McCown, RL; Carberry, PS; Foale, MA; Hochman, Z; Coutts, JA; Dalgliesh, NP (1998)
The FARMSCAPE approach to farming systems research
Proc. 9th Aust. Agron. Conf., Wagga Wagga (1998) 633-636.

The FARMSCAPE approach to farming systems research

R.L. McCown[1], .P.S. Carberry[1], M.A. Foale[1], Z. Hochman[1], J.A. Coutts[2] and N.P. Dalgliesh[1]
[1]CSIRO/APSRU, PO Box 102, Toowoomba, Qld. 4350
[2]Rural Extension Centre, Univ. Queensland, Gatton, Qld. 4343

Abstract

From six years of participatory action research has emerged Farmers', Advisers' and Researchers' Monitoring, Simulation. Communication And Performance Evaluation (FARMSCAPE) as an approach for supporting farmers' management of dryland crop production. In contrast to the strategy of producing decision support software for farmers, FARMSCAPE features simulation-aided discussions about management among farmers, advisers, and (sometimes) researchers. The key is a capability to flexibly simulate the consequences of a wide range of crop and cropland management alternatives in a variable climate at a paddock scale using local soil and weather data. The high level of interest among farmers has led to a current focus on transfer of the technology to agricultural service providers.

Keywords: Farming systems, on-farm, simulation, soil monitoring, action research

The term "farming systems research" is most commonly used in Australia to mean "research on bio-physical sub-systems aimed at improving systems of farming". Research methodology tends to be a flexible and pragmatic use of formal experimental design and statistical analysis. Experiments are designed to represent aspects of farming sufficiently realistically for results to be meaningful to farmers and advisers but without unnecessarily or overly straining professional standards for methodology concerning making valid comparisons with adequate confidence. In the interest of the former, experiments are often located on commercial farms, and, increasingly, with farmers.

A second established way of interpreting the term "farming systems research" is "systems research which is about farming". Here the emphasis is the application to farming of *systems* concepts and methodologies that have evolved over the past 50 years, mainly outside agriculture. This paradigm has been termed "systems agriculture" (1). Emphasis here is on approaches to learning/ research/ intervention when the system under study does not lend itself readily to scientific experimentation. Feasibility of the latter declines with increases in scale and/or, complexity and temporal variability. Two pools of methodological resources for addressing such systems are available—often termed "hard" and "soft" approaches. "Hard" systems approaches have, at their core, mathematical models of the systems of interest designed to represent the essential aspects of function in relation to environment. But the hard lesson in the main stream of the hard systems movement has been that the approach turns out to be appropriate only to those aspects of systems that are *not* complicated by people with purposes and freedom of choice (3). The fact that the specific nature of a farm system substantially reflects the design and management efforts of a farmer means that a "soft" systems approach, eg participative action research, should enhance the usefulness and impact of the research on real farming.

Since 1992 we have been actively learning how a hard systems approach might more effectively contribute to improved dryland farming in the northern grain-growing region. In using an action research approach to allow the evolution of a methodology, we have been using hard systems tools in interactions with farmers and advisers in ways that utilise important principles of soft systems thinking. This paper summarises our experience to date and goes some way in interpreting it.

Cropping in this region is problematic mainly due to a rainfall climate in which (a) cumulative returns are strongly limited by inadequate rainfall, (b) production risks are high, and (c) rainfall uncertainty allows for only weak planning for contingencies. It is a local cliche that success is about farming rainfall, and rainfall is the least reliable aspect of the production environment. Ever since the advent of digital computers in research, some scientists have recognised a potential for assisting this aspect of farm management through the combination of simulation models of important crops and historical rainfall records. The main strategy for implementing this hard systems approach has been the production of Decision Support Systems for farmers. But farmer acceptance of DSSs has been low both in Australia (5) and around the world (13, 14). The question we set out to answer was "when barriers to appreciation are minimised, can farmers value cropping system simulation as a means of trialing their own management ideas and in their local context?"

Results

Figure 1 depicts the result of this action research program at the end of 1997. We distinguish activities in the real world (in this case, farmers producing crops) from systems activities aimed at learning and conjecture about management innovations in real farming. We further distinguish (weakly) between hard and soft systems activities.

