Invited paper for symposium on Farming Systems

Australian Soc Agronomy, Hobart, 2001

Farming Systems Research and Farming Practice

R.L. McCown
Agricultural Production Systems Research Unit
CSIRO Sustainable Ecosystems, Toowoomba, Queensland

ABSTRACT
Farming Systems Research began in the 1970s as on-farm methodology to make agricultural research more relevant to farming practice in special circumstances where the 'gap' between theory and practice was especially large. After nearly three decades, it is now clear that farming systems research is needed even in Australia to enhance research relevance to management practice. But successive 'reinventions' have demonstrated that farming systems research is more an important *perspective* than *methodology*. Appropriate methodology needs to emerge from situations of management practice where farmers, advisers, and researchers share a farming systems perspective and strive together to solve problems and discover opportunities. The paper examines the interface between farm management practice and research about farm management practice and successive paradigm shifts in methodology and perspectives at this interface. It is conjectured that a continued dynamic approach has a promising future.

KEY WORDS

Farming systems research, on-farm research, situated practice, action research, simulation, FARMSCAPE

INTRODUCTION

My task in this symposium is to contribute to some general setting for subsequent thematically diverse papers pertaining to farming systems research. Although the required brevity rules out any comprehensive treatment, the need for comprehensiveness has been reduced by recent publications (e.g. 10, 28). But, in trying to say something 'holistic' and brief about an activity that covers 'practically everything' in agricultural production, I am conscious that in abstracting complexity "all that can be said about practically everything is practically nothing." Rather than risk this trap by reviewing reviews. I will instead limit my treatment by focusing on the basic idea of farming systems research—but focusing through the stereoscopic oculars of 'practice' and 'theory', i.e. of *farming practice* and *research about farming practice*.

Agricultural research encompasses diverse activities, but from early days there has been a tension about how much research should be closely linked to farming practice and how much farmers should influence the research agenda (4). Since the 1970s the term 'farming systems research' has signified that research in which *what scientists normally do* and *what farmers normally* do are brought closer together than usual in the interest of research being more directly relevant to practice than usual. It was the circumstances of international agricultural development assistance programs that stimulated the invention of Farming Systems Research (FSR) as methodology (24). The bringing of scientists and their technology developed for agriculture in an industrialised society together with farmers using traditional practices in pre-industrial societies created the greatest possible gap between *science* and *practice*. In hindsight, although it took some time for FSR to be considered necessary or appropriate in industrialised countries, the extreme ‘development’ situation proved to be instrumental in better defining the nature of the gap between theory and practice in farming and in developing methodology that was eventually seen to be useful in more ‘normal’ circumstances (24).

With an eye on an FSR approach that is seen as relevant by farmers and that significantly influences their practice, the first part of this paper addresses the superficially elementary questions, “what is farming practice?” and “what is research?” In the light of the answers, the second part of the paper traces successive reinventions of FSR which are still occurring and which are needed if FSR in Australia is to be what it needs to be to support farmer needs in the 21st century.

REVIEW AND DISCUSSION

What is practice?

Researchers know that practical farming is profoundly different from ‘scientific’ farming. But there has been little incentive for them to be good students of the differences. A scientist could focus on science and technology with a belief that the product of his/her research could and should benefit farming. Transactions between the research and the farming problem were largely someone else’s responsibility. But the climate for agricultural research is changing, and there are new incentives for researchers to understand, and feel responsibility for, the interface between their science and farmers’ practice.

Figure 1 is a simple model of a farm/farming system adapted from Sorensen and Kristensen (35). The Production System is that domain of the farm that is of common interest to agronomists and farm managers. But they see it from quite different perspectives—farmers from the ‘inside’ and agronomists from the ‘outside’. To the ‘outsider,’ *practices* are farmers’ *operations* in the Production System. By this view, research can make practices more effective and efficient through provision of general principles and technologies that can be *applied* to local physical conditions.

Depiction of the meaning of ‘practice from the *inside*’ is especially challenging because it entails a momentous leap beyond adapting production technology to the near edge of a domain which, at its core, is about ‘what it is to be human.’ The construct of the Management System of Figure 1, although a gross oversimplification, does enable discussion of farming to distinguish between the technical and the human, or social, element of the farm. Consideration of practice as *social* is a crucial departure from the notion of a practice as a consistently reproduced *technical* behaviour. It is an individual’s *purpose*-related commitment and activity that makes practice social in the first instance. But this *telic* stance is integral to a network of concepts and actions of a *community* in which sets of concepts and actions make sense and are regulated—not by explicit rules, but by mutual understanding of ‘what is an error’ (8).

The telic view of practice of the ‘insider’ can be likened to a felled tree as viewed from the trunk end (the *basipetal* perspective), with individual purpose and agency branching into strategies and plans and further branching into diverse objectives and technical practices. The view of practice of the ‘outsider’ can be likened to viewing the felled tree from the apex.

From this *acropetal* perspective, specific instrumental/ technical practices are seen as branch tips in two, and to some degree, three, dimensional space. The degree to which the invisible structural 'branching' relationships involving coherent purposes and plans can be safely *presumed* depends on the degree to which the 'outsider' shares/understands this form of (farming) life (8).

