Are science rigour and industry relevance both achievable in participatory action research?

P.S. Carberry
Agricultural Production Systems Research Unit (APSRU)
CSIRO Sustainable Ecosystems, Toowoomba, Qld. 4350

Abstract

Agricultural scientists are under pressure in Australia to deliver increased benefits to our industry and community clients. However, many appear to be ignoring this modern reality, preferring instead to concentrate on maintaining rigour in their science, as judged by their disciplinary peers, as the chief criterion for continued support. Yet the current expansion in "farmer-driven research" activities in Australia could be argued as evidence of an irrelevancy of our traditional research methodologies and institutions. The objective of this paper is to argue that our personal aspirations for undertaking good science can still be achieved while addressing client needs, but to do so we will have to shift our research paradigm to one that encourages greater participation in the research process. Participatory action research (PAR) is one approach that enables credible research outcomes to be delivered in a highly relevant manner. Hence, this paper briefly reviews farmer-driven and participatory research efforts in Australia and describes two PAR projects being undertaken in northern Australia – the FARMSCAPE and the Eastern Farming Systems projects. While this paper strongly argues in support of a PAR approach, many of the difficulties in its implementation – the high time cost of participation, a reliance on qualitative data, unfamiliar data analysis techniques, poorly appreciated evaluation procedures, publication barriers and a lack of career and reward structures – are acknowledged, but then recomposed to represent some of the key challenges for our profession. Participatory Action Research will allow us not only to meet our own personal research aspirations but also to address the challenges faced by the clients of agricultural research.

Key words

Participatory action research, farming systems research, farmer-driven research, FARMSCAPE, on-farm research

Introduction

The question agricultural researchers, and our institutions and funders, must address is how we will meet the challenge of maintaining a significant role for our profession in today's society. Governments are demanding more cost-effective outcomes from shrinking public funding for research (22), the private sector is becoming the key provider of the development and extension activities which were once the responsibility of public agencies (56) and proactive farmer groups are initiating their own research by entering the competitive R&D funding programs (37). These developments have clearly led to pressures being placed on agricultural research professionals employed in the State Departments of Agriculture, CSIRO and the Universities. For researchers to ignore such challenges, as many are, will inevitably lead to publicly-funded agricultural research becoming increasingly irrelevant to our industry and community clients.

That our science has indeed delivered benefits, not only in terms of industry innovation (22), but also in terms of fulfilling our own personal aspirations, there is little doubt. Whether such benefits are being delivered cost-effectively or in areas of chief concern to clients of research are more the questions currently being posed by those who are questioning science's role in the community (e.g. 25, 29, 30, 36, 45, 55). Malcolm (33), in reviewing fifty years of farm management research in Australia, admitted that his profession had lacked relevance and had been largely academic in its attention. Such self-reflection has been rare in agricultural research. How would agronomic research fare under the same critical self-review? Significantly, one of the highest priority issues nominated by

the northern GRDC Research Advisory Committees[1] over recent years has been the need for more effective RD&E to ensure that research results are made more relevant and accessible to farmers (53).

One reaction to the irrelevance problem of publicly-funded science has been to transfer the research mandate to clients – in this case, to farmers and agribusiness. An increasing number of farmer groups are conducting their own research trials, and their claims of achieving benefits to farmer participants and the broader community are well publicised (27). For instance, the Birchip Cropping Group (www.bcg.org.au) has become a registered research authority, has invested in office and laboratory infrastructure and spends over $2 million a year on cropping research (37). In the next few years the Shared Solution Association program, supported by GRDC, plans to have 13 regional farmer groups conducting research in all grain regions of Australia (37). The investment component by GRDC in these groups and this new program is not likely to be additional RD&E funding but rather an investment done at the expense of publicly run research – it could be regarded as a real quantifiable cost of the perceived irrelevancy of our traditional science agencies.

