

The future challenge: the search for system

R.L. Ison

Systems Discipline, Centre for Complexity and Change, The Open University

Abstract

We live in an ever unfolding present in which the future and the past are stories which we tell to ourselves. Some traditions which have informed agronomists practices but which have been found wanting are identified. It is suggested that these traditions have generated stories which we need to leave behind and that we need to create new stories about agronomists future practises and about the agricultures which they may help to design. The case is made for moving the boundary around agronomists' systems of interest to incorporate rural livelihood systems in the context of global sustainable development and environmental decision making. This will involve agronomists taking responsibility for their actions and being responsive to consumers and other stakeholders needs and aspirations.

Key Words

Traditions; environmental decision making; managing change; designs for agricultures; new metaphors; systems of interest.

The future and the past are different manners of living in the present

Too often we forget our biological constraints and possibilities as human beings and live **as if** there was a future and a past rather than an ever unfolding present. This is my starting point in addressing the question of the "future challenge". I choose to start here because the explanations, or stories, we accept about our past and anticipate for our future determine how we behave in the present, or, in other words, how we choose to live together and do what we do. As Maturana (33) has observed, explanations are not trivial - if we accept different explanations then our lives change. For the purpose of this paper I define the "challenge" as seeking to understand why we agronomists choose to do what we do. By exploring this question it might be possible to create new or different stories about what is to be done in the future. Any attempt to address this question necessarily involves exploring: (i) our traditions of understanding from which we choose to think and act; (ii) the ways in which we conceptualise systems of interest and relate to our environment (in its broadest and systemic sense) and (iii) the designs for agricultures which emerge from the former and to which agronomists contribute.

Etymologically agronomy derives from the Greek words *agros* (land) and *nomos* (to arrange, take, divide or allot) which implies engaging in a human activity associated with managing, or relating to, land. This meaning is often lost in the contemporary definition of agronomy: "the science of soil management and crop production" (6) and thus in the practises of agronomists who do the science of soil management and crop production. This etymological difference mirrors the tensions that have existed between "agriculture" and "agricultural science" for almost 200 years (see 42). Long and Long (31) describe this as the "battlefields of knowledge". My purpose in this paper is not to set up a straw man and in the process to perpetuate an unhelpful dualism (Figure 1) - agriculture *or* agricultural science but to invite you to consider them as a duality - agricultural science in the context of agriculture. Because explanations are not trivial that which is accepted will determine what we do in the future and particularly how we institutionalise what we, as agronomists, do.

Figure 1. An explanation of "duality" and "dualism" which may provide an alternative way to consider the relationship between agriculture and agricultural science as forms of human activity.

Duality and dualism

It is now widely known that light can be treated as both a wave and a particle depending on the experiment we, as observers (or experimenters), have decided to use to observe its behaviour. This apparent paradox, i.e. wave-like behaviour and particle-like behaviour, was described for many years as the 'wave-particle dualism' which implied they were separate or opposite phenomena. The term used to describe antagonistic or negating opposites is a dualism, e.g. mind/matter, objective/subjective. Two concepts form a dualism when they belong to the same logical level and are viewed as opposites. The logic behind this dialectic is negation. Alfonso Reyes (45) suggests that dualistic thinking is a product of the prevailing objectivist Cartesian world view with its orthodox logic under which we are still brought up. He also suggests that dualisms are responsible for ephemeral and endless debates, e.g. centralization versus decentralization. Dualistic or either/or thinking can often represent a trap.

It was not until it was recognized that phenomena we observe in 'nature' are not independent of our observing that this paradox was resolved by appreciating that wave-like and particle-like behaviour were complementary behaviours that constitute a *duality*. Taken as a whole they do not negate each other but constitute a unity or whole. A commonly used example of a duality taken from ecology is the predator-prey relationship. Two concepts form a duality when they belong to two different logical levels and one emerges from the other. The logic behind this dialectic is self-reference. The following pairs are examples of dualities: environment-system; control-autonomy; constraint-freedom; 'what?'- 'how?'. When recognized as complementary pairs the discussion is potentially more rewarding and exciting.