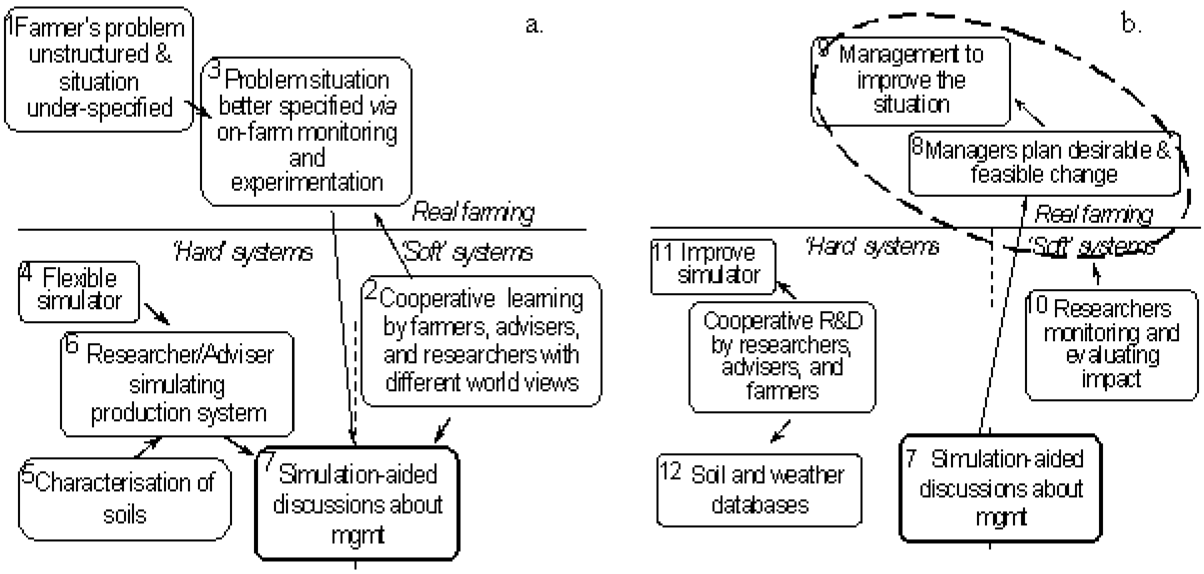

Figure 1. A model of the FARMSCAPE methodology. (a and b are sequential, linked by step 7)

The process begins (Fig.1a-1, 2) with unhurried discussion and negotiation among a farmer, his adviser, and the researchers concerning:

- problems, from the farmer's perspective, of managing crops and croplands in such an environment;
- the tractability of the problems relative to the skills, tools, and time available for investigation; and
- a course of action (6).

This is the beginning of the co-learning that is a primary outcome of this approach. Without exception, initial interest of farmers has been primarily in co-operative study of a commercial crop, with or without imposing treatments of interest to the farmer (Fig. 1a-3). Either way, the most appreciated *field* activity has been the monitoring of soil water and nitrogen throughout the root zone and using the information to guide management actions, to explain crop performance, and to learn about the crop-soil system.

Although, the potential of the simulator (Fig 1a-4) to contribute was always raised by the researchers early in discussions, the characteristic response of the farmer is "I don't mind if you use it, but I can't see how it can help me"—a response which relegates system simulation to the back burner for a time. But the inevitable problem of uncertain general applicability of learning from any brief experiment or experience in a highly variable climate always provides an opportunity to re-introduce simulation as a way to get a "prolonged experience" quickly. Elements of the typical conversation are: "How would results have differed if we had done the study last year? We can simulate the experiment using last year's weather, but to test if the simulation should be taken seriously, let's first see how well the model simulates the results we just obtained." This initiates a process of replacing scepticism with respect for the simulator that is required in order for this tool to aid discussions about management (Fig. 1a-7). Our experience is that most farmers are unwilling to engage in this until the credibility of the simulator is demonstrated to their satisfaction. (See Ref. 2 for aggregate performance of APSIM in a farm context.)

The simulation-aided discussion about management (Fig.1a-7) is at the heart of this methodology. The venue is most often the kitchen or dining table of a farm home. With a simulator which can reliably predict the consequences of management actions and strategies for the range of weather conditions represented in historical records, very practical experiments for periods of decades can be "conducted" during the discussion in response to participants' "what if.. ?" questions (and for the duration of the entire rainfall record for presentation in the next discussion). These naturally begin as extensions of the field studies (Fig 1a-3), where soil and weather data are being measured and valued in their own right. The addition of soil water storage characteristics of the specific soil (Fig. 1a-5) makes possible a highly specific representation of the paddock and the conduct of a wide range of virtual experiments spanning all the years for which rainfall records are available. (See Ref. 11 for an actual case and an important outcome.)

Following the "kitchen table session" participants go back into their real worlds to plan and act (Fig. 1b-8,9). Fundamental to any assessment of this approach is the degree to which managers' intentions and actions are affected by the interactions, and monitoring and evaluation of this is a discrete and methodical soft systems activity (Fig.1b-10) (see Ref. 7). Importantly, this multi-faceted component utilises scientific researchers with new appreciation of the "people" content of systems research and new skills for para-professional practice in this area.

An on-going hard systems activity is improvement of the simulator (Fig 1b-11). Contrary to most expectations this is very much a joint activity. While the researchers look after the scientific modules, the achievement of a high degree of realism in representing the management "rules" of individual farmers is attributable to (and claimed by) farmers. Farm advisers and consultants, who are primary operators of the simulator in any future service based on this approach, have had a major influence on computer interface evolution. In addition, there is an ongoing soil characterisation and data base development program, with tasks shared among farmers, advisers, and researchers (Fig 1b-12).

The acronym, FARMSCAPE, -- Farmers', Advisers' and Researchers' Monitoring, Simulation, Communication, And Performance Evaluation -- provides a convenient checklist for summarising this approach to learning and the improving of farmers' adaptations.

