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■ *Research Paper*

Community Resilience and Contemporary Agri-Ecological Systems: Reconnecting People and Food, and People with People

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Alternative agricultural systems that emphasize ecological and community resilience provide a bridge between traditional agriculture and natural resource management. These can be referred to as agri-ecological systems and include systems such as Organic Agriculture, Biodynamics, Community Supported Agriculture (CSA), Permaculture, Farmers Markets and Community Gardens. This paper reports on current research by the author to explore a range of these systems and how they contribute to agri-ecological and community resilience. For example, resiliency can be seen as a system's ability to adapt and respond to external impacts on a system, and farmers markets show resiliency to sudden market changes (such as price or consumer preferences toward organics, through direct sale and the involvement of a range of consumers and producers offering a broad range of organic produce). That is, this paper reviews these alternative approaches to food production in relation to key concepts from ecological systems thinking, such as ecological resilience, biodiversity and holism. More specifically, the paper explores how agri-ecological systems contribute to more sustainable and resilient communities, through community development processes such as relationship building, genuine participation, inclusiveness, resource mobilization and creating space for knowledge sharing. The paper concludes by comparing ecological systems models to agri-ecological systems, and suggests how ecological systems theories and concepts might contribute to thinking about the future of community-based agri-ecological resilience. Copyright © 2008 John Wiley & Sons, Ltd.

Keywords agricultural systems; ecological systems; food systems; community resilience; sustainability

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INTRODUCTION

Alternative agricultural systems that emphasize ecological and community resilience provide a bridge between traditional agriculture (e.g. broad scale mono-cropping rotations) and natural resource management (e.g. maintaining pristine environments). These can be referred to as agri-ecological systems and include systems such as Organic Agriculture, Biodynamics, Community Supported Agriculture (CSA), Permaculture, Farmers Markets and Community Gardens. Government agencies, private industries (and to some extent Universities) primarily focus on traditional agricultural systems. Where sustainability and community health issues are considered, the usual emphasis is on how these traditional systems might be adapted or managed to reduce environmental or health impacts (within the current economic and production paradigm). Communities however, are taking the lead in developing agri-ecological systems that address today's environmental and social justice imperatives. These approaches often require more systemic change, as well as a shift from an economic paradigm to an ecological one. Figure 1 provides a conceptual diagram to help locate agri-ecological systems in relation to traditional agriculture and natural resource management.

Background

The Green Revolution was a turning point in terms of how agricultural systems were managed to support livelihoods through food and fibre production. From systems that would today be referred to as organic and locally owned, came systems that required high technological and chemical inputs that eventually expanded into

