependency on food imports- a striking question appears for Western Australia- in the face of all these changes, how will WA secure 1.9 billion kg of affordable, clean, food for its 2.8 million people in 2031?

The ethics of organic agriculture – downsizing production

While there are numerous discussions on the multitude of benefits for conversion of conventional agriculture to organic production practices such as better management of soil and water, animal health and improved health in the food chain with the reduction of pesticide use, it is the ethics, the grassroots basis of organic production that could assist with providing a solution to future planning of WA’s agricultural sector.

In many parts of the world, organic food has become a bourgeois status symbol that speaks dollars to big business, adopting conventional farming infrastructure to supply volumes of organically grown produce to the specialty sectors of the world market. While organic agriculture seeks to utilize those advances that consistently yield benefits that discard methods that have led to negative impacts on the environment, the movement and ethics behind organics had more to do with small scale land and farm management, often family operated, and a reconnection of the consumer to the farmer, building on local food networks.

The ethics of organic production makes a unique contribution to food sufficiency by retaining in actual practice food production methods which are capable of adding to “community food security”- a sufficiency that is secured when food is locally grown and with cultural practices that support a reduction on distant and/or interruptible resources (http://www.csus.edu/indiv/d/dundons/Orgnsoul.htm). Many organic farms within WA are small family owned and operated businesses that supply either direct to the consumer or through specialty food outlets.

WA could look at leaving its primary export market to its resource mining base and begin to focus on how it’s going to address its future food security in light of the increase of oil prices and establish future planning that:

- Dedicates fertile land and water and critical to farming within a reasonable proximity to urban areas
- Encourage small, diverse and manageable farming systems that assure supply to urban areas while also encouraging natural resource management that protect the soil and waterways

Establish economic and regulatory conditions for farming that protect the health of the soil and waterways and the safety of its crops.

This would involve a ‘downsizing’ of current farm production- not in the total volume of product produced, but in the actual size of an individual farming operation. By encouraging smaller farms that could be more easily managed a more flexible, practical and resilient system and network could be put into place that would assist with future food security and actually provide a pathway for sustainable community development. The cultural aspects of communities to have direct linkages to farming systems within close proximity of their urban dwellings not only gives access to healthier, cheaper food but also encourages an understanding of the food supply chain for future generations, which currently, is being degraded, as many of the younger generations do not understand where and how their food is produced.

Smaller farms pocketed within and around metropolitan districts can provide reductions in transport costs and also return a net benefit to the preservation of native biodiversity. While the production methods might be considered a littler more intensive, the encouragement of organic production practices can assist with improved environmental outcomes.

Conclusion

Peak Oil is having and will continue to have a major impact on agricultural production systems, and will begin to erode the future of food security for Western Australians unless current planning practices take into account its impact and begins developing strategies to counteract its affects. The ethics of organic production systems can provide a pathway that could encourage policies and institutions which tie food production to its community, assist with the development of jobs, and enhance outcomes of benefit to the environment. Organic systems can provide renewed ethics to the basis of sustainable farming and build a robust and resilient future for the supply of food.

Fresh thinking: from farm gate to dinner plate

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Nostalgia can be a significant driver of social change. So, stop for a moment and be transported...

The sky is a searing bright blue, the sun hot on your back, tanning the flies. You pull into a 'Tidy Town', its main street lined with battered utes and 4WD vehicles, verandahs or peppercorn trees delivering shade, often to dusty, vacant shops, the 'For Lease' signs long removed. There is usually a milk bar, a post office, school, and a pub or three, but no bank. Churches still signpost high ground.

Sometimes this rural town snapshot boasts a swimming pool, bowling club, RSL, community hall, and on the outskirts of town, the showground or race track.

Our generic nostalgia forgets to paint in the IGA, or Woolworth's, the Landmark depot, Shell petrol station, the Reject and Rivers store, and the Telstra shop, purveyors of global goods to sustain our contemporary appetites.

This template works equally for many of Australia's country towns, places where we holidayed as kids, where uncles and parents lived. A simpler life that we all secretly hanker for.

My childhood vacations were spent occasionally on a dairy farm in Gippsland, and a grazing property 30km west of Orange. Now, my infusion of fresh country air comes courtesy of the Hilltops region near Young, in south-western New South Wales.