No longer are communities of people content to have decisions made for them with little consultation, either personally in terms of their own health (16) or collectively by Governments (36) and this is becoming increasingly apparent in the field of agricultural research (5). Gibbons *et al*. (25) point to an emergence of a new mode for the production of knowledge (Mode 2) which is acquired in the context of applications, is market-responsive and captures social and economic perspectives of a broad range of players – the contrast is made with traditional science (Mode 1) which is disciplinary-based with "cognitive and social norms (that) determine what shall count as significant problems, who shall be allowed to practice science and what constitutes good science". As Biggs (5) points out participation has become the new orthodoxy in agricultural research and extension. Farmers and agribusiness rightly expect not to have research done for them, but rather that they participate in some manner. The emergence of "farmer-driven research" activities is a consequence of both the increasing desire of Australian farmers to be involved within their activity systems as well as perceived inadequacies in the RD&E undertaken by the traditional research agencies.

As much as industry may be critical of the lack of relevance of the volumes of published (and unpublished) research results, likewise research professionals have been dismissive of attempts to undertake research in farmers' fields (34) – such work is generally relegated to developmental or extension programs. On-farm research, with large, possibly unreplicated plots and often relying on more qualitative data, has been seen as having low rigour by our disciplinary peers and consequently it has been difficult to publish.

Obviously, in evaluating research driven by researchers or by farmers, one needs to be clear on the criteria by which efforts will be judged. This debate could be depicted as being polarised between research rigour (data integrity, replicability) and industry relevance (currency, responsiveness). Bonoma (6) and Crookston (18) have suggested a linear trade-off between rigour and relevance (Figure 1). If one accepts this trade-off and that client benefit, either today or in the foreseeable future, is the chief criterion for research justification (25), what consequence is there for our traditional research methodologies and profession?

Here I will declare my bias for a belief that research can deliver demonstrable benefits to our clients, whether they be farmers, agribusiness or the broader community, and achieved in such a manner that can also fulfil our personal aspirations to maintain rigour in our research, as judged by our disciplinary peers. Participatory research methodologies, in particular participatory action research (PAR), may provide the resolution that enables credible research outcomes to be delivered in a highly relevant manner (Figure 1). The objectives of this paper, therefore, are to briefly review farmer-driven and participatory research efforts in Australia, to describe two local examples of PAR being

[1] The Grains Research & Development Corporation supports eight RACs in the northern region. Each RAC is made up of farmers, agribusiness and research representatives from a particular cropping region. Their mandate is to provide GRDC with advice on priority research issues for their region.

implemented, and to finish by making some conclusions as to the future for agriculture research in Australia.