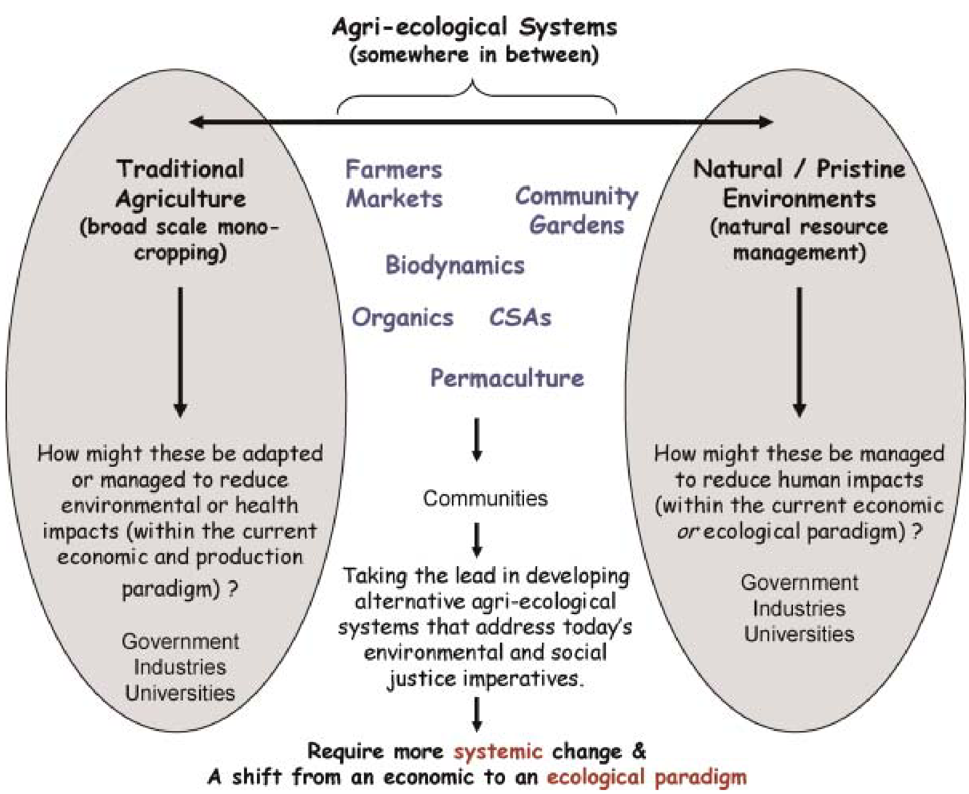

Figure 1. Locating agri-ecologcal systems in relation to traditional agriculture and natural resource management

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highly industrialized and commercial enterprises. The Green revolution at the time was seen as an alternative (and superior) way to reduce famine after the Second World War economic crisis, by increasing agricultural production through the use of chemicals such as pesticides, herbicides and fertilisers (Coutts, 1997).

Although the immediate response to this alternative was dramatic increases in production levels and improved varieties, it did not take long for people to realize that this was a short-term solution. The revolution converted rich farmers into richer agro-industrial entities through access to bank loans and bulk products purchased at discount prices, such as fertilizers, chemicals, irrigation systems and machinery. Poor or small farmers, however, were being increasingly squeezed out of the sector. Environmental degradation was associated with these intensive agricultural farming enterprises and associated practices, destabilizing the ecosystem and carrying consequences such as an increased number of insect plagues in crops, soil salinity, soil and water contamination and loss of biodiversity. Gunderson and Pritchard (2002) describe the ways in which loss of ecological resilience (and loss of ecosystem capital) can occur, including mining, eutrophication, modifying key ecosystem relationships and homogenizing temporal and spatial variability, all of which can result from intensive agriculture.

Ecologically, intensive agriculture produced a 'no-win' dilemma—farmers either had to (i) increase productivity at the cost of long term sustainability (resulting in ecological destruction of the resource base on which their livelihood depended) or they could try to (ii) maintain ecological diversity at the cost of short-term higher yields that were necessary to keep them in farming. Today, a global agriculture is emerging, defined by market liberalization and a regulatory regime, supported by most countries around the world. The markets theoretically are self regulated, operating without (direct) government interventions such as subsidies, border control and other market interventions, but it is difficult to say whether this globalized approach achieves sustainability objectives. For example, globalization has increased financial pressure on farmers, leaving them with limited resources to compete with large industry players monopolizing the market or to respond to large market price fluctuations (McMichael and Lawrence, 2001).

MANAGING SYSTEMS FOR RESILIENCE

The increasing decline in ecosystem capital has presented urgency for new ways of managing agricultural and natural systems. Particularly prominent in the natural systems domain, is managing systems to increase system resilience. Underlying these different ways of management are different assumptions about the properties of ecological systems. That is, there are different perspectives of ecosystem resilience, and each perspective assumes a different course of action in management. These can be represented as models and three models commonly in use (at least theoretically) are described below.

Model 1—Engineering Resilience

This definition of resilience focuses on efficiency and assumes constancy and predictability. From this perspective, systems exist close to a stable or equilibrium steady state, and a system's resilience is measured by resistance to disturbance and the speed of return to the steady state following a perturbation (King and Powell, 2000). This type of resilience focuses on maintaining efficiency of function and can be aligned with 20th-century economic theory (Gunderson and Pritchard, 2002). Researchers explore system behaviour near a known stable state (i.e. near-equilibrium behaviour) and operate deductively in the tradition of mathematical theory that imagines simplified, untouched ecological systems. This model also draws on the engineering discipline which is motivated to design single operating systems (i.e. optimal design).

This model is grounded within a positivist epistemology, where scientists aim to develop an objective understanding about an ecological system. An objective understanding implies a number of assumptions in terms of managing for sustainability. The first assumption is that a

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system can be known and one 'truth' exists, suggesting one best management option. Second, objectivity also suggests that people are separate from nature, and often the way people interact with nature is unsustainable. Third, sustainability is viewed as something that can be 'reached' and is often goal describing. Gunderson and Pritchard (2002) suggest that this model is '*certainly consistent with the engineer's desire to make things work—and not to intentionally make things that break down or suddenly shift their behaviour; but nature and human society are different*'.