(Source: adapted from 45)

A further rationale in my paper is to encompass all facets of the meaning we give to the word "challenge", viz. : to call to account; to invite or summon discussion; to lay claim to; to stimulate; to offer interesting difficulties; to take exception or object; to deceive (6). I shall do this by interpreting some of the points made in the papers of other invited speakers and by offering some thoughts based on my own experiences. The subtext for my paper is "the search for system". My purpose here is to invite (re)consideration of a particular tradition of understanding as a basis for thinking about our futures. The concept of "system" has had a varied and disputed history within the discourses and practices of agronomists (see 3; 21).

Agronomist's traditions of understanding

Human beings have unique experiential histories and it is only through the process of communication, and the cultural discourses that arise from this, that we can attempt to create common understandings. As Ison and Russell (22) have observed: "Traditions are very important to a culture because they embed what has, over time, been judged to be useful practice. The risk for any culture is that a tradition can become a blind spot when it evolves into practice lacking any manner of critical reflection being connected to it. When a society stops looking back and no longer appraises the value of a set of practices it quickly becomes blind to the relevance of its origins, the circumstances which were current at the time, and which triggered the practice into existence. The upshot is that there are no longer processes which foster the ongoing modification of the practice as a result of what we experience in daily living. The effects of blind spots can be observed at the level of the individual, the group, the organization, the nation or culture and in the metaphors and discourses in which we are immersed."

Vickers (51) made the same point in a different way when he talked about "traps" in our thinking from which we find it difficult to escape, just as the lobster caught in the lobster pot. The French historian, Michel Foucault also draws attention to how our traditions of understanding become enmeshed in "networks of power" which include our theories, practices, institutions and language (see 34; 35). I draw attention to our "traditions" because I consider a future challenge to be the need to strive to become aware of the traditions from which we operate in all that we do because we cannot "artificially separate out people from environment, as the histories of people and their environments are so deeply intertwined" (50).

Stories from my past

I became an agronomist largely because of the enthusiasm my grandfather, a wool grower whom I respected, had for two particular pasture agronomists. These were Malcolm Campbell (formerly of NSW Agriculture) and Frank Crofts (formerly of the University of Sydney, and a wool grower in his own right (see 11). The stories I heard as a young boy related to the "good work" Malcolm was doing in the fight against serrated tussock (*Nassella trichotoma*) and the "sub and super" strategy employed by Frank Crofts who had become my grandfather's neighbour when he purchased his property on the Bridle Track north of Bathurst. Frank later lectured to me when I went to the University of Sydney and I was fortunate to work closely with Malcolm in the early days of the Grassland Society of NSW. I continue to hold them both in very high regard.

I like to consider myself as having come from a tradition of doing agronomy epitomised by the ways in which Frank and Malcolm pursued their careers - from my perspective they never opted to be mainstream members of the agronomy "club". By this I mean they remained committed to rigorous research and the "real" issues they experienced as being faced by farmers. This dual commitment was often not popular in their organisation in the face of intense scientism. Both were concerned with how innovations contributed to what today I would choose to call "rural livelihood systems". I shall return to this below. These early experiences led me to enter university and agronomy (with farm management) on the wave of enthusiasm that accompanied the wool booms and associated pasture improvement possibilities. As you know this was not to last.

My early courses in pasture agronomy (both temperate and tropical) were exciting - they created a sense of possibility and left me feeling that I would like to contribute. They were largely agronomic, and not ecological, and they took as their starting point the pioneering work of Australian pasture science contained in Australian Grasslands (38). This was for several generations of students the "bible" and established their traditions of understanding. Other courses did the same in other domains. We did not have access to works such as "The Future Eaters" (14) which from my perspective is now essential introductory reading for any would be agronomist.