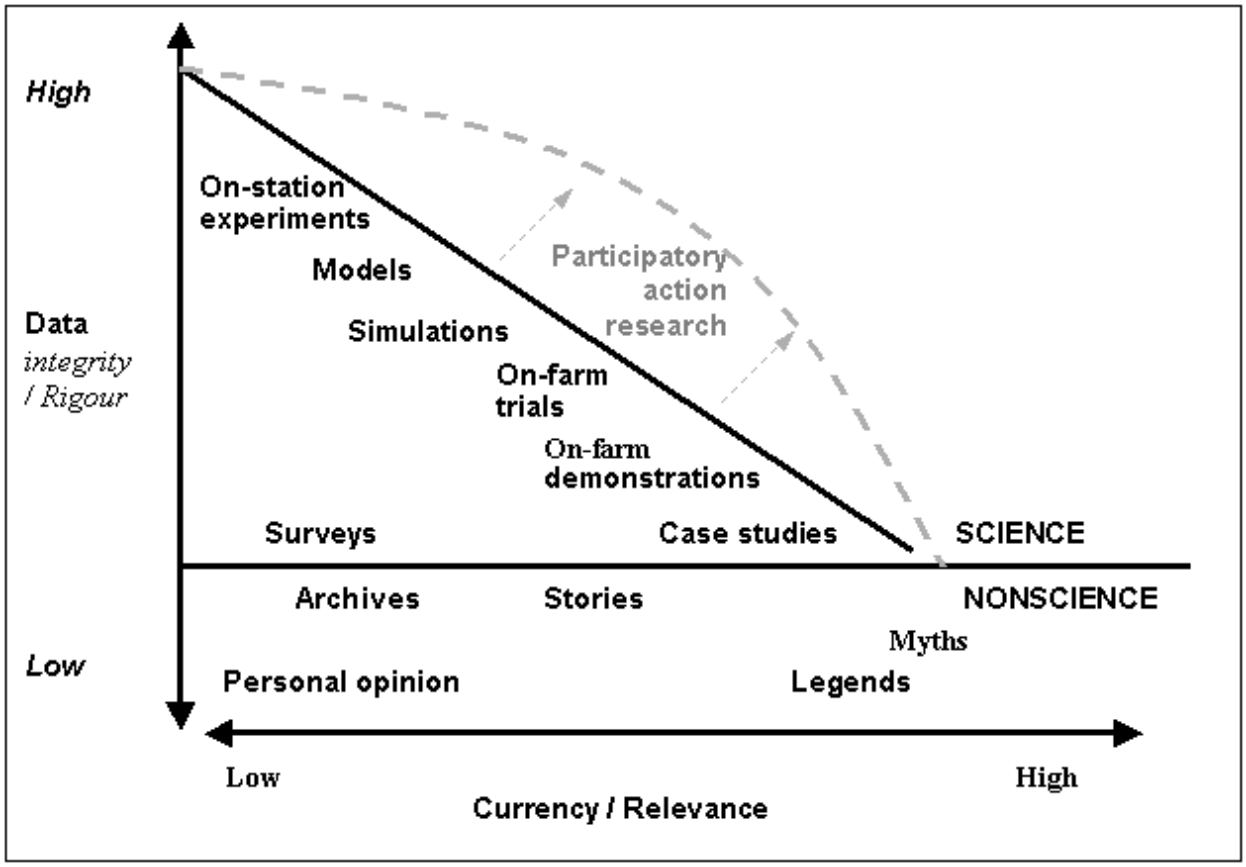

Figure 1: Existing (solid linear line, adapted from Bonoma (6) and Crookston (18)) and proposed (dashed curve) relationship between rigour and relevance in science.

Farmer-Driven Research

Farmers conducting trials on their own farms is not a new phenomenon, whether they are using simple fertilizer strips or exploring more complex issues. However, in more recent years in Australia, there has been an emergence of pro-active, coordinated farmer groups with explicit aims of undertaking organised research into their farming systems. The philosophy of four of these groups, the Birchip Cropping (BCG) and Southern Farming Systems (SFS) groups in Victoria, the Mingenew-Irwin group (MIG) in WA and the Walgett Sustainable Agricultural Group (WSAG) in NSW, was outlined in a series of Ground Cover articles (27); for example:

> "*… a few of the local farmers decided to form the (Birchip Cropping) group and do our own research. We had the support of the GRDC, industry sponsors and cropping consultant … to conduct the initial trials, and it's grown from there*" (BCG)
>
> "*… the group is determined to find innovative answers to cropping through experimentation, and to have this backed by reputable scientific research*" (SFS)
>
> "*The research and development program has grown to more than 100 field trials. … MIG aimed to work in partnership with government agencies, plus private enterprise, to ensure that the latest and most relevant in farming systems research was carried out in the Mingenew and Irwin Shires.*" (MIG)
>
> "*(A company) is being set up to handle research for WSAG … with plans to carry out more research in its own right*" (WSAG)

A common rationale for initiating research-focused farmer groups has been both the desire to have locally-relevant research activities as well as some sentiment that such localities were "*in a bit of a no-man's-land*" for publicly-funded RD&E effort (27). More recently, the Shared Solutions concept

proposes a more ambitious goal with a stated belief that " … *leading edge growers will become the deliverers of research information and the marketers of regional innovation*" (37). Such groups are now employing agricultural graduates, developing research infrastructure such as long-term trial sites and laboratories, gaining sponsorship from agribusiness and Rural Industry Research Funders such as GRDC, and are producing their own trial result and extension publications. There is involvement of professional researchers in trial activities of these farmer groups, either through joint experimentation or membership of Scientific Management Teams (e.g. SFS), although the majority of trial results are reported without acknowledgement of such input (50)

It is difficult to critique the growing efforts of "farmer-driven research" in Australia given a lack of formal documentation. It is particularly difficult in trying to judge whether such research has become simply a substitute for the RD&E efforts that have traditionally been controlled by agricultural science professionals in public agencies. While "farmer-driven research" efforts are likely to be highly relevant, they do need to be reviewed, not just in terms of participant satisfaction but also in the broader light of research credibility – Gibbons *et al*. (25) argue that professional review is not compromised in conducting Mode 2 knowledge generation, but constitutes an attribute of quality control along with attributes such as usefulness and equity.