Model 2—Ecological Resilience

This model of resilience focuses on persistence, despite changes and unpredictability. In terms of ecological resilience, it assumes conditions far from any stable steady state, where instabilities can shift or flip a system into another regime of behaviour to another stability domain (Berkes and Folke, 1998). Resilience is measured by the magnitude of disturbance that can be absorbed before the system is restructured with different controlling variables and processes. This focuses on maintaining existence of function. Researchers search for alternative stable states, the properties of the boundaries between states, and the conditions that can cause a system to move from one stability domain to another. This model has its tradition within applied mathematics and applied resource ecology, and aligns more with contemporary economic theory which has identified multi-stable states (Gunderson and Pritchard, 2002). As with the first model, management is aimed at achieving system *stability, is often system-prescribing*, and therefore can be equated with conventional notions of sustainability.

Model 3—Adaptive Capacity Resilience

This model addresses the management of unstable states or non-equilibrium systems. Non-equilibrium systems are often associated with the work of Clarence Holling and his popular Figure-Eight Model (Holling, 1973; 1987). This model represents systems as

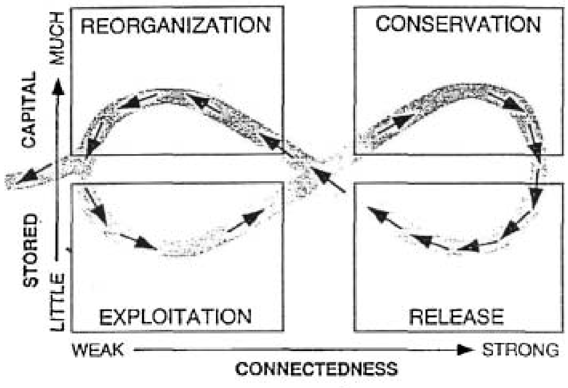

Figure 2. Holling's Figure-Eight Model of system dynamics (Holling, 1987)

dynamic, not static and is said to give a better representation of complex systems. The model suggests that a system moves cyclically between four domains: *conservation*, *release*, *exploitation* and *reorganization* (Figure 2). As the system shifts between the different domains, conventional notions of sustainability are challenged on two fronts (King and Powell, 2000). First, the degree of coupling, connectedness or linearity between impacts and the system is shown to be domain dependent. At a second level, the earlier definition of sustainability, which speaks of 'maintaining capital constant and undiminished', is contested. In the Figure-Eight Model the degree of stored capital is once again domain dependent. In fact the model suggests that, if the release of capital from the system is suppressed (by remaining in the *conservation* domain for an extended period), then its release will have catastrophic consequences (King and Powell, 2000).[1]

This model is grounded in a constructivist epistemology. From this, understanding is subjective and people cannot be separated from

[1]A number of authors have revised Holling's conceptual Figure-Eight Model to align it with data based on actual observation, suggesting that the original model makes the assumption that the amount of biomass before a destructive event and during the renewal of the system is equivalent, where in reality this is not often the case. For example, Kay (1994) changed the model so that the loop consisting of phases 2 and 3 is larger in size than the loop consisting of phases 1 and 4. Hansell and Bass (1998) also revised the model to more accurately represent the linkages between biodiversity and climate change. Nevertheless, Holling's original model provides a good conceptual model in which to understand the main assumptions behind Model 3 and ecosystem dynamics.

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nature, but are a part of nature. In fact, there are a number of case studies which show that if people are removed from nature (or uncoupled from nature) the system is likely to be less sustainable (Russell and Ison, 1993). Sustainability is also a term that has many meanings and is part of an on-going process of shared learning. Here, measurement of resilience is undertaken in terms of a coupled system's capacity to learn (evolve) co-dependently. This third model allows the possibility of managing a coupled system in terms of *plasticity*, of function, structure and process. King and Powell (2000) highlight that this model recognizes (i) the need to reduce uncertainty in order for governance to function, (ii) the precautionary principle as the justification for action (rather than, as it is sometimes taken to be, a rationale for blocking action) and (iii) there will be bad decisions with serious, perhaps irreversible consequences. Thus, here the emphasis is on maintaining continuing capacity to *generate options* and *scenarios*. Research involves shared identification of and learning about key variables, relationships and processes and the opportunities for influencing these variables, relationships and processes.

Table 1 provides a summary of these three models of resilience in terms of a range of characteristics and associated assumptions for each model. The three models imply different ways in which systems can be managed for resilience.