My experience of University education was more in the mould of being taught "how the world is" rather than being offered explanations of how individuals or groups had come to describe the world based on their experiences of it. However, when one is open to one's own experiences it does not take long to realise that particular theories or explanatory devices are not helpful, or do not fully explain what has been experienced. Unfortunately not all people are open to their experiences and there has often been a failure to recognise that particular theories are context dependent, or of limited utility, or have been found wanting. This has led to unintended consequences (see 50; 22).

Stories from our collective past

There are a number of stories from our past that have been found wanting. These are still potent because they continue to inform, implicitly or explicitly, our individual (and sometimes) collective actions. I also think there are others that require some reconsideration. I only have space to list them here; for more detailed explications you are referred to the references. They include:

The unquestioning adherence to Clementsian succession in contexts where it did not prove adequate (and in the process defining what were "good" and "poor" grasslands and "good" and "poor" managers) (see 43);

The discourses and practises which were developed and/or subjugated around Australia's endemic flora in the years when agricultural science was emerging as a named disciplinary area in Universities and Departments of Agriculture (see 14);

Our failure to respond earlier to salinity and acidity given that the "science" was known beforehand and, in the right institutional and social contexts, could have been brought to bare on the issues much earlier. History may judge this as a period of unquestioning commitment to the legume and in particular to annual pastures. I claim no great prescience on these matters but would draw to your attention what can be achieved by collaborative learning between a group of motivated students and staff from different

disciplines working in a genuinely interdisciplinary manner and not constrained by institutional mores and traditions (13). In this example students were able to appreciate the "acid soil problem" in ways that did not generally become accepted in the broader agronomic community until almost a decade later. They gained insights and became aware of possible options that are now mainstream (see 41).

The pervasiveness of the "transfer of technology model", its associated "diffusion of innovations model" and at their core the limited model of human communication as "signal transfer" which has driven much of post-second world war extension practice and organisation of rural R&D (47; 48; 22);

Values associated with family farming and service to country which became embodied in closer settlement policies that committed many to years of hardship and deprivation and to forms of land management which were not sustainable (e.g. see 5);

The institutional and cultural isolation of scientists and policy makers from rural people as they became committed to "good science". Interestingly, in 1928, Ian Clunies Ross, who contributed much to the emergence of institutionalised agricultural and veterinary science observed that: "the lack of a close association between the two vital factors in disease prevention - the research worker and the livestock owner - is liable to cause the latter to adopt a wrong attitude of mind in regard to the part he [sic] has to play. Too often he has come to regard his role as that of passive acceptance of benefits to him from scientific research, without at all appreciating the need for his active cooperation" (16).

From our current vantage point one can sense several contradictions in this statement - entrenchment of gendered perspectives, a recognition that R&D needed to be collaborative, but perhaps suggesting that responsibility for forging and maintaining collaboration resided with the "graziers". I have no doubt of the good intent but as so often happens when we institutionalise our intents they become "trapped" in practices and networks of power that have more to do with maintaining institutional positions than with building active and meaningful collaborative learning or researching networks. In the 1920s the graziers were a formidable coalition of interests whose place in political decision making was far different from that of today. The reverse may have been true of scientists. One of the traps we have collectively fallen into is to fail to research our institutional forms and practices (see 28; 50; 22).