It's an orcharding district best known for cherries. The blocks are often small, based on original soldier settlement entitlements of 20 acres, but they can be very productive. Peaches, apricots, plums, cherries, plumcots, nectarines, figs, persimmons all thrive, providing Mother Nature delivers a fair dose of rain.

Yet, if you check the windows of the main street's real estate agents or the pages of the Young Witness, you'll spot countless orchards for sale. Prevailing fruit prices simply don't sustain viable operation, so orchards have been bulldozed. Increasingly, the crop is housing.

Preservation of viable farmland is critical to the health of a nation. So too, increasingly, are local food systems – a concept best encapsulated by another nostalgic image – picking warm, vine-ripened tomatoes or zesty lemons from the backyard garden (Figure 1). Or the sight of a chef nipping out of his kitchen to pick salad leaves from the on-site kitchen garden for the meal you have just ordered.


Figure 1. Victorian farmer George Haysom

With the rising global cost of fuel, food miles suddenly start to look like a very expensive luxury. Add the reality of factory farming, the dominance of retail food giants, and other disturbing food supply trends and it's no wonder there is increasing debate on the role and benefits of local food systems.

Pivotal to this new food activism are farmers' markets. Across Australia this vibrant grassroots movement is changing the way we eat, and changing the lives of the farmers and food producers who, wittingly or unwittingly, are the guardians of our healthy future.

Come Saturday and Sunday mornings, at showgrounds, racetracks, parks, in sheds, on vacant car-parks, in town squares there is a new attraction – the local Farmers' Market (Figure 2).

Figure 2. Cardinia Ranges Farmers' Market, Melbourne

As old as mankind, yet shiny bright and relatively new, these direct-from-the- farmgate-to-the-plate fresh food markets have popped up like perpetual spinach across Australia, from Albany and Carnarvon in the West, to Willunga and Wauchope, Collingwood, Pakenham, Orange (Figure 3), and Byron Bay.

Figure 3. Orange Farmers' Market

The first farmers' market started trading in 1999. By the end of 2002 there were approximately 35 farmers' markets. Now the count is about 100 operating in all states, delivering an estimated annual turnover of $40 million and a factored economic impact of $80 million.

These startling figures emanate from national research undertaken by the Department of Primary Industries in Victoria (2005), and flag the very healthy growth of farmers' markets across Australia, and their viability.

The recent independent research underlines the incontrovertible win-win benefits of farmers' markets for all stakeholders – for the farmers who support them, the communities who host them, and the shoppers who turn up in droves hungry for the taste of fresh, healthy food packed with flavours that trigger those nostalgic memories we have of picking a ripe, sun-warmed peach, its sweet sticky juice running down our chins, exploding a big happy smile on our faces. That's exactly the legacy we should all seek for our children and the future.

Fools rush in where angels fear to tread: leadership reflections for Oceania Pacific

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Introduction

We may not know it, but the world of Organics is a very hip place to be. We are the fastest growing food sector and many want a slice of our action. It is difficult to maintain our fast paced lifestyle; everyone wants to come to our party. It is heady times for the rich and famous...yeah right!

It is true that the growth over the last five years has seen our own institutions mature, develop and evolve to meet new demands, but are we any closer to managing the situation? Should we try and bother? We have seen attempts in the Oceania Pacific region (O&P) to organize ourselves co-operatively at the national level. For example, through the recently formed national bodies Organic Federation of Australia (www.ofa.org) and Organics Aotearoa New Zealand which evolved from the Organic Federation of Aotearoa New Zealand and Te Waka Kai Ora, and the Oceania and Pacific Initiative Forum. This has come from the belief that by uniting, and operating in a more co-operative manner with designed intent, we will bring about a preferred future, one of our making, true to our philosophical base.

Self belief that we are ‘powerful not desperate’ has been a potent tool. Yet there is absolutely no room for anything but brief celebration. As we evolve so to does the environment we find ourselves having to manage. The Organic paradigm needs to be comfortable with this. It is consistent with our philosophy and principles based on an ecological and biological consciousness. A prominent New Zealand dairy farmer once explained when asked what Organic meant to him that, ‘Organics is jazz; collective, responsive, improvisation’ (Pers comm.. Jammie Taite-Jaimeson 2001).