APPLYING THE CONCEPTS OF RESILIENCE TO AGRI-ECOLOGICAL SYSTEMS

Due to the social, environmental and health problems caused by globalization and conven-

Table 1. Assumptions behind different characteristics of the three models of resilience

Characteristics	Engineering resilience	Ecological resilience	Resilience as adaptive capacity
Focus	Efficiency	Persistency	Plasticity
Tradition	Engineering and traditional mathematical theory	Applied mathematics and applied resource ecology	Non-equilibrium systems (Holling)
Assumption	Constancy and predictability	Changes and unpredictability	Changes and unpredictability; structural coupling
Focus	Equilibrium behaviour	The conditions that can cause a system to move from one stability domain to another	Co-evolving, learning
Measure	Speed of return to steady state	Magnitude of disturbance that can be absorbed	Coupled systems capacity to co-evolve
Research	Search for characteristics of system behaviour near a known (optimal) stable state	Search for alternative stable states and properties of boundaries between states	Search for alternative dynamic states and properties of boundary patterns between states
Measure	Speed of return to steady state	Magnitude of disturbance that can be absorbed	Coupled systems capacity to co-evolve
Management	Maintaining efficiency of function	Maintaining existence of function	Managing cyclical patterns and non-linear processes with multi-stakeholders
Sustainability	Goal describing	System prescribing	Negotiated and co-evolving
Governance	Governance of function by deducing certainty (reactive)	Governance of function by reducing uncertainty (cautionary)	Reduce uncertainty in order for governance to function (precautionary)

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tional industrialized agriculture, communities all over the world have been developing alternative agri-ecological systems that are more sustainable. Below are six systems that are becoming increasingly popular in Australia. They are presented here, to provide a brief overview of each system and to compare the system's underlying assumptions with the models of resilience previously discussed.

Organic Agriculture

Organic agriculture can be simply defined as agricultural systems that rely on ecosystem development rather than conventional agricultural inputs such as synthetic fertilizers and chemicals. The demand for organic produce has been steadily growing in recent years for three main reasons, including health, environment and/or food security. A study by Woodward-Clyde (2000) highlights that there has been an overall decline in public confidence in modern farming and processing methods, and an increasing consumer awareness of food-borne hazards such as pesticides, antibiotics, hormones and artificial ingredients. The expansion of organic sales over the last two decades has increased worldwide to around US$20 billion and growing 20–50% per annum. In Australia the value of organic production has expanded 10-fold between 1990 and 2000, and is currently valued at around AUD$250 million, of which about $80 million worth is exported (Palaszczuk, 2000). It is expected that by 2013, 30% of Australian food will be organic (GRDC, 2003). In 1999, the FAO/WHO Codex Alimentarius Commission used the following definition:

> *'Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system' (FAO/WHO Codex Alimentarius Commission, 2007).*

Today, it is generally accepted in the wider community that food grown organically is healthier, not only because it does not contain chemical residues, but because it may also be higher in nutritional value (e.g. Goldstein, 2000; King and Pahl, 2003) and promote ecosystem diversity. A study by Bengtsson et al. (2005) compared organic and conventional farms by analyzing published reports and concluded that organic farming usually increases species richness on average 30% and also abundance of organisms by 50%. Although organic agriculture is gaining acceptance, it has been criticized for not necessarily being a more sustainable option or holistic enterprise, where the elimination of chemicals has led to an increase in other practices that contribute to environmental degradation (e.g. increased mechanization). For example, in Australia, research has showed generally lower yields on organic farms stemming from low-phosphorous soils, having several implications for sustainability such as reducing energy efficiency and the ability of a system to respond in a flexible manner to problems such as dryland salinity (Davidson, 2005). However, organic agriculture does keep redefining itself, and in 2005 the International Federation of Organic Agriculture Movement (IFOAM) defined organic agriculture as *a whole system approach based upon a set of processes resulting in a sustainable ecosystem, safe food, good nutrition, animal welfare and social justice*. Davidson (2005) suggests that organic production today is more than a system of production that includes or excludes certain inputs (Davidson, 2005).