Some areas which I speculate might be worthy of reconsideration:

The explanations we have accepted about the changes in native vegetation under the effects of cloven hoofed animals (see 38); I have returned to the original PhD study by Moore and found the evidence less than convincing. In our work in the Forbes Shire, oral tradition suggests that the earlier settlers had maintained what they classified as farming country and grazing country. The grazing country was never farmed because cultivation wiped out the native grass species. Prior to about 1950 there were few pasture species that regenerated following cropping. Wheat was almost the sole crop that was grown. The standard rotation was alternate years of fallow and crop. With the increase in abundance of naturalised annuals such as barley grass (*Hordeum leporinum*) and annual ryegrass (*Lolium rigidum*) in the farming country, the distinction between farming and grazing country became much less marked, and the proportions of the farms cropped gradually increased (55). Our increasing understanding of the ecology and grazing responses of native grasses suggest that at best the stories that were taught by me and others to generations of students were greatly simplified. As Flannery (14) highlights, the withdrawal of regular burning has had major impacts on flora and fauna and our assumptions about the effects of plough and animal on grassland dynamics have too often neglected this.

The way we conceptualise plant competition (as opposed to plant cooperation); Darwinian theories of evolution are under increasing critique and challenge. It is possible to speculate that much of the early work on plant competition arose in an historical context which privileged certain metaphors over others. Whether this has circumscribed what has been observed and theorised is an interesting question worthy of inquiry. As Weizsacker et al (54) observe: "Darwin was describing and explaining the increase of diversity during evolution. Simplistic economic Darwinism in contrast, is about the destruction of diversity"

Policies developed from regional or continental assessments of soil erosion, degradation, vegetation condition etc. which rely on models based on linear dynamics and where resource pressure and impact are linked together in simple deterministic ways which may also assume spatial homogeneity. As noted by Leach & Mearns (30) and Scoones (50) for Africa, these approaches aggregate and simplify across landscapes, regions, nations and sometimes continents and fail to adequately account for local and context dependent variation.

In the past when critiques of this type have been made there has been a predisposition to regard it as criticism. This is not my intention. As Lacefield et al (27) recognise in their paper "our challenge is to develop the interpersonal relationships needed for collaborative work". At the heart of this challenge is the ability to consider and admit into conversation multiple perspectives. If agronomists as a group do not enter into critique then they will continue to lose ground to other actors in the rural R&D system. This has already happened in the practices of the research corporations when, as outlined by Doyle and Kelly (12), they go to groups such as Boston Consulting, to name both the "problems" and opportunities".

Rural livelihood systems in a context of global sustainable development and environmental decision making

Moving the boundary - rural livelihood systems

In 1994 I was fortunate to be in South Africa just after the historical elections; the experience of euphoria and the sense of possibility will always remain with me. My reason for being there was a month long "process or learning-based consultancy" - the first ever funded by ODA (now DfID) - involving a team of 13 made up of South Africans and non-South Africans (see 9). We developed co-learning processes with a range of stakeholders in the area of agricultural research and extension and land reform. This process surfaced the prevailing view then existing in the Ministry of Agriculture that the trajectory for "development of black farmers" was to provide the conditions for them to become like white farmers. This embodied particular views of what it was to be a farmer (rarely a woman), a focus on productivity, often through commercial cropping and a range of other unquestioned assumptions. Senior officials found it impossible (at the time) to conceptualise agriculture as only part of possible rural livelihood systems despite the local realities widespread artisanal activity, extended kinship networks, complex livestock owning patterns and the importance of remittance wages from miners (who often invested in cattle as a form of saving). Similar complexities apply to Australia and there are increasing concerns about the viability of rural communities (e.g. 29). How, for example, are agronomists contributing to the maintenance of development of rural livelihood systems? It represents a major challenge for Australian agronomists and rural policy makers.

Are inter-state competition and rivalries still an issue? I found it difficult to understand why a comprehensive invited paper on the Victorian Dairy Industry should feature in the conference- why not a paper on an Australian Dairy Industry? I had hoped that the activities of the DRDC may have helped to move the conceptualisation of the industry beyond State boundaries. I do have some concerns that our historical focus on farm management and the optimisation of profit (e.g. profit per farm in the paper by Doyle and Kelly (12)) as opposed to household income or livelihood, because the latter forces the recognition of the economic activity of women who may work off farm and other strategies for leading meaningful lives in rural communities. It is possible to speculate that a stable and sustainable dairy industry would have a diversity of enterprise types rather than all being on the same managerial and technological treadmill.