If we were to use this explanation to describe how we would manage our success we might: behave as a collective – yet permit individual eccentricity, be quick to respond – being well trained and disciplined and improvise - with trust in each other’s commitment and ability to perform. There is no specific script or song sheet for what we are doing, we should remind ourselves that Organics is not lineal or prescribed in thought or action.

Taking our experience to the world

Being elected to the International Federation of Organic Agriculture Movements (IFOAM) World Board in 2005 has been an insightful opportunity. There has been ample occasion to see that whilst we, in the O&P region may have our differences, that there still remains a collective ‘down under’ consciousness that is unique on the world stage.

This was clearly demonstrated at IFOAM’s General Assembly in Adelaide 2005, where our ANZAC spirit of collegiality was clearly apparent on several critical issues. Unrehearsed, we literally stood alone with a few other countries, one being France, on several critical issues. It was clear to me that this would be continued at the Board level and my ‘hunch’ has proven to be true.

Our concern was, and still is, the direction Organics is taking internationally. The road map or strategy of achieving our global collective goal of, ‘the worldwide adoption of ecologically, socially and economically sound systems based on the principles of Organic agriculture,’ (http://www.ifoam.org/about_ifoam/inside_ifoam/mission.html) is not comprehensive, well articulated or understood.

It is not to say there is no strategy, far from it, within IFOAM there are genuine attempts to deliver with restricted resources (http://www.ifoam.org/about_ifoam/inside_ifoam/program.html). A limiting factor however is our capacity to deliver what is required, at the necessary pace. For an international organization with IFOAM's responsibility the budget is only 1million Euros.

It seems that a current dominant position (I would not call it a strategy) is the 'mainstreaming of Organics'. Again however, little time or energy is placed on developing any collective conscious thought of what 'mainstream' actually means. As a result there is a counter position (also not evolved to a strategy) that this is taken to mean the 'conventionlisation of Organics', which describes an environment that sees product and place certified but hardly sustainable. It is not hard for us to identify examples of either. We maybe the fastest growing food sector in the world, but hardly closer to achieving the 'Organic ideal' our principles lay out for us.

While the rationale for 'mainstreaming' Organics, as we are seeing it, may temporarily quench the thirst and feed the consumer monster, it hardly fits our principles. This concern is not a recent phenomenon and was first brought to my attention a decade ago in Woodward et al's classic 'The Organic Dilemma' (Woodward, L., Flemming, D., Vogtmann, H. 1996 Health, Sustainability and the Global Economy: The Organic Dilemma. Paper 11th International IFOAM Conference Copenhagen, Denmark 1996) published in 1996. This concern was reiterated by two of IFOAM's grandparents, Hardy Vogtmann and Stuart Hill, during plenary sessions, in Adelaide 2005 (Voghtmann, H and , Hill, S. Key note addresses 15th IFOAM Organic World Conference, Adelaide Australia 2005). In short, I am not a lone voice in my concern of the direction we are trekking.

It is true that we want the world Organic and on our terms, but I'm less convinced we are currently driving the change, rather reacting to it. Leadership has a responsibility to address this, not lightly but from a deep strategic platform that questions the fundamental assumptions of Organics, who we are, our heritage, our role in society and how we strategically direct our efforts over the next 10 years. If not, my concern is that we will see (are seeing) a split in the Organic community.

So how do we, support IFOAM's mission of 'leading, uniting and assisting the Organic movement in its full diversity'? Given our recent experience at the national level and modest attempts in communicating with each other, we would have to conclude that the task is onerous.

Should we 'down under' even care about this at the international level? Especially given how difficult it is to maintain our relationships nationally. I personally believe that not only should we care; we should be proactive, assertive and assist in leading. We need to internationalise our voice and demonstrate how we bring together some new meaning of 'mainstreaming' so that it does not mean the 'conventionalistion' of Organics.

Making IFOAM truly international is important because historically I have often heard IFOAM referred to by the cynical (experienced) 'down under' members as U-FOAM (as in Europe), with clear resentment of colonial tactics in shaping the Organic world, especially standards. It is true that membership outside Europe is disproportionate and continents like the Americas, even though they were fundamental in its creation have basically ignored IFOAM. The only continent with growing membership is Asia, whom I'll come back to later. As one European colleague once remarked sulkily, 'Few care of IFOAM outside of Europe.'