A number of observations can be made in reviewing the activities reported in the 1999-2000 Shared Solutions Manual (50):

- Many of the trials appeared little different to traditional research trials, employing small replicated plots suited to using Analysis of Variance to determine treatment differences.
- A high proportion of trials addressed simple technologies, such as herbicide application strategies – similar to trials typically undertaken by commercial chemical companies.
- There was generally little attempt to interpret results beyond the site and season experienced in the trial under study. A number of trials were repeated over several sites and seasons, yet interpretation of results in this context was limited both by the trial designs and analysis tools.
- Unexpected results from trials were found difficult to interpret. Such difficulties were compounded by limitations in data collection methodologies and design.
- Speculation about results and their consequence was common, with many conclusions made on results from single trials influenced by the site and season experienced.
- What quality checking was undertaken of the published results and interpretations is unknown.

While such a critique has been cursory, without substantial review of procedures and results beyond that reported in the Shared Solutions Manual, it is based on the information, recommendations and conclusions as were distributed to 14,000 grain growers in Australia (37).

Participatory Research Methodologies

There exists a number of brands of participatory research in agriculture – e.g. Farming Systems Research (FSR) (13, 38, 39, 42, 46), Farmer Participatory Research (FPR) (4, 34), Participatory Technology Development (PTD) (5, 30) and On-Farm Research (OFR) (43). In essence, what these systems approaches have in common is a movement away from a view that science can research the management of agricultural systems without real participation of systems managers. Where they differ is on degree of participation, particularly in terms of how situated the research is within the farmers' activity systems and where control of the research rests (40). These systems approaches have been developed and pioneered in research undertaken in less developed countries, mainly in response to the failures of traditional research methodologies to engage the issues of small-holder farmers. In Australia, such systems approaches have been promoted since the 1970's by researchers such as John Dillon (21) and Bob McCown (38, 39, 40, 41, 42).

Most authors concerned with participatory research processes have emphasised the benefit of greater relevance of such activities in relation to the issues of interest to farmers. Disappointingly, in proportion to the number of authors who have exhorted researchers to adopt such approaches, there are far fewer who have been able to provide concrete examples of participatory research processes

having achieved impressive impacts in terms of improved farming practices. Fewer still have reported new science knowledge outcomes from participative on-farm research activities. This observation is not so much to doubt whether such examples exist, but rather to suggest reporting these successes in the "conventional" agricultural science literature has not been a frequent occurrence – a quick appraisal of year 2000 edition of AJAR found that of more than 50 published papers addressing crop agronomy research only two (2, 47) appeared to fulfil the criteria of participative on-farm research. Is the lack of successful case studies because such research has forgone research rigour (and publication opportunity) in order to gain relevance? For instance, Petheram and Clark (46) provided strong argument for participatory research approaches in their review of FSR, but ignored science rigour as an important criterion in assessing RD&E performance.

Participatory Action Research (PAR) is a process that can encapsulate both relevance and rigour. In a field of enquiry, PAR enables the "production of knowledge that guides practice, with the modification of a given reality occurring as part of the research process" (40, 44). Zuber-Skerritt (57) describes Action Research as being:

- *participative and collaborative* – a researcher is not an outside expert but rather "a co-worker doing research with and for the people concerned with the practical problem and its actual improvement";
- *practical* – "the results and insights gained from the research are not only of theoretical importance to the advancement of knowledge[2] in the field, but also lead to practical improvements during and after the research process";
- *emancipatory* – "all people concerned are equal participants contributing to the enquiry".
- *interpretive* – "solutions are based on the views and interpretations of the people involved in the enquiry (with) research validity achieved by rigorous methods";
- *critical* – participants act as "critical and self-critical change agents … (they) change their environment and are changed in the process".

PAR is often depicted by the action research cycle (57) consisting of iterative cycles of planning, action, observation, reflection and replanning (Figure 2).