Biodynamics

Biodynamics has its foundations in Anthroposophy, a spiritual movement created by Rudolf Steiner. Anthroposophy was designed as a 'spiritual science' to renew and transform human activity and society through increasing human cognitive capacity, based on a reunion of science, art and religion (Lorand, 2001). Central to an

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understanding of anthroposophy is the evolutionary concept: that all of life is in a process of change, transformation and metamorphosis. Lorand (2001) describes successful biodynamics as a true daughter movement of anthroposophy with *identical goals and methods*, simply *applied to agriculture, however, suggests that* we have hidden these realities about biodynamics to avoid being seen as fanatical. Advocates of biodynamics see it as a more purposeful process than organics, suggesting that although *organic agriculture rightly wants to halt the devastation caused by humans; organic agriculture has no cure for the ailing Earth* (Wildfeuer, 1995).

Wildfeuer (1995) describes biodynamics as *a science of life-forces, a recognition of the basic principles at work in nature, and an approach to agriculture which takes these principles into account to bring about balance and healing*. Comparing biodynamics to conventional and organic agricultural systems, biodynamics is *an ongoing path of knowledge rather than an assemblage of methods and techniques*. Some of the basic principles of biodynamics reported by Wildfeuer include (i) the broadening of our perspective on agriculture, (ii) careful observation of the dynamics (e.g. seasons and soil types) and language of nature, (iii) applying an understanding of cosmic rhythms to agricultural practices (e.g. sowing, cultivating), (iv) recognition of the interconnections between plant life and soil life (e.g. building up of humus through composting), (v) chemically free production that aims for quality (that stimulates human vitality), (vi) the use of biodynamic preparations in the field based on seasonal rhythms and life forces (e.g. enhancing the capacity for a plant to receive light), (vii) a self-sufficient farm that seeks to preserve, recycle, produce what is needed and provide learning opportunities to imitate nature (viii) an economics based on the knowledge of farming bringing together producers and consumers for mutual benefit (e.g. CSA). Wildfeuer (1995) provides some insights into Rudolf Steiner's motivations and grounding for biodynamic systems:

> *'Yet it was wonderfully significant; you could learn far more from peasants than from the University .... It was a kind of cultural philosophy. I've often thought that was a scathing indictment of university learning from one who had seen the best universities in the world! Yet, to go back to an earlier stage of development was never a goal for Rudolf Steiner. Always he sought to develop, out of an older form, something entirely new. He did not contemplate a return to the feudal system out of which the peasantry came, nor did he wish to ignore the gains of agricultural science or a scientific education. He wanted farmers, scientists and commercial interests to form new relationships and for farmers to develop new faculties of consciousness. Perhaps most importantly, he did not think that food grown on increasingly impoverished soil could provide the inner sustenance that is needed for spiritual activity'*.

Community Supported Agriculture

CSA is a recent idea that originated in Japan and Switzerland around the 1960s, which is based on a partnership between farmers and consumers who share the risks and benefits in food production (Hawkins *et al*., 2003). Through this process, consumers expect to benefit by receiving safe food and farmers benefit through feasible ways of commercialization. Consumers make an arrangement to support the farm during the season assuming the operational costs and risks, and purchase the crop at reasonable prices. In the same way, farmers offer good quality, healthy and environmentally friendly produce following sustainability principles (and are generally organic).

The CSA movement was born in the Biodynamic movement and is spreading rapidly. CSAs reflect the culture of the community they serve, the capabilities of the CSA and the farmers who manage it. Therefore CSAs are not likely to be the same and tend to be dynamic as community needs vary and change over time. However, we can categorize the CSAs into four different types, namely (i) farmer managed, (ii) shareholder/subscriber, (iii) farmer cooperative and (iv) farmer/shareholder cooperative (Wilkinson, 2001).

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The supportive relationship between farmers and the community helps to create an on-going learning relationship which increases consumers' awareness about the implications of producing food that meets certain criteria (e.g. seasonality, choices in management practices, cost of production) and increases farmers awareness about consumers' preferences. That is, the relationship enables purposeful feedback and adaptation. The CSA itself (as an organization) has the potential to serve a range of other functions, such as exploring alternatives and distributing information to all its stakeholders about a range of issues such as innovations in food technology, environmental impacts of different food production systems and how to improve their management system through sourcing information about other CSAs (Diaz Vera, 2005). In addition, advanced agreements can help improve the economic viability of small scale organic producers and encourage conventional farmers to try and test other more sustainable options over the season.