I personally adhere to the goal and mission of IFOAM whole heartedly; I would not be there otherwise. The global adoption of Organics resonates with my own Organic econation2020 vision (www.econation2020.org). I see the European domination therefore more of an inability for the rest of the Organic world to assert itself and articulate what it wants and how, than some grand European master plan of control. We need to organize ourselves so that we participate more effectively and assist IFOAM in a required reform that truly internationalises the organisation. This reform can only come from its member base and I suggest that the O&P region can offer credible and critical voice to bring about required change. I would also suggest we move quickly.

We should however be mindful and reflect that IFOAM’s current status is built predominantly by European nations who have placed huge resources in initiating the global version of what we are replicating in O&P. We always need to be respectful of this.

Indicators that we need to act fast

Walmart is going Organic (Pollan, M. June 4 2006 ,New York Times. ‘The Way We Live Now: Mass Natural. . Known as the Walmart affect, when they make a decision, it sends ripples out in the big consumption pond. To get a sense of scale, Walmart’s turnover is US $312 billion, they employ 1.7 million people, are the 20th largest economy in the world and the 5th largest in the United States of America (USA) (Pers comm. Unilever Sustainable Agriculture Advisory Board Meeting report June 2006). When they send a message out that they, ‘See the environment as the single biggest opportunity in the 21st century’, and a chance to change the operating dynamic, including triple bottom line goals and modelling the possible future (*ibid*), then their ripple turns into a wave perhaps even a tsunami, especially when their suppliers scramble to follow.

Walmart is not alone, conventional supermarket chains have been rushing out their own organic store brand lines, costing significantly less than comparable brands in natural food stores. On average, prices on private-label goods are about 27 % below brand products. SuperValu Inc., second largest supermarket chain in the US, is introducing a line of 50 organic products called Nature's Best with cereal, juice, apple sauce and pasta. 100 more organic products will have been introduced by the end of June. Its goal is to have an assortment of 300 products by mid 2007. Nature's Best's prices are about 10 to 15 % lower than comparable products from the US. Safeway Inc. recently introduced 150 organic products and plans to have as many as 300 organic products by the end of next year. It is estimated that organics will reach 15.5 - 16 billion US dollars this year (www.post-gazette.com).

Given the discussion on mainstreaming, what does this mean to the Organic sector?

Implications for suppliers mean they in turn must change their practices, follow Walmart et al’s vision and meet their demands. It is not so simple; to even contemplate supplying Walmart et al you have to be very large in scale.

We have witnessed only the beginning of the implications of this for the Organic sector. USA Organic companies Horizon and Aurora, who together control up to 65% of the organic dairy market in the USA were recently finger pointed by the Organic Consumers Association (OCA), for blatantly violating traditional organic standards by purchasing the majority of their milk from factory-style dairy feedlots where the cows are kept in intensive confinement, with little or no access to pasture. Both Aurora and Horizon supply Walmart and other large food businesses like Costco, Safeway, Giant, and Wild Oats. OCA has organized a boycott to, according to them, ‘protect Organic standards’. OCA states that through their on line voting system 96% encouraged the boycotting of Aurora and Horizon products. The argument in defence of Aurora and Horizon is that they are simply filling a niche in demand and the USA standards permitted the practice.

On a recent visit to the USA, Rodale’s’ farm manager Jeffery Moyer, who sits on the USA’s national standards committee, when asked about the Aurora / Horizon example, reminded me that we are all human. People will always push the boundaries. Like tax, people will find gaps, and methods to create an advantage. It is why standards have moved from a single A4 sheet of paper, at their conception, to volumes of documents. It is also a reminder that not all involved in Organics adhere to the principles. It might be time our standards move to be more performance driven, where the certified demonstrate measurable performance to principles and accepted practices over time.

Also under pressure to meet demand are giant food transnationals like Unilever (information provided as member of Unilever's Sustainable Agriculture Advisory Board). They know that Walmart et al's move to create their own brands will affect them. They also know the transition to Organics is difficult requiring a cultural shift beyond their current sustainable agriculture, or company and cultural ideals. Whilst Unilver has no Organic policy they do have their finger in the pie by owning Organic brands that have certified Organic produce (e.g. Bertolli [http://www.bertolli.us] pasta sauces certified by CCOF www.ccof.org and olive oils, and Ben and Jerry's [http://www.benjerry.com/features/organic/index.cfm?s=new]).