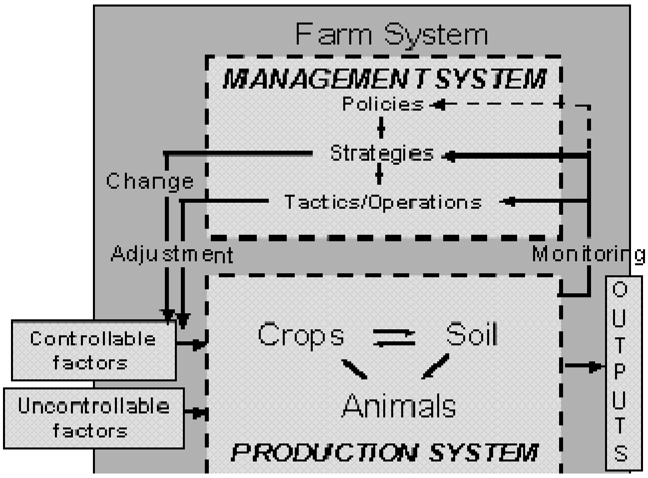

Figure 1. The farm as systems of production and management.

The tradition of research to improve farming practices has been to simply deal with problems and opportunities at the instrumental level of branch tips through applied research in appropriate scientific disciplines. But for our research to be more consistently relevant to farming 'practice,' we need to better appreciate that the internal human structure of practice is *essential*, rather than merely a rustic substitute for the 'rational', scientific structure. We need to broaden our research approach to include the internal structure of practice as an *aid* to system intelligibility rather than an *impediment* whose effects need to be minimised. By involving both farmers and researchers, farming systems research offers a pathway for combining the benefits of external scientific/technical perspectives and the internal practical perspectives.

In a paper, whose value in aiding insight to research and practice is only marginally diminished by its economy in language Oquist (26) defines '*practice'* as 'policy and action in the context of determinate structures and processes'. Somewhat inconveniently, in agricultural research the term 'policy' is used to refer to something other than the internal management process of an individual farm/farmer, but the latter usage is common in other fields. Oquist's definition, in turn, of '*policy'* is hierarchical, comprehensive, and terse: '…needs and interests, values and norms, ends and objectives, plans and programs, operations and evaluations, and resources related to a given action or potential action.' In explaining the Management System of Figure 1, Sorensen and Kristensen (35) state that 'Human activity [i.e. Oquist's 'practice'] manages the use of controllable factors in order to maintain the farm in harmony with the overall purpose of farming.' Jantsch (16) invokes the concept of *personal* policy to encompass this holistic aspect of practice.

A policy is a set of principles laid out for the purpose of regulating simultaneously and in a viable mode a multitude of interacting relationships pertaining to many qualities and dimensions of human life--in short, a theme underlying a life (Jantsch (16), p. 6).

In their search for relevant links to practice, scientists often exaggerate the farm's nature as either a business or an ecosystem, depending on their own speciality. The risk in this is delusion by the outsider about the central *theme* of a family farm (Jantsch quote above) and unnecessary puzzlement and surprises regarding responses to technological interventions. Recent work by Frost (14) shows that it is a mistake for outsiders to view the Management System too narrowly as a business. The overall picture provided by in-depth interviews with 140 farmers in Western Australia showed that 'expressive' values involving personal fulfilment through 'pride of ownership' and 'worthwhile work' were as important in explaining practice as 'instrumental' values concerning income and security. Clearly one of the needs for a more effective engagement of researchers on the 'outside' of farming practice with farmers on the 'inside' is a way of achieving a better understanding of each others perspective.

Practice from the inside is not only social, it is *local.* Both social and local are embodied in the term 'situated' (7). Situations are *experienced.* The shape of a practice evolves in response to an individual's experiences, and this history gives it relevance. From the 'outside,' scientists see farming systems as extremely complex, and tend to perceive need for scientific assistance in recognizing logical imperatives for action. The reality of situated practice is that while it is enormously complex in terms of scientifically describable mechanisms, much of this complexity is invisible and irrelevant to the experienced practitioner. This is because, as the very successful farming systems researcher, Mike Foale, says, 'although every farm is complex and unique, nearly every farm is managed by 'the world expert' on *that* farm'. Experiential knowledge concerns *procedural* relationships between action and outcomes and such knowledge constitutes *expertise*. Complexity becomes an issue only when a farmer is a novice regarding a practice or when a relationship between action and outcome breaks down. Unfamiliar breakdown or a radical change in technology or strategy is all it takes for an expert to become a novice again. At these times, the 'outsider' view of scientific structure of practice can be very important to a practical farmer.

Figure 1 also depicts 'localness' of situated practice. The nature of the connections between the Management System and the Production System make the farm a cybernetic system, i.e. feedback from the Production System influences future management action. At the operational level, an awareness of the state of those aspects of the Production System that are influenced by Uncontrollable Factors enables adjustments to be made. At the level of Strategy, feedback from the Production System, information of the state of an uncontrolled external factor, e.g. the market, or availability of a new technology may lead to a decision that substantially changes the structure of the Production System (Figure 1).

Over long periods of trial and (elimination of) error, the essential nature of socially and physically *situated* farming practice enabled the emergence of adapted agriculture over much of the earth. But, the efficiencies of modern agriculture could never have been achieved without scientific research.

What is research?