Permaculture

Permaculture is a design system which aims to create sustainable food, resource and community systems by following nature's patterns. The word 'permaculture', was coined by Australians Bill Mollison and David Holmgren during the 1970s, who started to develop ideas that they hoped could be used to create stable agricultural systems (Mollison, 1988). Although they coined the term 'Permaculture', they were inspired by a number of earlier people and concepts (e.g. Odum's work focused on system ecology; Yeoman's observation based approach to land use and keyline design, 1973, Permanent Agriculture of Franklin King, 1937; Pattern language of Christopher Alexander).

The permaculture concept has evolved over time and is difficult to define. Today permaculture can best be described as an ethical design system applicable to food production and land use, as well as community building (Holmgren, 2006).

Central to permaculture is its 'inter-disciplinarity' where disciplines such as ecology, landscape planning, architecture and agroforestry are integrated both conceptually and practically, to help people create an approach and way of living that is both productive and sustainable. It is inter-disciplinary (as opposed to multi-disciplinary) because its focus is on the relationships between the disciplines; the whole becoming greater than the sum of its parts. In addition, a key aspect of Permaculture is the development of a person's capacity to recognize universal patterns and principles (through critical awareness and observation) of natural system and apply these in practice in their own context. Holmgren (2006) provides a more current definition of permaculture, which reflects the expansion of focus implicit in Mollison and Holmgren's earlier book (i.e. Permaculture One) where the aim of permaculture is '*consciously designed landscapes which mimic the patterns and relationships found in nature while yielding an abundance of food, fibre and energy for provision of local needs*'. Its underlying processes are highlighted in the following description by Permaculture International (2006):

> *Permaculture (permanent agriculture) is the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability and resilience of natural ecosystems. It is the harmonious integration of landscape and people providing their food, energy, shelter and other material and non-material needs in a sustainable way. Without permanent agriculture there is no possibility of a stable social order. Permaculture design is a system of assembling conceptual, material and strategic components in a pattern which functions to benefit life in all its forms. The philosophy behind permaculture is one of working with, rather than against, nature; of protracted and thoughtful observation rather than protracted and thoughtless action; of looking at systems in all their functions, rather than asking only one yield of them; and allowing systems to demonstrate their own evolutions. From a philosophy of cooperation with nature and each other, of caring for the earth and people, permaculture presents an approach to*

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designing environments which have the diversity, stability and resilience of natural ecosystems, to regenerate damaged land and preserve environments which are still intact.

Permaculture is a broad-based and holistic approach that has many applications. At the heart of permaculture design and practice is a fundamental set of 'core values' including Earthcare (Earth is the source of all life and we are a part of the Earth, not apart from it); Peoplecare (supporting each other and developing healthy societies); and Fairshares (or placing limits to consumption and ensuring equitable use). Permaculture is however, human centric. It has its origins in the search for an alternative food production system where people could break their reliance on industrialized agriculture. In this context, it stressed the importance of low-inputs and diversity as opposed to high-inputs (e.g. fossil fuel technology) and monocropping. This resulted in an increasing number of small scale market and home gardens for food production. To reduce inputs, permaculture has a basic principle of adding value to a crop in alternative ways such as mixed cropping for multiple outputs or exchanging crops for labour (e.g. LETS scheme). Importantly, it seeks to address problems that include the economic question of how to either make money from growing crops or exchanging crops. Each final design therefore should include economic considerations as well as giving equal weight to maintaining ecological balance.

Farmers Markets

Farmers markets are becoming increasingly popular, with now more than 80 farmers markets across Australia. Research presented at the 2nd National Australian Farmers' Markets Conference, held at Albury–Wodonga in August 2005 showed that farmers markets are now producing more than $80 million worth of economic benefit across the host communities in Australia (Organic Gardener, 2005/2006). The Global trade watch website (2006) highlights the benefits of farmers' markets in Australia suggesting that they are:

a real alternative to export markets which force Australian farmers to over produce, overuse chemical inputs and which pay them lower and lower prices. At a farmers' market, farmers from a local area sell their food direct to the public. Buying food from a farmers' market means that is locally produced, and the money goes straight to the person who grew it. It guarantees farmers a decent income, encourages face to face interaction, creates communities and avoids destructive efforts of the global trading system. (Global Trade Watch—Farmers Markets in Australia (www.tradewatchoz.org/localfood/)).