The move to conceptualise agriculture as only one possible part of rural livelihood systems is an example of making boundary changes around potential systems of interest (4). Such systems have now to be conceptualised in the context of sustainable development (of which there are many interpretations) and environmental decision making.

A global programme for sustainable development?

In his paper, Lawrence (29) suggests that globalisation is providing opportunities for regionally based groups "prepared to accept the conditions for [international] interaction". The extent to which local people

in a region will be able to identify its needs and act to co-ordinate their activities may mean, he suggests, "moving 'beyond' the state" and "fostering the growth of self-help organisations aimed at securing globally linked production and other activities". If this is to be the case then it is unlikely that it will be achieved without such groups entering meaningfully into the discourses around "sustainability", including Agenda 21. This presents challenges on a number of fronts including (i) education; (ii) funding and (iii) political will, including new coalitions. With regard to the first, the U.S. President's Council on Sustainable Development (1996) sees the imperative in the following terms:

"Education for sustainability is the continual refinement of the knowledge and skills that lead to informed citizenry that is committed to responsible individuals and collaborative actions that will result in an ecologically sound, economically prosperous, and equitable society for present and future generations. The principles underlying education for sustainability include, but are not limited to, strong core academics, understanding the relationships between disciplines, systems thinking, lifelong learning, hands-on experiential learning, community-based learning, technology, partnerships, family involvement, and personal responsibility".

Australia is well positioned to respond to this imperative if there is a will. Almost twenty years after Hawkesbury initiated its radical curriculum reorganisation around systems and experiential learning-based approaches to agricultural change and rural development it is heartening to see what I hope is an emerging commitment to learning-based approaches to managing agricultural innovation and change (e.g. 12; 37). I mention Hawkesbury as a major, and often unacknowledged innovator in this field, but of course recognise that they are one of many actors that have led to this transition. It is ironic and ill-conceived that at the time when these approaches blossom in the community, that Universities should be forced into, or choose to revert to, highly instrumental curricula and modes of teaching (as opposed to learning).

Agronomists and farmers as environmental decision makers

There are widely divergent views about what environmental decision making implies. However, the main challenge seems to be not one of replacing economic, political and social considerations with an environmental agenda but one of bringing these factors together in our decision making (40). As Morris et al (39) point out, there has not been as yet any significant application of the various environmental management standards to farming enterprises in Europe. The principles on which these are based are outlined in Table 1.

Table 1 Examples of the principles behind environmental management systems (Source: 40)

Voluntary
Self-regulating?
Polluter pays principle?
Market instrument?
Site based (industry) /administrative unit based (local government)
Focuses on direct process effects (industry)

Focuses on indirect service delivery or product effects (local government)?

Promotes continuous improvements in environmental performance?

In a European context two standards may be of importance to agricultural enterprises in the future (40). These are: (i) EMAS, the European Commission's Eco-Management and Audit Scheme (EMAS) for industry (and local government) which is a voluntary regulation that came into operation in April 1995 in all member states of the EU; and (ii) ISO 14001 Environmental management systems - specifications with guidance for use which is the international standard for EMSs. While ISO 14001 is described as a 'standard', which implies a level to be attained, and EMAS as a 'regulation', which implies rules that must be obeyed, they fulfil much the same functions. These are to improve the quality of environmental management and to help organizations to gain public recognition and/or competitive advantage from these improvements. They are both 'voluntary', in that organizations can choose whether or not to try to reach the standard or to comply with the regulation. The procedures that must be followed if an organization wants to achieve either EMAS or ISO 14001 are not voluntary.