During the past century, the prevailing tradition of science has been the discovery of the 'deep' structure of nature and the use of this knowledge in controlling and manipulating nature in unprecedented ways and with unimagined efficiencies. Although humans have been creating their own 'worlds' for a long time, the unprecedented pace of this has occurred once *design* could be based on theoretical understanding of how the biophysical world works. Such 'theory' about 'what is not impossible' influences human affairs in two primary ways: (a) informing the design of potentially useful artefacts and (b) guiding human actions regarding new possibilities for achieving aims and in preventing or alleviating problematic situations. Science explicates the workings of the 'conditions and constraints' end of Simon's definition of *substantively* rational practice, i.e. 'behaviour appropriate to the achievement of given goals within the limits imposed by given conditions and constraints' (34).

The most dramatic contributions of research to farming have been the inventions of radically new material technologies, beginning with inorganic fertiliser in the first half of the 19^{th} century and evidenced most recently by the breaking of natural barriers to genetic recombination to achieve extraordinary organisms, attributes and social utility. In both cases the understanding of 'deep' structure of nature that is invisible in ordinary situated practice created new possibilities for technology design and development. But there has not been a comparable success in using theory to design optimal management practices.

It might be said that the very aspect of science that is so powerful for showing up hidden possibilities for material engineering is also the weakness of science in designing better farming practices. Research to develop general theoretical principles about 'how the world works' has to be conducted in a manner that *eliminates* the effects of local situations. The abstracting of *structure* from the local content and context of situations is central to the powerful function of *theory* in science and engineering. But this abstraction also underlies the main obstacle to adoption, which depends on *application* in ways that are meaningful to practitioners in real situations. Recommendations based on structural inferences or explication of structure can be helpful to a manager, but more commonly, uncertainty concerning local specific conditions (content and context of the situation) dominates decision and action.

But there is an earlier tradition of science in which experimentation has nothing to do with theory construction but, instead, features accurate description—the production of *facts* concerning content of the experienced world. The science paradigm advocated by Francis Bacon, one of the fathers of experimental science, was described by Medawar (23) as the *experiential* method of science.

The unique contribution of science to empirical thought lay in the idea that experience could be stretched in such a way as to make nature yield up information which we should other wise have been unaware of. The word 'experiment' as it was used until the nineteenth century stood for the concept of stretched or deliberately contrived experience; for the belief that we might make nature perform according to a scenario of our own choosing instead of merely watching her own artless improvisions (Medawar (23), p. 335).

Although, this so-called *inductive* type of research was criticised for providing an inadequate formal logic for extrapolating from the experiments (29), much of the research in agriculture aimed at applying principles to local situations has been of this empirical type. While there seems to have been broad agreement that we need both theoretical and empirical approaches, there is a tension between the two (27). In the past, this tension surfaced mainly as an internal science practice matter (4). But with recent restructuring of agricultural research in relation to industry, it is increasingly a matter of research efficacy. There is unavoidable uncertainty about the 'optimum' mix due to the uncertainty about the future payoffs from either type of activity in any period and place, complicated further by conflicts concerning who pays and who enjoys the payoffs.

A third research paradigm that became important with the advent of computers combines theory and local empirical ‘experience’. This is *systems research* that uses simulation models (e.g. ‘hard’ systems, Operations Research, Management Science.). As far as possible, general theories are used in model construction and these are tested using data sets from diverse specific situations. In principle this provides an enormously powerful means of overcoming both the problem of applying theory to real farming situations and the inherent limitations of extrapolating from the results of site-specific experiments aimed at answering the question of ‘what happens if…’ in a problem context. If we turn again to the ‘tree’ metaphor regarding *practice* and the view from the ‘outsiders’ acropetal perspective, what distinguishes this ‘hard’ systems research paradigm is its concerns with (a) interactions among the technical practices of the branch tips and (b) aggregate outcomes as influenced by external Uncontrolled Factors (Figure 1). Such research enables the use of biophysical and economic theory to design practices that are notionally aimed at the targets of ‘insider’ purpose revealed as stated goals, but are realistic in keeping with what the external environment will allow. When achieved, the results are *substantively rational*, i.e. congruent with biophysical reality, and *normative*, i.e. it is what a rational manager *ought to do* to achieve the stated goal.

These three paradigms of research, i.e. (1) documenting contrived experiences (experiments), (2) figuring out underlying mechanisms in the production system, and (3) using theory to design best practice correspond to ‘descriptive’, ‘nomothetic’, and ‘policy’, research in the typology of Oquist (26) (Table 1). The output of descriptive and nomothetic research is knowledge concerning ‘what is the case’ in the world; the output of policy research is knowledge concerning ‘best practice’, with reference to theoretical possibilities and limitations. This dichotomy is often abbreviated using the ‘shorthand’ of Ryle (32), i.e. ‘knowing *that…*’ and knowing *how*’.

The fourth research type of Oquist (26) (Table 1), ‘action’ research also concerns ‘knowing how’ in practice. But instead of reference to *theory*, the referent for action research is the *shared experience in the practice situation*. Practitioners and professional researchers together conduct research, taking advantage of the so-called action learning cycle: Action à Observation à Reflection à Planning à Modified action. This ‘participative’ research approach was describe by Checkland as

The concept of action research arises in the behavioural sciences and is obviously applicable to an examination of human activity systems carried out through the process of attempting to solve problems. This core is the idea that the researcher does not remain an observer outside the subject of investigation but becomes a participant in the relevant human group. *The researcher becomes a participant in the action*, and *the process of change itself becomes the subject of research*. In action research the roles of researcher and subject are obviously not fixed: the roles of the subject and the practitioner are sometimes switched: the subjects become researchers...and researchers become men of action (Checkland (6), p. 152, my emphasis).