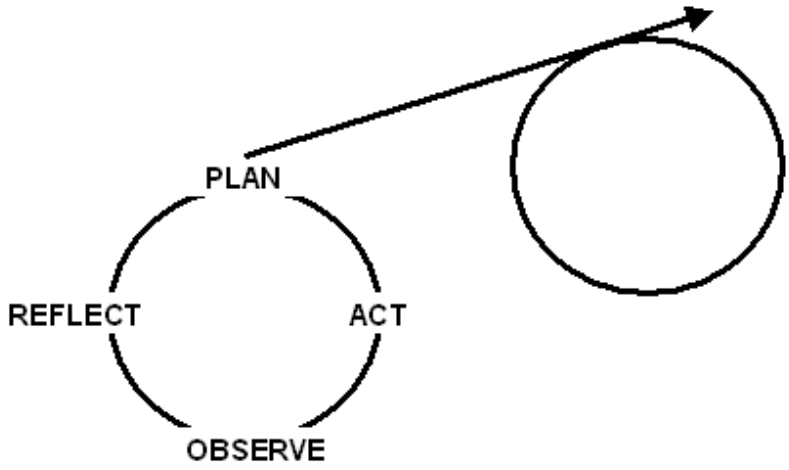

Figure 2: The Action Research cycle (57)

In nominating PAR as a preferred process, I defer to McCown (40) as providing convincing argument for PAR being the appropriate paradigm for agricultural systems research. But are his (and others) arguments convincing enough for the research community to move from a traditional science paradigm? In such a shift, the real and perceived risks are high. Once researchers relax the "tried and true" traditional science process for a more pluralistic, participative paradigm, the prospect of reverting diminishes. And the costs of participatory research need to be appreciated. Martin and

[2] Underlines are my emphasis to indicate importance of new knowledge generation and rigour in PAR.

Sherington (34) provided an excellent review of participatory research methods and, while strongly arguing in support of these approaches, they were also candid about many of the difficulties in their implementation. The realities of participatory research methods include a high personal time cost of participation, high dependence on qualitative data, likely large errors in quantitative data collection, a lack of appropriate data analysis techniques, general inexperience in evaluation procedures, difficulties in publication and a lack of reward structures for such activities in current research institutions. Case study examples demonstrating successful implementation of PAR will greatly enhance the arguments for its broader adoption.

Case Studies

FARMSCAPE research program

In 1991, APSRU initiated a participatory action research program on the Darling Downs in south-east Queensland. In 1995, the acronym FARMSCAPE (Farmers, Advisers, Researchers, Monitoring, Simulation, Communication And Performance Evaluation) (www.farmscape.tag.csiro.au) was created as the title for a GRDC project that featured farmers, agribusiness and researchers exploring together how crop and soil management could be improved by conducting on-farm experiments and holding simulation-aided discussions (12, 28, 41). In 2000, APSRU has initiated a program to train and accredit agronomists from four agribusiness companies to use the "FARMSCAPE approach" to serve their clients in the northern grains/cotton region.

While acknowledging that FARMSCAPE has represented a significant research investment over the past nine years, its achievements in bringing benefits to both industry and the broader research agenda over this period have been significant and demonstrable (17). In conjunction with many collaborators, FARMSCAPE has

- gained continued industry support for its research agenda – 15 FARMSCAPE-related projects have been funded by four different R&D funders over the past nine years, a number of which have been initiated by farmer and agribusiness collaborators.
- helped change how the soil resource is viewed by farmers and agribusiness – soil water is now commonly referred to, in private and public extension material, as depth of water in millimetres measured by a soil core as opposed to depth of wet soil measured by a push probe. To complement such a paradigm shift, more than 50 soils in the region have been characterized for plant available water content by FARMSCAPE and this number is being increased daily by farmers and agribusiness (19).
- contributed to the establishment of soil monitoring as a routine management practice in the northern cropping region – over 50 hand corers and 20 hydraulic soil coring rigs, both designed within FARMSCAPE, have been built for and used by farmers and agribusiness. Many farmers in the region are now also recognizing the value of deep soil N and measuring it (23) – the number of deep soil samples commercially analyzed for N has increased exponentially since 1993 (unpublished data from INCITEC Analysis Lab). The manual '*Soil Matters*' (19) has provided farmers and agribusiness with information on sound procedure to sample soils and interpret results – over 300 copies have been distributed to date.
- increased industry acceptance of modelling as a source of management support – a three-fold growth in APSRU resources and staff over the last 10 years, an expansion funded primarily with industry support, is a good indicator of increased acceptance of modelling. FARMSCAPE has led APSRU's efforts to test simulation in real-world farming and advising practice.
- helped promote the use of seasonal climate forecasting – FARMSCAPE is a pioneer in linking seasonal climate forecasting based on the SOI phase system (51) with soil resource monitoring and simulation modelling at the paddock level. This has been done with farmers and agribusiness over the past 8 years in small group 'What If Analysis and Discussion' sessions (WIfADs) aimed at exploring management options on participants' own farms. This approach has been instrumental in making the SOI meaningful at a paddock scale and has contributed to its greater use by farmers and advisers (14).