It remains to be seen if these are adopted as part of voluntary schemes, or in the absence of pro-activity, they are forced onto the farming sector. It may be that food firms such as Woolworths will adopt these requirements in their supply chain management systems. Peter Pokorny (44) outlines Woolworths proactive position with supply chain partners in meeting and exceeding customer needs (although he does not state what these are or how they are negotiated, monitored and evaluated). He sees Woolworths as the "consumers buying agent" and describes associations with industry groups "which enables them to learn together". Whether this would be recognisable as environmental decision making or "environmental learning" is not addressed. A challenge for Australian farmers would be to move quickly to introduce these or similar schemes, including energy and eco-efficiency audits, as a possible means to gaining some competitive advantage.

As Table 2 indicates, the business community is in the process of adopting a range of environmental decision making processes (although to what effect is often not clear). Agriculture needs to lead rather than follow and countries like Australia should be well positioned to do so. However from my current UK base the folly of the Australian position at the Kyoto climate change summit has been readily apparent. It undermines any credibility Australians may have as environmentally responsible citizens (and producers) at least in the eyes of Europeans.

Table 2 Some recognized 'approaches' within the international business community for environmental decision making (Source: 40; adapted from 24)

Program	Source
Ecoefficiency	Schmidheiny, 1992, World Business Council for Sustainable Development
Environmental accounting	Unilever, Deutsche Bank
Environmental and social reporting	Migros, Norsk Hydro
Environmental audit	Ciba-Geigy, Royal Dutch/Shell Groups, 3M

Environmental awards	UK, Germany
Environmental banking and investment	Hypo-Bank, Acorn Ethical Unit Trust, Deutsche Bank
Environmental codes of conduct	Petroleum and mining industry
Environmental ethic or philosophy	The Body Shop
Environmental impact assessment	Most countries
Environmental information system	Siemens, IBM
Environmental labelling	German Blue Angel, Canadian Environmental Choice, Green Cross
Environmental officer	Siemens, IBM, Ciba-Geigy, Bayer
Environmental public relations and marketing	Esprit, Opel, AEG, Johnson Wax, Oc?
Environmental risk and liability management	Colonia
Environmental sponsoring	IBM, Lufthansa, Daimler-Benz
Green industrial architecture	The Body Shop, J. Sainsbury
Life-cycle analysis	EPA: Dutch chemical industry
Natural Step	Forum for the Future, Co-operative Bank U.K
Pollution prevention and waste-management strategy	3M, Dow Chemicals, Procter & Gamble, The Body Shop, BMW
Principles for sustainability	International chamber of commerce
Product stewardship	IBM, Noika Data, BMW, Du Pont, McDonald?s, Alcan
Responsible care	Chemical industry

Agronomists as co-designers of agricultures

In her invited paper to the last conference, Ann Hamblin (15) claimed that "the agronomist is often the leader or synthesiser to the group coordinating the design, methodologies and results of the component studies, and is therefore in a powerful position to introduce new approaches". She goes on to issue an invitation to agronomists by means of "a story" about a possible future: "If my view of the agronomist as leader and integrator is correct, future Australian agronomy conferences will be held jointly with the professional meetings of ecology, plant and soil science and ecological economics to consider novel land-use and product options at landscape scales." This is a story worth retelling (although I might wish to include some other stakeholders) because it invites us to consider our future roles as agronomists in the light of different actors and perspectives. It would involve moving outside our "club" or community of conversation but it may lead to new stories and emergent insights.

Gender, youth and ageism

Maturana (33) argues that a change in a human social system can only take place in the network of conversations that its members generate. He recognised two ways to trigger change in human social systems both of which require experiences outside the network of conversations that constitutes these systems: (i) through encountering others in a network of conversations that are not confirming as when encountering foreigners or when moving beyond the normal ranges of a community or "club"; and (ii) through interactions that trigger in us reflections upon our circumstances of coexistence with other human beings, as occurs in strong emotional situations associated with friendships and love.