Table 1. Oquist’s Typology of Research (26).

Descriptive Research	Delimits phenomena within typologies of facts and events.
Nomothetic Research	Attempts to explain and/or predict phenomena with regard to the external relations between a given phenomenon and one or several variables and constants. [Mathematical model-making]
Policy Research	The production of knowledge that guides practice, with the modification [in practice] of a given reality occurring *subsequent to* the research process.
Action Research	The production of knowledge that guides practice, with the modification [in practice] of a given reality occurring *as part of* the research process.

Interpretation of farming systems research is greatly aided by this typology of research in relation to situated *practice* and technical *practices*. But this does not mean that interpretation is straightforward. Oquist (26) claims for his typology (Table 1) that each type assumes and builds on the prior type, i.e. *nomothetic* 'standing on the shoulders' of *descriptive* research and underpinning *policy* research. Early scientific research concerned acquisition of facts about the *apparent* world, and only later did the emphasis shift to construction of theory about the normally *unseen* world (22, 29). But the emphasis in both cases was on *rigour of process to avoid error* in ascertaining the nature of nature. In the research 'mainstream', the first paradigm that primarily concerned itself with *relevance* to human action ('knowing how') rather than *rigorously true* knowledge about the world ('knowing that') took the path that featured designing 'best practice' using theory. But theoretical practice was rarely seen by practitioners to be relevant to situated practice. It might be said that farming systems research was able to avoid repeating the mistakes of this approach, mainly because many of its early pioneers were agricultural economists who had just experienced the demise of Farm Management Research due to the un-relatedness of 'policy research' (Table 1) to situated policy and practice (e.g. 17, 12). A more direct interpretation is that Farm Management researchers enthusiastically embraced FSR as a welcome second 'shot' at research about management practices that was more relevant to farm management practice.

What is farming systems research?

This 'invention' of what has become known as Farming Systems Research (FSR) took place in the early 1970s mainly in CGIAR International Research Centres, prompted by the general concern that low adoption rates might be due to technology not being sufficiently relevant to situated practice and this due to failings in the research *design* stage. A prominent contributor to early FSR concepts was John Dillon, the foundation Professor of Farm Management at the University of New England. After two decades of leadership in applying economic theory to farming practice in the mode of Oquist's policy research (Table 1), Dillon recognized that this approach not only was not working, but that it could not be made to work. Even more remarkable was his willingness to announce this as a learning.

In general the criticism can be summarised as saying that…FM [Farm Management Research] based on production economics has lost or must inevitably lose touch with farmers' needs and the practicality of farming because of this emphasis on logically attractive but largely inapplicable theory (Dillon (12), p11).

Dillon pinpointed the problem as an underestimation by researchers of the inherent difference between theoretical farm management and farm management in practice (12). Figure 2 depicts this contrast between the enterprise of scientific/economic research with a responsibility for findings to be generally applicable and the local and social (situated) enterprise of farming. For the remainder of his professional life, the conceptual challenge of bridging this gap between theory and practice occupied much of John Dillon's attention. In later papers (13, 1) Dillon and colleagues endorsed the approach depicted by Collinson (9) as reproduced in Figure 3.

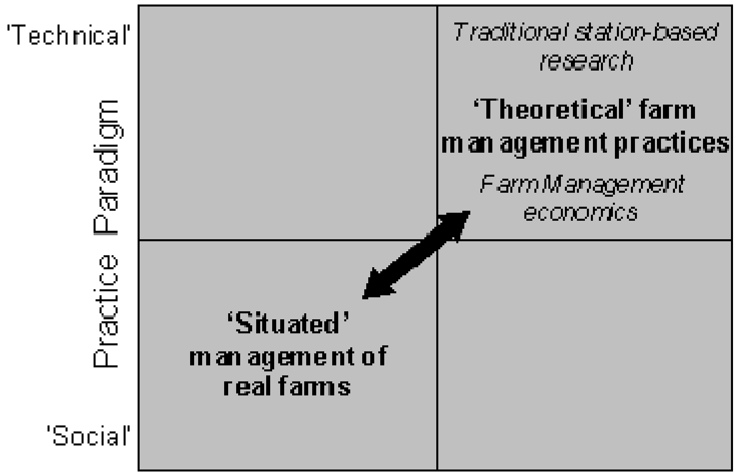

Figure 2. 'Internal' *vs.* 'external' views of farm management framed by two criteria important to FSR.

The outstanding feature of Collinson's schema is that it so 'sensible'. If a research organization set out with the primary intent to benefit farming practice, common sense would lead to something close to this. *Relevance* is enhanced by moving research to the farm. *Rigour* is retained by retaining experimental techniques in on-farm experiments and through ties with station-based research. This approach became Farming Systems Research and occupies the location in the matrix of Figure 4 of 'Technical-Local'. During the early 1980s FSR became a 'bandwagon' in agricultural research internationally, led mainly by agricultural economists and largely ignored by researchers in places like Australia. As Dillon (11) noted,

Most early farming systems work was done by agricultural economists who specialized in farm management. [ ] Biological and physical scientists in developed countries have seldom become involved in FSR. In part, this is due to the fact that farmers were expected to be the integrators of new information (p28).