Discussion

There is evidence of changed farming practice due to FARMSCAPE. Soil sampling for water and mineral N in the "bucket" accessible by crop roots has increased markedly. Hydraulic soil sampling rigs are being locally manufactured for advisers and farmers, while some farmers are making their own. New soil sampling/analysis services are being offered (8). The number of analysis of "deep" soil nitrate analysis has risen exponentially over the past six years (15). Some farmers are claiming that combining intensified soil data gathering plus simulation using historical weather as inputs and the forecast provided by the Southern Oscillation Index pays off (4, 9, 7).

FARMSCAPE presumes (a) a simulator that is adequately comprehensive re the region's crops, soils, and management issues and (b) crop and soil process models that are scientifically robust so that simulation accuracy depends mainly on quality of data. APSIM (12) presently goes a long way in providing this and is institutionally well-supported for on-going development, including appropriate interfaces for different uses and users (16).

Central to the new degree of acceptance of simulation technology by farmers as a tool for thinking about management issues has been the simulation of the farmer's own paddock, crop, and management that relate to real farming. This requires not only site -specific soil data for initialisation of the simulation, but prior characterisation of the soil water storage properties. In a climate where full recharge of soil water storage is infrequent, adequate progress has required techniques for recharging artificially (8). Any comprehensive advisory service will require a comprehensive database of such information, and its acquisition represents a substantial investment.

As the scepticism of simulation of participating farmers and advisers has given way to respect, there is some indication that a climate of greater receptivity in the farming community, generally, for information stemming from simulation is developing. This may mean that for certain advisory purposes, the high requirement for customisation and local testing, which we found necessary to establish the credibility of the simulator, will be less in the future. However, if so, this places an even greater responsibility for quality control of simulation onto the operator, be it scientist or consultant.

It seems worthwhile to consider futures of FARMSCAPE in terms of both an advisory service to farmers and a methodology for farmers and scientists to learn together (11). In the northern cropping region, a new market for a commercial service to provide the contents of FARMSCAPE has developed, as well as growing interest among consultants to provide such a service. But recent participatory research in a commercial consulting environment indicates that the costs and difficulties can easily be underestimated. At the same time, exciting opportunities for using the Internet to provide cost-effective support for service providers are developing rapidly (10).

The enthusiasm of farmers and advisers for what is provided in the FARMSCAPE approach is encouraging. The FARMSCAPE approach results from the combination of ideas and tools from both hard and soft systems schools of thought, influences more often than not at loggerheads. While much remains to be debated between professionals representing different schools of systems thinking and practice, a new level of accommodation, willingness to learn from each others' experiences, and cooperation in providing benefits for agricultural industries and communities may be possible.

Time will tell if FARMSCAPE represents a sustainable paradigm shift in the way researchers of farming systems and farm advisory services interface with real farming, marrying hard and soft systems thinking and methods in a form of systems agriculture (1).

Acknowledgments

The farmers who have generously given their time, effort, and patience are too numerous to list. They know, and we acknowledge, how important their influence has been on the FARMSCAPE approach, which continues to evolve as we all learn.

References

(1) Bawden, R.J. 1992. *Agric. Systems*, 40,153-176.
(2) Foale, M.A. and Carberry P.S. 1996. *Proc.Third Aust.Sorghum Conf.*, Tamworth, pp. 63-74.
(3) Checkland P.B. 1983 *J. Opl. Res. Soc*.34,661-675.
(4) Collis, B. 1997. *The Bulletin*, Nov. 25, pp. 32-33.
(5) Cooke P. 1994. *Farming Ahead* 26, 3.
(6) Cox, P.G., Garside, A.L., and McCown, R.L. 1993. *Proc. 7th Aust. Agron. Conf.*, Adelaide, p.332
(7) Coutts, J.A., Hochman, Z., Foale, M.A., McCown, R.L., and Carberry, P.S. 1998. *Proc. 9th Aust. Agron. Conf.* pp.
(8) Dalgliesh, N.P., McCown, R.L., Bridge, B. and Cawthray, S. 1998. *Proc. 9th Aust. Agron. Conf.* pp.
(9) Foale, M.A. 1997. *Farming Ahead* 71, 42-43.
(10) Hargreaves, D. 1998. *Proc. 9th Aust. Agron. Conf.* pp.
(11) Hochman, Z., Skerman, R, Cripps, G, Dalgliesh, N.P. and Carberry P.S. 1998. *Proc. 9th Aust. Agron. Conf.* pp.
(12) McCown, R.L., Hammer, G.L, Hargreaves., J.H.G., Holzworth, D.P., Freebairn, D.M. 1996. *Agric. Systems* 50,255-271.
(13) Plant, R.E. 1997. *AI Applications* 11, 33-39.
(14) Seligman N.G. 1990. *In: Theoretical Production Ecology: Reflections and Prospects*, eds Rabbinge, Goudreaan, van Keulen, Pennning de Vries, and van Laar. (PUDOC:

Wageningen), pp. 249-58.
(15) Strachan, R., INCITEC, *Pers. Comm.*
(16) Verrart, V 1997. *Agronomy Abstracts*, Anaheim, p. 21.