At a personal level I relate to both of these; it was only through moving outside my Australian cultural context when I conducted my PhD research in Bali that I was able to appreciate my mother as farmer and to begin to understand the injustices outlined so powerfully in Margaret Alston's (1) paper. She relates very powerful stories of 200 years of excluding women's voices from all aspects of agriculture except the hard work; whilst the institutional context is changing and the forums in which women's voices are being heard is increasing, her research suggests that this is not happening quickly enough. Institutions themselves constrain change (e.g. 19; 23) as do curricula and the cultural perpetuation of "boys clubs" (see for example 7).

For me, one of the main "future challenges" relates to the question of who participates in shaping the contexts in which future agronomists are to practise? This was a point I made to the Australian Rangeland Society in 1992 (17): "Gender and ageism, or its reverse, become critical in this context - decision making and thus agreement about what is desirable change has for too long in rural Australia suffered from the lack of full and open participation by women. We also run the risk of constantly making decisions which are generationally skewed as those in positions of power draw on experiences which are past and no longer relevant to the experiences of the present." A challenge therefore is to involve women and young people, particularly, but not only, in rural areas in the design of policies and practises relevant to the world they inhabit or would wish to inhabit.

For example, in the UK we have research, conducted in conjunction with the NGO charity, The Children's Society, which builds on research the Society is doing with children's experience of participation in constructing their neighbourhoods. The research explores and develops theoretical and methodological approaches to using metaphors which enable multiple stakeholders to explore their diverse experiences and to participate in constructing their environments. It also considers the Children's Society's own organisational arrangements and whether these facilitate children's participation.

Systemic ecodesign

Agronomists are in a good position to facilitate the design of new agricultures - what I have called elsewhere participative or systemic ecodesign (17;18). Coventry et al (10) make a similar point when they

argue that "the process that is occurring in the South Australian low rainfall areas is the redesigning of the production system with increasing complexity and increasing requirement for management and research inputs. Future farming will require more complex integration of the system components ..as well as adaptation at district and farm level. Unfortunately they do not suggest the processes by which this might be achieved, nor specify the stakeholders who might be involved.

In recent research in Australia and the UK my co-researchers and I have been developing ways in which multiple stakeholders might participate in R&D so as to realize more relevant research and design criteria for new systems. This research has concerned (i) evaluation and further refinement of RRA and PRA for the purposes of generating contextualised research questions and for initiating stakeholder involvement in co-researching systems (20; 49; 2; 53); (ii) the notion of enthusiasm as theory, biological driving force (predisposing individuals to action) and methodology (attempting to create the context in which individuals who share the same enthusiasm might work in co-researching groups) (see 22; 48); (iii) understanding both graziers and researchers discourses around vegetation management and the "problem" of degradation in the NSW western division and using this as a basis for the design of "dialogue" meetings (25; 26) and (iv) eliciting the metaphors used by farmers and members of FWAG (Farming and Wildlife Advisory Groups) around "farming" and the "countryside" in the U.K. These metaphors were then used as a basis for understanding their current paradigmatic commitments and for the design of a research methodology from which new metaphors, and thus new designs, for farming and countrysides might emerge (36).

Brian Arthur, of the Santa Fe Institute, has argued that "non-scientists tend to think that science works by deduction but actually science works by metaphor. And what's happening is that the kinds of metaphor people have in mind are changing (52). He adds that "an awful lot of policy-making has to do with finding the appropriate metaphor. Conversely, bad policy-making almost always involves finding inappropriate metaphors (52). Too often there is a generational lag of metaphors for understanding and action. From a UK vantage point, Australian agriculture requires some creative new metaphors because we are no longer "the lucky country"- this will also apply to agronomists for new metaphors will shape what it is that we do.