- contributed to achieving innovative changes in farming practice – the introduction of spring-sown mungbean as a new management option (47) and renewed interest in dryland maize (52) are two recent cases where crop management practices have changed with a contribution from FARMSCAPE.
- established a commercial delivery mechanism for FARMSCAPE – APSRU recently advertised for four companies to become trained and accredited in the FARMSCAPE approach to support farmers' learning, planning and decision-making in uncertain environments. Expressions of interest were received from eight commercial companies. The four companies selected have each contributed staff and funding to the FARMSCAPE training program.

Of the above achievements, the research on spring-sown mungbean reported by Robertson *et al*. (47) provides a seminal example of the benefits of participatory action research in generating both industry change and research knowledge. While there had been on-going investment in traditional, station-based research on mungbean for many years (eg. 31), it was via interactions between industry representatives and researchers that the alternative hypothesis for spring-sown mungbean emerged. On-farm participatory research allowed testing of spring sowing of mungbean in commercial crops. The researchers contributed a level of crop monitoring and analysis that permitted explanation for the high variation observed between crops. In this research, the contribution of the APSIM simulation model was essential both to recognising the initial opportunity and to assisting in analysis and extrapolation of measured results. Involvement of farmers, agribusiness and extension was essential in making spring-sown mungbean fit within their business and farming systems – for example, a new market was developed for early delivered mungbean grain and emergent agronomic problems such as early insect attack needed solving. A 10% industry adoption of spring-sown mungbean was reported after two years of on-farm research (47), but this has likely increased to greater than 20% in subsequent years.

Robertson *et al*. (47) demonstrated that participatory on-farm research – using large, unreplicated plots in commercial crops – can be published in our traditional journals. However, such efforts will require a shift in perceptions of what is considered good research. The struggle for publication, and between research paradigms, can be best characterised in the words of two of the anonymous referees who reviewed the paper by Robertson *et al*. (47):

> Referee 2 – "*this work …on the grounds of both its methodological aspects and its results … deserve publication …to stress the importance of this approach for agronomists across Australia. It is one of those rare studies that makes its point by showing rather than by telling*."
>
> Referee 3 – "*The paper is unduly evangelistic concerning the value of interactive work between researchers and end users, as opposed to 'traditional' work on experiment stations ...the rather sweeping dismissal of on-station work superficially ignores one of the original purposes for such work. It was often more efficient to eliminate uneconomic options using small-scale trials by agronomists than have farmers sort them out in the course of earning their living. The question that needs to be addressed is the cost of experimentation by farmers relative to anticipated gains through more rapid adoption."*

FARMSCAPE has been pioneering a participatory action research approach, utilizing on-farm trials, simulation and farmer/adviser groups, to address research issues of interest to grain and cotton farmers of northern Australia. There is evidence that this approach has had an impact beyond the original FARMSCAPE projects. On the national scene, interest has come from groups in WA, NSW, SA and Victoria for research proposals aligned with the FARMSCAPE approach. Internationally, two international research institutes (ICRISAT and CIMMYT) have initiated research programs in collaboration with the FARMSCAPE team in countries such as Zimbabwe, Malawi and India. Locally in the northern region, GRDC has implemented a participatory on-farm research approach in farming systems projects for western, eastern and Central Queensland cropping zones. The guidance GRDC provides to researchers nationally has been certainly influenced by the lessons and approach pioneered by FARMSCAPE.