In time, in various places and forms, the ideas of FSR diffused into Australian agricultural research (28).
But the FSR of Figure 3 did not stand still. While the importance of the idea of moving research to the farm was widely acclaimed, criticism soon focused on shortfalls in bridging the gap mainly due to *relocation-to-the-farm* not equating to *becoming-situated-in-farming*. Research was criticised for being a testing or demonstration of solutions introduced and tailored by 'outsiders'—a portable, lightweight form of policy research (Table 1). Roling (31) saw early FSR as a kind of 'market research' that tended to analyse the client system with a

view to better targeting the 'product' of research. But it was a move in the right direction. It was a natural progression for FSR to be reinvented through a paradigm shift from policy research to action research (Table 1). This shifted the aim to co-operative learning by participating ‘outsiders’ and ‘insiders’. Participatory Action Research (e.g. 37), or alternatively, Farmer Participatory Research, (e.g. 25) represented a shift in philosophical paradigms for the inherently *socio-technical* FSR from a form which was guided by ‘outsider’ *technical* considerations to one which was guided by ‘insider’ needs and preferences, providing the *social* framework (Figure 4).

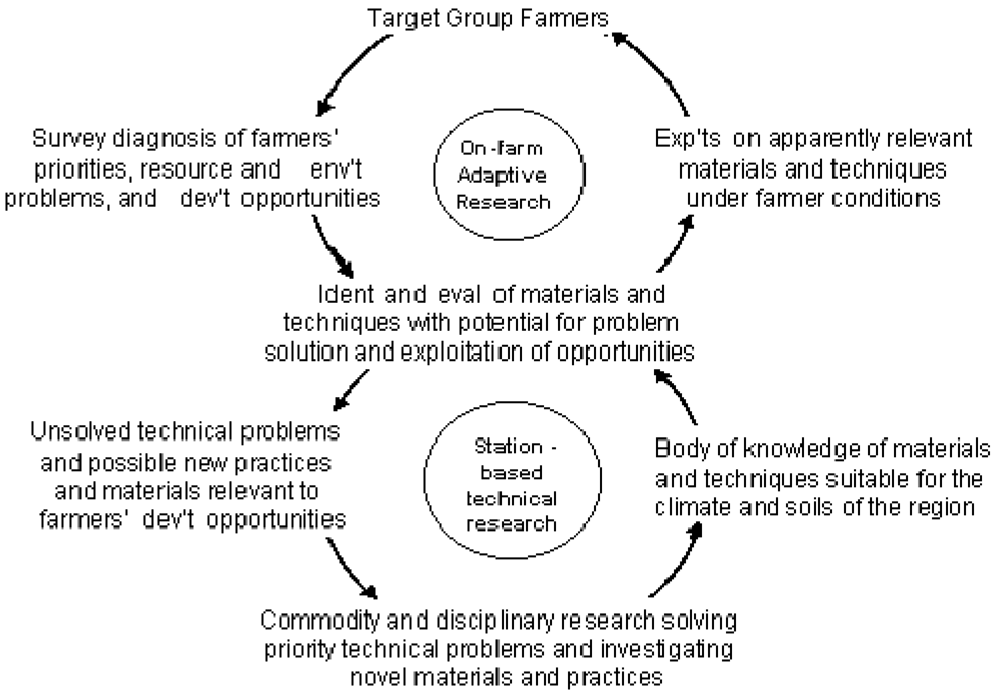

Figure 3 The ‘classic’ Farming Systems Research (9).

The ‘Social-Local’ cell in Figure 4 includes a second type of PAR that has been discussed (eg 33) as a further reinvention of FSR, in which the control of the research agenda and process moves even further away from the researcher towards the farmers.

The reinventions of socio-technical Farming Systems Research have been overwhelmingly progressive changes in the social structure of the broad knowledge system of agriculture that can be traced in the framework of Burrell and Morgan (3) (Figure 5). FSR as depicted in Figure 3 was in the ‘Functionalist’ paradigm—improving the performance of systems through expert intervention. PAR aimed at improving the performance of systems, but recognised that effectiveness was enhanced by processes in which farmers’ subjective views were featured. This is achieved in an ‘Interpretive’ research paradigm which features social engagement and mutual understanding of the between farmers’ ‘inside’ views and professional researchers’ ‘outside’ views. Both the Functionalist and Interpretive forms of FSR are aimed at efficient performance of farming systems (Figure 5, x axis). Action research in the ‘Interpretive’ paradigm empowers farmers through their management learning construction, often aided by new insights to underlying structure of the Production System. Action research to change the structure of farmers' social/political environment belongs in the 'Radical Humanist' paradigm. In places where poor farmers constitute a social underclass, this has been advocated and used by some researchers to enable these farmers to discover that their experienced status and conditions may not be necessary or inevitable and to empower new 'aspiring'. But in Australia, progression beyond the interpretive paradigm has taken a different form.