Farmers' markets not only show benefits for farmers and purchasers at the markets, but there are also advantages for local retailers, processors and restaurant owners (RIRDC, 2006—New Generation Farmers' Markets in Rural Communities which was launched at the 2nd Australian Farmers' Market Association Conference) showing the ability for farmers' markets to impact and enhance wider systems. This report was launched by Senator Colbeck at the Conference, who stated that *markets cultivate direct interaction between growers and consumers, creating fertile ground for new product innovation* (Organic Gardener, 2005/2006). The report also found that farmers' markets (i) are complementary to existing businesses, (ii) effectively showcase local produce and help educate customers about local food, (iii) provide and opportunity for radical change in production and marketing, (iv) provide a forum for communities interested in fresh food, its source, and ideas for new products, (v) provide an opportunity for business and personal growth, (vi) require a high level of passion, imagination, perseverance and skill by the market manager to be successful (RIRDC, 2006).

Farmers' Markets enhance consumer interest in local produce and this can lead to a willingness by urban communities to support the local farming community. They show potential in reconnecting urban consumers with food, as well as people from the rural community. In this sense, Farmers' Markets help to break down the

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well-known 'rural–urban divide'. In Australia, the concept of farmers' markets has moved into e-business, producing the on-line farmers market website. This site tries to connect people with food and people with people (i.e. consumers and producers) through a virtual community, by providing local farm directories to access locally grown food and products, and promoting regional food groups that supply a variety of different foods from their regions.

Community Gardens

Community Gardens are becoming more and more prominent in Australia. The Australian Community Gardens Network (2006) website provides a useful historical account of community gardens in Australia, stating that community gardens have their origin in the 1970s, a time that was characterized by increasing concern over environmental conditions, greater leisure time and changing recreational activities (Australian Community Gardens network, 2006). In the mid 1990s, in response to the growing number of community gardens, the Australian Community Gardens Network was established. Gelsi (1999) compares the number of community gardens in Australia, with other industrialized countries, suggesting that Agricultural activity within cities, compared to formal rural agriculture, is minuscule. They account for this by the marked economic, social and cultural differentiation between city and country in Australia. Although the number of community gardens recorded in 1996 was 38, this number has been growing at an ever increasing rate over the last decade.

Reported benefits of community gardens are diverse, including physical and psychological well being, providing community spaces for learning and shared decision making, relationship building, and community development (Australian City Farms and Community Gardens Network, 2006). Curran (1993) found that community garden organizers and community gardeners have different opinions about the benefits of community gardening. This research showed that community organizers believed that community gardens improved the environment, benefited the wider community and led to political empowerment. Community gardeners, however, emphasized personal and psychological benefits, but never environmental benefits or political effects. What these two groups did agree on, however, were the beneficial effects on income and food consumption.

Crabtree (1999) draws on ecological theory to highlight the use of permaculture in community gardens. Two concepts are seen as particularly important, including the role of edges and the role of replication. Crabtree (1999) explains how community gardens enhance resilience by using (i) 'edges' within both physical design (e.g. keyholes, spirals) and social organization (e.g. enhancing areas of communication) and (ii) 'replication' at the physical and social levels, where it is desirable to have each required function fulfilled by numerous components and each component fulfilling multiple functions. In addition, she suggests that such concepts create space for education and community development. In terms of community development, Gelsi (1999) illustrates that community gardening has '*shown itself to have potential as an effective tool for civil society . . . as places where people come together, grow fresh food, improve local environments and contribute to humane, liveable cities*'. Wider system benefits are also illustrated in a quote by Gelsi (1999):

> *'Community gardening may seem another of many ''leisure'' activities for very few people, and thus of little relevance to problems that perturb governments and policy makers. But, when viewed within the broader context of the development of capitalist social relations, the culture of consumption and the rise of environmentalism, community gardening may be one way in which small groups of people try to redefine consumption by addressing those social, ecological and moral issues ignored by the consumer ideology of ''more is better'''*.

SUMMARY

The examples of alternative agri-ecological systems above can be compared with the three models of resilience. Table 2 illustrates each system and corresponding resilience model. As each of the

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Table 2. The predominant resilience model for each agri-ecological system and how each system contributes to ecological and community resilience