Unilever are a company moving quickly into sustainable agriculture practices like integrated pest management, pesticide reduction programmes and self imposed sustainability performance criteria. They understand the business of producing food commodities and the time required to create quality products. Their marketers tell them it's the way the company has to move their business now, because, 'the train has left the station' (Pers comm.. SAAB Unilver meeting June 2006). They may not like to admit it as a company, but they are being forced to head our Organic way.

Again what does this mean to Organics? How can we assist?

This expansion is taking place without even the mention of China, India and the demand emerging from within the China market alone is expected to outstrip USA by 2012. I have been witness to some attempts for Asian nations to organize themselves nationally and share best practice with their neighbours. This is not an easy task. Firstly language possesses a huge boundary for them to operate internationally and their political environment is not as simplistic as ours. We in O&P need to be mindful of this and I want to reiterate how easy it is for us to meet, share and co-operate compared to most international environments.

Little or no strategic dialogue is taking place with this, what does it mean for Organics?

Issues of 'mainstreaming' Organics are not all strategically grand scale. Right at home we all have the consistent barrage of the blatant misuse of the word Organic and certification and poor labelling (people wanting to gate crash our party). The sophistication of this is extending to the point where I have witnessed 'certified Organic' cleaning products from Australia being sold in stand alone shops in Taiwan (http://www.naturesorganics.com.au/haircare_organic.htm). On investigation, the only claim from their brand is that hair products 'contain a nutrient blend of organic extracts.' Savvy consumers in Taiwan, as in all countries, are not impressed. Consumers expect more; it is a relationship we in the Organic sector need to acknowledge consciously and nurture, consumers are our strongest ally. How do we build better relationships with our consumers?

Oceania Pacific's place in the organic world - what we can offer

It is a personal believe that O&P as a collective can provide strategic direction and leadership to the world.

We in O&P already contribute significantly to the world of Organics. Our statistics internationally are impressive. With over 12,151,000 hectares (39%), we host the largest area under Organic management (Willer, H. and Yussefi, M. (Eds.) 2006. 'The World of Organic Agriculture; statistics and emerging trends 2006.' pp. 28-30). Twelve percent (4 of 33) of IFOAM's Accredited Certified Bodies are from O&P (International Organic Accreditation Service, February 2006 'IFOAM Accredited Certified Bodies.' www.ioas.org), and internationally some of the most respected. We are active within IFOAM's working groups and task teams. For the last 17 years there has always been an O&P member on IFOAM's

World Board (Bob Crowder [NZ 1987 – 1996] and Liz Clay [Australia 1996 – 2005]). We have hosted 2 of IFOAM’s 15 international conferences, both in the last twelve years.

It is also true that we are at times culturally challenged by our European colonial past, but I personally have found this an advantage. We are not tied by history and have a healthy disrespect for authority. We are generally international in perspective and well travelled. We are geographically close to Asia and recognize the importance of our relationship with the peoples of it. We live in diverse cultural environments and understand tribal consciousness.

Perhaps most importantly is our rare combination of pristine environment, simplistic politics and relaxed ‘can do’ attitude. We are able to hold the Organic line at a time few internationally can. We have some of the oldest Organic institutions of the modern era (1930’s onward), are highly innovative, and demonstrate a keenness and ability to cooperate. We can still (for the most part) boast the ability to have products GE Free. Our production systems cover a wide range of climatic zones and ecological biomes. We tend to celebrate our diversity, finding it easy to communicate across a wide range of socio / economic and cultural barriers.

There is hardly a place on earth that could achieve IFOAM’s mission and goal, more easily than our own.

A personal view of what these changes could mean

I have described the ‘conventionalisation of Organics’ as a negative result of rapid growth and ‘mainstreaming’ ideology. It has also been used to describe that being certified Organic can increasingly equate to being unsustainable in practice. I find this contradiction untenable. It goes hand in hand with large scale operations that indicate they are part of the negative aspects of globalization. I say the latter because I believe that at the essence of Organics is that the family farm and or garden is a fundamental part of a sustainable society. Our current global economy does not necessarily favour the small farmer, and globalisation is often a strategy that results in the consolidation of farmlands and resources into large holdings owned by fewer people and the expansion of monocultures whose principle development strategy is short term profit.