Instead of radical change processes stimulated by action research, farmers have gained greater control over agricultural research that affects them through progressive changes that have not involved researchers. It has been, and continues to be, realised by restructuring of public institutions providing services to agriculture. Increasingly research is funded by competitive grants from R&D Corporations, in which government funds are complemented by industry levies on producers. As farmers' levies have become a larger fraction of the nation's research budget, farmer representation and influence in the funding organizations' policy and management has increased. The shift of farming systems research in the direction of the local farming community is further reinforced by the allocation of industry funds to farmer groups to conduct their own research. In terms of Figure 5, this amounts to a continuation of the regulatory intent (x axis). Radical change has occurred in the social composition and even the *definition* of the research institutions, but driven by the equity principle of 'user pays' and the corporate democratic principle that 'shareholder has influence'.

What is farming systems research in Australia?

Perhaps the most significant underlying difference between the environment for FSR in Australia and the third world 'development' environment, concerns approaches to the issue of wealth distribution within the farming community and its economic and social implications. The dominant trend in evolution of FSR in 'development' is a humanitarian response to the plight of farmers who are poor, socially and politically disadvantaged, and whose circumstances are likely to worsen before they improve. But in Australia, policy regarding farmers in poverty is shaped by three dominant factors: agricultural commodities provide major export earnings to the nation, accelerated land degradation often accompanies undercapitalised farming, and government social welfare programs are well developed. This results in an expectation, even by farmer organizations, that as Australian farmers continue to make changes that keep them internationally competitive, the best option for some farmers at the low end of the income distribution will be to leave the land. Government policy is to support an option for such a farmer that is more attractive than to remain in farming under very unfavourable conditions. On the other hand, research support for agricultural production tends to benefit the better producers, and this is rationalised as being in the national economic interest.

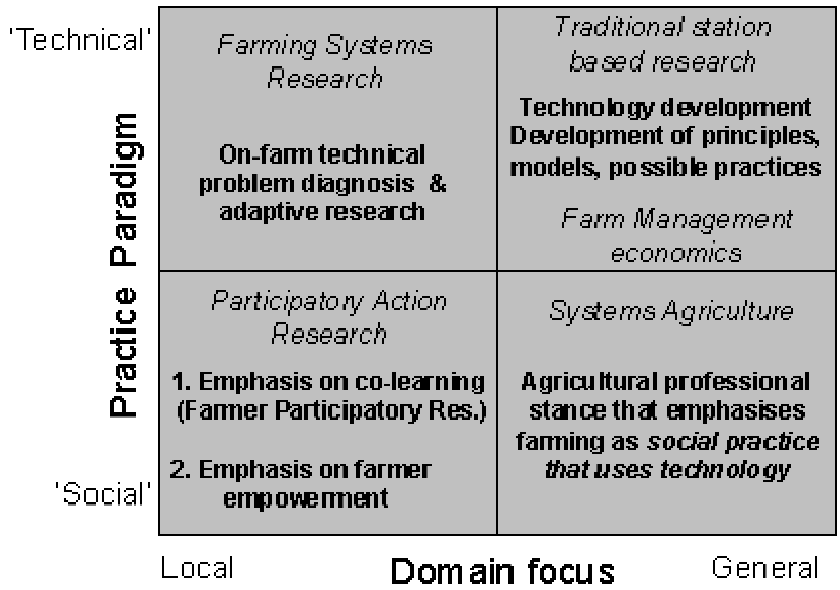

Figure 4. A typology of concepts for interfacing agricultural knowledge production with farming practice

Australia has benefited enormously from (as well as contributed to) past developments in international FSR. But in contrast to a decade ago (19), it now seems obvious that FSR development has proceeded in Australia to a point where the peculiarities of the Australian environment requires a local approach that has already diverged conspicuously from the international 'development' FSR effort.

What is the status of farming systems research in Australia today and what might the future of this approach be? Carberry (5) provides anecdotal evidence of the present marginality of on-farm, participative research *vis a vis* traditional research, but indicates that this is not the case in all regions. Over the past decade, in Queensland, the State Departments of Primary Industries and Natural Resources, the Rural Extension Centre of the University of Queensland, and CSIRO all have experimented with variations on Farmer Participatory Research (Figure 4) and 'soft' systems research (37). A considerable degree of institutionalisation of this paradigm has taken place in this period. Today, GRDC allocates a large portion of its grants in the North through large multi-institutional Farming Systems Projects in three subregions (5).

In this Northern region, with the assistance of GRDC, a major experiment in FSR has been conducted in using the 'hard' technology of simulation models within an interpretive / 'soft' paradigm. This experiment was designed to see if a flexible cropping systems simulator could aid farmer planning and learning under climatic uncertainty as an enhancement to FSR (15, 21, 20) using an action research approach. FARMSCAPE (Farmers-Advisers-Researchers, Monitoring, Simulation, Communication, And Performance Evaluation) was conceived as a style of farming systems research that enhances Participatory Action Research with simulation (20, 21), and evolved to feature 'what if?' discussions with farmers made possible by simulation of action/event consequences in situations meaningful to involved farmers (20, 15). The role for a flexible simulator in farming systems research is coupled to the infeasibility of on-farm experiments to deal with important aspects of management problems, namely climatic uncertainty and uncertainty of the effects of management on the rate of soil/landscape degradation (or rehabilitation) (21). The essential difficulty is in making management sense of necessarily short-term on-farm experiments. In much of the world, and especially in Australia, seasonal variability makes it problematic to interpret an experiment beyond the season in which it was conducted. But the combination of historical weather records and well-developed simulation models offers significantly enhanced interpretation of on-farm experiments (e.g. 30).