Agri-ecological system	Predominant resilience model	Contribution to ecological resilience	Contribution to community resilience
Conventional agriculture	I	High input and low output over time (negative contribution)	Reduced community health and well being (negative contribution)
Organics	II	Low input and high output over time	Community health and well being
		Biodiversity	
Biodynamics	III	Low input and high output over time	Enhanced adaptive capacity and consciousness
		Biodiversity	Self-sufficiency
		Adaptive capacity	Deliberate learning
CSAs	II	Shared risk and pre-season agreements enables farmers to try more sustainable options	Creating networks across rural–urban interface
			Co-learning
Permaculture	III	Self-sufficiency and produce exchange reduces demand for less sustainable options	Maintaining networks for exchange
		Enhances biodiversity	Self-sufficiency
			Deliberate learning
			Small business niche market opportunities
Farmers markets	II	Reduced risk and higher prices enables farmers to carry out more sustainable practices	Creating networks across rural–urban interface
		Fast feedback mechanisms for changing market demands	Co-learning
			Small business niche market opportunities
Community gardens	III	Self-sufficiency and produce exchange reduces demand for less sustainable options	Enhancing space (edge) for communication, information sharing, deliberate co-learning;
			Creating flexible social institutions

systems may have characteristics that could sit within more than one model, the *predominant* model is presented. That is, the model and its underlying assumptions which show most similarity to a particularly system (in its 'ideal' sense) is presented, although it is understood that there are variations of the different systems in 'reality'. The table also highlights some key processes in each system that contribute to both ecological and community resilience.

CONCLUSIONS

Communities are taking a lead role in developing agri-ecological systems that address today's environmental and social justice imperatives.

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There are many similarities between ecological (model II) and adaptive capacity (model III) resilience models developed through exploring the resilience of persistent natural ecosystems *and* alternative agri-ecological systems developed by communities through relationship building and collective learning, as well as learning with the environment. Resilience models also show promise in helping guide the design of alternative agri-ecological systems that are an alternative to conventional agriculture.

One common question asked by researchers of more sustainable agricultural systems is 'which system is best?' Some key findings from Gunderson and Pritchard (2002) who draw upon their understanding of adaptive capacity resilience help to address this question. They highlight the following:

- When a system has shifted into an undesirable stability domain, the management alternatives are to (i) restore the system to a desirable domain, (ii) allow the system to return to a desirable domain on its own, or (iii) adapt to the changed system because changes are irreversible;
- Resilience is maintained by focusing on (i) keystone structuring processes that cross scales, (ii) source of renewal and reformation, and (iii) multiple sources of capital and skills. No single mechanism can guarantee maintenance of resilience;
- In ecological systems, resilience lies in the requisite variety of functional groups and accumulated capital that provides sources for recovery. Resilience within a system is generated by destroying and renewing systems at smaller, faster scales;
- Ecological resilience is re-established by the processes that contribute to system 'memory', those involved in regeneration and renewal that connect that systems' present to its past and to it neighbours;
- Resource systems that have been sustained over long periods of time increase resilience by managing processes at multiple scales;
- In economic systems, multiple technologies add resilience in the face of shifts in demand and factor prices and availability; and
- It is linkages and connectivity across time and among people that helps navigate transitions through periods of uncertainty to restore resilience.

These key findings provide some guidance for future strategies in designing, managing and scaling-up of alternative agri-ecological systems. For example, it would seem that to allow for future unpredictability and surprise, no one system is 'best'; and a variety of agri-ecological systems that enable diversity of function at multiple scales would enhance ecological and community resilience. From a constructivist perspective, we would perhaps progress into reconnecting people with food, and people with people and leave the notion of a 'best' system behind. That is, there needs to be a deliberate intention to facilitate systemic ways of approaching the change needed and this may lie in communities imagining novel human (activity) systems which take organic/biodynamic/permaculture/CSAs and whatever else 'concepts' and 'practices' and build and learn their way towards resilient (rather than stable or optimal) linkages.

Conventional industrialized agricultural systems have persisted over the past 150 years. This resilience has been heavily grounded in an economic paradigm and a resilience that has been maintained (and buffered) through regulations, subsidies, trade negotiations, policies and other 'blockages'. These systems are contributing however, to an ever increasing loss in ecosystem resilience. Perhaps an understanding of the different models of resilience will help design strategies to breakdown, transform and renew these conventional systems. That is, a knowledge of resilient systems may not only provide ways of moving forward and transformation—but provide processes to strategically deconstruct current conventional systems and the political institutions in which they are nested.

Capra (1997) provides a conceptual framework for the link between ecological communities and human communities. He calls for a people to be 'ecoliterate' and states that being ecoliterate means understanding the principles of organization of ecological communities (i.e. ecosystems)

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and using those principles for creating sustainable human communities. Community-based agri-ecological systems seem to provide opportunities to reconnect people with people and people with food, opening up spaces for 'ecoliteracy' to develop through shared and reflective learning.

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