We also need to be conscious that the gap between Organic and conventional is closing fast. We do need to congratulate ourselves for creating many of the pathways that have enabled this. However, for some time, I have described the current Organic community and practices as ‘running on empty’. We are being driven by the fuel placed in the tank during the 70’s 80’s and early 90’s. We need a resurgence of energy, and enthusiasm that is not only consumer, or market driven (current) but content driven that makes management of land an exciting and fun place to be. The resurgence (renaissance) has to ensure Organics remains part of the solution. I for one would be happy to see it evolve beyond our current comprehension, so that in forty years time Organics of today will be seen as conventional then. We have only just begun to realise our own potential.

We now need to continually push the boundaries from the conventional [Organic] paradigm, through the efficiency and substitution models we currently operate in, and launch into the whole ecosystems redesign. We seriously need to be the progressive dynamic learning community we espouse.

As we all know, the message of Organics is actually very simple. Our leadership (top down, bottom up) needs to communicate this far more effectively than we have been. We need to use the right language (and different) to the right audience. Organics is not a prescription formula, its fluid, jazz...remember? It may well be time to admit what we do well and what we do not (part of good strategy) and engage skills we seem to failing in –communications would be one.

We should be conscious that as Walmart et al develop their own organic line they could also develop their own quality standard. And while protecting what Organic means is paramount, standards is only one tool for doing this. Like a driver's test, owning a license gives little indication to the ability or quality of the driver. Organics actually has little to do with standards or certification. It is a crude and limited tool of measuring what we actually do. It has also driven our strategy to focus on trade as a dominant means to accomplishing our mission and goal. One result is that our thinking is now dominated by technical issues – hardly the things that mobilise a movement.

Our strategies need to take everyone with us. That is what a uniting community does. We do need to identify where the leadership (top down, bottom up) is and support it. We in O&P have, to varying degrees, an existing national platform. I believe it is very important we see the strategic importance of working towards an effective O&P forum that genuinely represents who we are internationally.

Equally important is for us to affirm existing relationships and reach out into unfamiliar ones. Most specifically here I believe that our relationships with Asia should be seen beyond trade and extending out to education, research and best practice; the full diversity of Organics. There is so much to share and learn.

Conclusions

The purpose of this paper has been to highlight some insights and observations from an international perspective. It is also to gain support. We are hardly fools and would barely graduate as angels, history will determine this.

If we want the world Organic, we need to work with the self belief that we are the 'powerful not desperate'. We are the legitimate leaders of this change. The ancestors of the Organic movement have given us this time. The high ideals of our own and IFOAM's mission and goal need to be believed and actualized in our lifetime. The stakes are high. The United Nations Millennium Ecological Assessment Report (http://www.millenniumassessment.org), signals a grim picture for humanity, estimating we have less than 50 years before we see major systems collapse.

The situation is moving very fast and to be effective we have to be anticipating and operating several years into the future today. This requires us to manoeuvre in a mode of recognizing pattern while appreciating detail, we can ill afford to be operating in a fact free environment. Yet how many more facts and figures do we really need to know that Organics is a corner stone to averting major systems collapse?

Organics is practice not only knowledge based, it has to be part of all of our daily lives. This is what gives it meaning. It is what marketers tell us is the reason consumers are reaching out for what we hold, they want our story and lifestyle. We have to become like the jazz musicians; thinking, talking, growing, giving, consuming Organics every single day. It has to resonate in everything we do, we become purpose driven, create deep cultural change, not a shopping alternative. Our organizations must demonstrate the change we want.

Finally, I recommend the following points for discussion, debate and hopefully action.

1. We have to learn to say no now. The danger of compromising the long term in the quest for short term success is fraught with danger. What we are responsible for transcends the short term horizon.

2. Have self belief, get in the drivers seat of the world going organic, and act accordingly.

3. Our leadership needs to drive a major strategic exercise starting at the O&P level. A core focus of this work would be reallocating available funds.

4. Support existing institutions that share the same vision, talk with those that are hesitant.

5. Engage skills we do not have, urge people with the right skills to help (ask for help).

6. Develop international relationships especially those in Asia.

7. Undertake massive consumer education programme with a specific focus on primary age children.

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