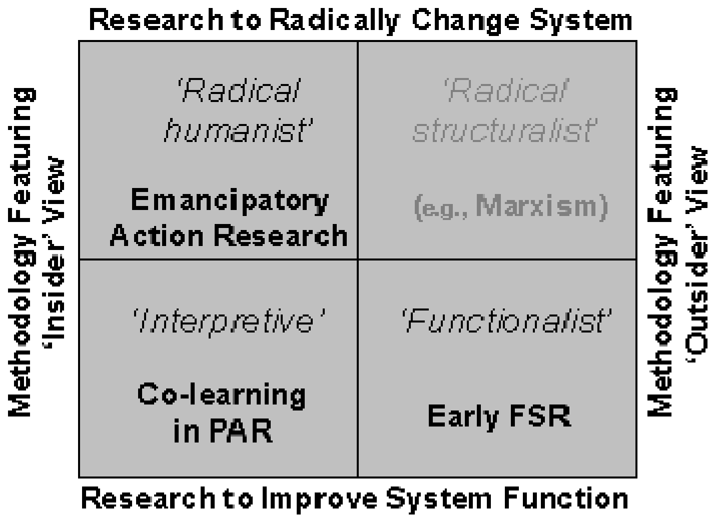

Figure 5. Four paradigms for analysis of social intervention (Burrell and Morgan 1979).

Demand by farmers for an ongoing availability of a situated simulation capability represents a drastic change from the scepticism about models at the outset in 1992. Presently 10 agronomists representing four agribusiness-consulting firms and two public institutions are undertaking training programs to gain formal accreditation in using a FARMSCAPE approach to support farm management.

The emergence of farmer initiated and organised research activities at a local level may contribute to a unique, adaptive form of farming systems research in Australia. The conditions that have led to this development seem to have included: a high level of dissatisfaction with the performance of traditional research services in meeting local farmers' needs; a high degree of competence and confidence of farmers in managing an independent effort; and a R&D structure that was sufficiently flexible to accommodate such a departure from traditions. This 'local and social' phenomenon is in keeping with the tradition and trends in farming systems research illustrated in Figure 4 that remove barriers to research being relevant to practice. Questions about the desirability of such development pertain more to research than to applications to practice, and are addressed by Carberry (5). But there may be some long-term risks for practice.

In the ideal world of agricultural R&D, one would expect to find constellations of farmers, consultants, advisers, and researchers where respective comparative advantages were being captured effectively and efficiently, and behind the scene, a process for designing a new constellation for a problem situation. In the real world, a constellation of players represents a pragmatic response to, not just the problem situation and comparative advantages in abilities, but to conflicts of interests of institutions and individuals. Clearly, the challenge is to manage the relative advantages and conflicts to minimise penalties in overall cost-effective performance. Scientists should be doing what they do best where it provides high returns. Much of the on-farm research of pressing interest to farmers utilises inductive 'experiential' method of research, in which experiments primarily serve the acceleration of experience. Much of the planning and conduct of this research can be done well by interested farmers and their advisers, who have the added advantage of on-site presence.

On the other hand, the creation of knowledge required in making Australian farming more ecologically sustainable involves coping with the long time lag between production action and landscape feedback. The experiments of sufficient duration to provide such information are highly problematic even on research stations (18). Cost-effectiveness is severely reduced by the problem of timeliness so elegantly expressed in the Arab proverb, 'Experience is the comb that life gives to a bald man'. It seems likely that to adequately address the grave environmental problems facing Australian agriculture, the best theory and technical expertise that agricultural science has at its disposal will be needed. But, history shows that without farmers' involvement in the *situating* of potentially valuable theory in *practice*, the problems and the gap between theory and practice persist (2). The logic of reinventing farming systems research to include sustainability issues and powerful scientific tools in Participatory Action Research is consistent with the farming systems research premise that 'extension' is no substitute for direct research-practice articulation and with the recent downsizing and role changes in extension.

Inclusion of this class of farm issues in farming systems research seems feasible only by using simulation. Such an enhanced form of FSR does not appear in Figure 4, as such, but it combines aspects of Technical-General with Social-Local. The fact that this is the diagonal whose problems prompted invention of FSR initially (Figure 2, 4) is a reminder that the crucial factor is whether such use of fancy models can be seen by a farmer as sufficiently *situated* to be taken seriously in his/her planning process. If this were easy, appropriate Decision Support Systems would be part and parcel of Australian FSR. But this has not happened. But FARMSCAPE builds on this experience, and recent piloting of simulation-based farmer 'what if?' discussions that combine situated production and sustainability considerations provide encouragement for this approach (Z. Hochman, pers. comm.).

CONCLUSIONS

Australia is in a position to lead the world in combining the human resources of its farming practitioners with those of its agricultural researchers in new ways to solve problems that in times past have often made agriculture nonviable. There seems no better vehicle for combining forces than a jointly reinvented farming systems research approach.