The professional challenge will be to adopt new metaphors which embody an environmental and sustainability ethic. Long (32) holds that agronomists have responsibilities which include product stewardship and ensuring their actions are in accord with moral and professional obligations and "a ..duty to those to whom they give advice to use a particular product and to others who might foreseeably be effected by such use". In the Helix case he reaches the very potent conclusion: "So who was all the promotion and marketing of Helix aimed at? Who recommended its use to cotton producers? Who was directly misled by ICI's failure to warn? Who relied on ICI's silence? The agronomists and cotton consultants, that's who." ... "The agronomists were lucky not to have been sued in the Helix case." As he points out, agronomists inherit the burden of community expectations as to the responsibilities of being a professional - and "the community" in the context of Australian agriculture will be those consumers who live wherever Australian products are, or might be, sold. The Helix case provides some powerful arguments for an ethics of practice as will, I suggest, the decision-making dilemmas around the release and incorporation of GMOs into the food chain.

The search for system

Systems thinking in the twentieth century was pioneered by biologists who emphasized the view of living organisms as integrated wholes. It has been further developed through *gestalt* psychology, ecology, quantum physics and more recently by the sciences of complexity (8). A "system" has come to mean an integrated whole *distinguished by an observer* whose essential properties arise from the relationships between its parts, and "systems thinking" the understanding of a phenomenon within the context of a larger whole. "To understand things systemically literally means to put them into a context, to establish the nature of their relationships" (8). Systems thinking is "contextual" thinking; and since explaining things in terms of their context means explaining them in terms of their environment, we can also say that all systems thinking is environmental thinking.

There is increasing recognition of the need for systemic thinking and action as a means of improving what we do (please note that I deliberately avoid the use of the phrase "solving problems"). Writing in *The Observer* (January 4, 1998), Simon Caulkin argues that the next big idea in management will concern the theories of complexity and chaos: "complexity seeks to explain how systems work and interact". Whilst we would argue that this idea is not new and that there are dangers in holding any set of ideas up as the latest "fix" we do recognise a resurgence of interest in systems thinking and action. At the OU, members of the Systems Discipline have just launched a new taught postgraduate Programme in Environmental Decision Making, an Undergraduate Diploma in Systems Practice and have a MSc in Systems Practice planned for 2001. Currently there are about 1500 students studying systems courses. Our focus in these programmes is to develop student abilities to search for system, that is to apply systems thinking to areas of complexity in their lives by formulating systems of interest which bring forth multiple perspectives and agreements about what would constitute useful change. It seems to me that agronomists require these skills as part of their professional competencies.

Conclusions

As a means of preparing this paper I invited a number of colleagues past and present to tell me what of significance they felt had happened in agronomy in the last four years. I do not claim any methodological rigour in generating this list, but the responses are interesting in that they capture some of the current "headlines" for stories that agronomists feel able to tell each other. The responses included: (i) Understanding the SOI and the management of probability i.e. seasonal climate forecasting - is being shown to be valuable to farmers in many ways (agronomy, marketing etc.); (ii) Dealing with major commodity deregulation; (iii) Management responses to salinity; (iv) Use of models in agronomic management - e.g. APSRU's (Toowoomba-based) efforts in this area where for the first time farmers are becoming really interested in these tools; (v) Precision agriculture - the latest fad pushed from the USA. Some aspects have caught on (automated steering systems, yield monitors) but the rest is a long way off (e.g. differential fertilizer applications); (vi) Skip row crops - a common strategy in dryland cotton is to miss planting every x number of rows to enable soil water to last longer. This strategy is moving into other crops such as sorghum.

My purpose in listing these is to conclude on a positive note; clearly there are important innovations to which agronomists continue to contribute. My only concern is whether these are enough - as some of you will have heard, rural people in Britain recently staged a major day of protest in Westminster. One of the speakers observed that no one thought it would be possible for 150,000 miners to disappear as they did under the Conservatives and that if they were not careful they too would disappear (R. Packham pers. comm.). Is such a scenario possible in rural Australia? It is hard to imagine that continued first-order change - more of the same - will be enough. There will be a need for second order change, change which changes whole systems.

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