REFERENCES

1. Anderson, JR, Dillon, JL, and Hardaker, JB. 1985. Proceedings of an international workshop held at Hawkesbury Agricultural College, Richmond, N.S.W., Australia, 12-15

May 1985. (Ed. J.V. Remenyi) (*Australian Centre for International Agricultural Research*: Canberra), pp77-88.
2. Brennan, L. and McCown, R.L. 2001. *Proceedings 10th Australian Agronomy Conference*, Hobart (this volume).
3. Burrell, G. and Morgan, G. 1979. Sociological Paradigms and Organizational Analysis. (*Heinemann*: London.)
4. Busch, L. and Lacy, W.B. (eds.) 1986. The Agricultural Scientific Enterprise: A System in Transition. (*Westview Press*: Boulder).
5. Carberry, P.S. 2001. *Proceedings 10th Australian Agronomy Conference*, Hobart (this volume)
6. Checkland, P.B. 1981. Systems Thinking, Systems Practice. (*John Wiley & Sons*: Chichester)
7. Clancey, WJ. 1997. Situated Cognition: On human knowledge and computer representations. (*Cambridge University Press*: Cambridge.)
8. Collins, HM and Kusch, M. 1998. The shape of actions: What humans and machines and can do. (*The MIT Press*: Cambridge.)
9. Collinson, MP. 1982. Farming systems research in eastern Africa: The experience of CIMMYT and some national agricultural research Services. MSU Inter. Development Paper No.3, (*Michigan State University, Department of Agricultural Economics*: Ann Arbor.
10. Collinson, MP. 2000. A History of Farming Systems Research. (*FAO and CABI Publishing*: Wallingford.)
11. Dillon, J.L. 1978. Farming systems research at the international agricultural research centres. Analysis and Proceedings of the consultative group on international agricultural research technical advisory committee. I. *(Technical Advisory Committee, CGIAR:* Washington, D.C.)
12. Dillon, J.L. 1979. *South African J. Agric. Econ.* **1**, 7-13.
13. Dillon, J.L. and Virmani, S.M., 1985. In: Agro-Research for the Semi-Arid Tropics: North-West Australia. (Ed. R.C. Muchow) (*Univ. of Queensland Press*, St Lucia). pp. 507-532
14. Frost, F.M. 2000. *Aust. J. Exp. Agric.* **40**, 511-518.
15. Hochman, Z., Coutts, JA, Carberry, PS, and McCown, RL. In press. In: Learning and knowing processes for change in agriculture in industrialized countries. (Eds. B. Hubert and R. Ison) (*INRA*: Versailles.)
16. Jantsch, E. 1975. Design for Evolution. (*George Brazillar*)
17. Malcolm, L.R. 1990. *Rev. of Marketing and Agric. Econ.* **58**, 24-55.
18. Martin, R.J. and Grace, P.R. 1998. Assessment of long-term agronomic experiments in Australia. *GRDC, LWRRDC*).
19. McCown, R.L. 1989. Proceedings of the 5th Australian Agronomy Conference Perth, Western Australia, September, 1989.
20. McCown, R.L., Carberry, P.S., Foale, M.A., Hochman, Z., Coutts, J.A., and Dalgliesh, N.P. 1998. *Proceedings 9th Australian Agronomy Conference*, Wagga Wagga, pp. 633-636.
21. McCown, R.L., Cox, P.G., Keating, B.A., Hammer, G.L., Carberry, P.S., Probert, M.E., and Freebairn, D.M. 1994). In: Opportunities, use and transfer of systems research methods in agriculture to developing countries. (Eds. P. Gold worthy and F.W.T. Penning de Vries) (**Levier,** Amsterdam). pp. 81-96.
22. Medawar, P. 1958. Pluto's Republic (*Oxford Univ. Press*: Oxford).
23. Medawar, P. 1984. The Limits of Science. (*Harper and Row*: New York).
24. Norman, D. 2000. In: A History of Farming Systems Research. (Ed. M.P. Collinson) (*FAO and CABI Publishing*: Wallingford). Pp. 293-298.
25. Okali, C, Sumberg, J, and Farrington. 1994. Farmer Participatory Research. (*Intermediate*

Technology Publications: London).
26. Oquist, P. 1978. *Acta Sociologica* **l21**, 143-163.
27. Passioura, J.B. 1996. *Agron. J.* **88**, 690-694.
28. Petheram, R.J. and Clark, R.A. 1998. *Aust. J. Exp. Agric.* **38**, 101-15.
29. Popper, KR. (1972). Objective Knowledge: An Evolutionary Approach. (*Clarendon Press*: Oxford.)
30. Robertson, M. J., Carberry, P. S., and Lucy. M., 2000. Aust. J. Agric. Res. **51**, 1-12
31. Roling, N. 1988. Extension science: information systems in agricultural development. (*Cambridge University Press*: Cambridge).
32. Ryle, G. 1949. The Concept of Mind. *Penguin Books*.
33. Scoones, I. and Thompson, J. 1994. Beyond Farmer First. (*Intermediate Technology Pubs.*)
34. Simon, HA. 1979. In: Philosophy and Economic Theory, Eds. F. Hahn and M. Hollis, (*Oxford University Press*). pp. 65-86.
35. Sorensen, J.T. and Kristensen, E.S. 1992. Global appraisal of livestock farming systems and study on their organizational levels: concept, methodology and results. (*Commission of European Communities).* pp. 45-57.
36. van Beek, P. and Coutts, J.A. 1992. Extension in a knowledge systems framework. QDPI Systems Study Group Discussion Note No. 2.
37. Whyte, W.F. 1991. Participatory Action Research. (*Sage Publications*: London)

Previous Top