Eastern Farming Systems project

The Eastern Farming Systems (EFS) project was initiated in 1997 with the challenge to develop and implement an enhanced RD&E process that could lead to increased adoption of research outcomes, and to better integrate the research effort across RD&E providers (Qld Departments of Primary Industries and Natural Resources, NSW Agriculture and CSIRO) in its mandate region. Accepting this challenge, the participants in the EFS project developed a vision for the project expressing a desired outcome where the farming systems practiced in the north-eastern grain belt will have benefited from farmers, advisers and researchers exploring together options for improved economic and environmental sustainability.

To achieve its desired outcome, the project developed three key strategies. Firstly, to involve farmers, advisers and researchers in planning project activities and instigating the research agenda. Secondly, it was intended that researchers would participate alongside their extension colleagues and farmers in utilising experiments conducted on-farm as the primary means for investigation of systems opportunities and constraints. And thirdly, action-learning programs would be developed and implemented to extend the principles developed in on-farm research to a far wider number of farmers in order to improve their skills and confidence in managing complex farming systems.

Enhanced scientific knowledge on the functioning of agricultural systems of northern Australia is being sought through undertaking participatory on-farm research (OFR) trials involving farmers, agribusiness and researchers. EFS definition of OFR – subsequently adopted nationally by GRDC (26) – is that it is

- located on farms, not on research stations;
- where issues are initiated in consultation with farmers;
- a legitimate research activity not a demonstration;
- where participation is wide, involving farmers, advisers and researchers;
- where participation continues throughout the research process – from identification and prioritization of research issues, to the design and implementation of an experiment or monitoring program, to analysis, interpretation and communication of results; and
- where the research outcomes are meaningful and rewarding to all participants.

While not suggesting that other R,D&E exercises are not valuable, or that they might not be the best way to approach some problems, for the purpose of clarification EFS excluded[3] from its approach to on-farm research:

- demonstrations - because they are not targeted at a research question;
- most core sites - because farmers have participation in the identification of the research issue but farmers are not involved in the research process (setting up and testing research questions); and
- most surveys - because they collect data from farmer fields without agreeing with the farmers on the original research question.

To date, the EFS project has sponsored 12 participatory on-farm research activities at locations ranging from Gilgandra in central NSW to the Jinghi Valley at the northern edge of the Darling Downs. Each of these OFR trials addressed a research question of relevance to one or more farmer / agribusiness groups. Lessons from the OFR trials and related research are being captured in the development of a number of action learning modules targeted at providing resources and workshop frameworks to facilitate information delivery to the broader grains industry – action learning topics include learning about soils, exploring ley legumes in cropping system, or analyzing economic performance of alternative enterprises. Demonstrable outcomes from EFS activities to date have included some new knowledge on the functioning of agricultural systems as well as contributions to measurable change in the farming practices of a number of farmers. Description of several OFR activities and preliminary results are reported by Butler *et al*. (9,10,11), Dalgliesh *et al*. (20), French (24), Rowlings *et al*. (48) and Schwenke *et al*. (49).

[3] Peter Hayman's contribution to this definition of OFR, particularly in explicitly excluding some approaches, can not pass without specific acknowledgment.

The EFS project is piloting a participatory action research approach to systems RD&E and, consequently, lessons are being learnt from its successes and failures. Self-reflection suggests that EFS has been successful to date in achieving a strong focus on farmer participation in project activities, in fostering cross-organizational collaboration, and in encouraging participant appreciation for evaluation processes. EFS has been less successful in maintaining rigour in its research portfolio (i.e. the design, analysis and reporting of OFR activities) and in following though with its evaluation and action learning module development. The key question being asked of such large, multi-organizational projects is whether they are the way of the future for research programs? Can they meet the ambitious goals of achieving increased relevancy to industry clients as well as being able to undertake an innovative research program? While the answers to these questions are yet to be concluded, it is clear that success for EFS will be judged not just against research outcomes but also on how participatory research is viewed and supported hereafter by its industry, institutional and funding stakeholders.

Conclusions

Traditional agricultural research and farmer-driven research are argued as both falling short of the research process needed to address today's issues – the former against a criterion of relevance, the latter against one of rigour. Participatory Action Research is proposed as an alternative methodology that potentially delivers the benefits of new science knowledge and improved farming practices – as well as providing the opportunity to continually improve our research process. McCown (40) and Brennan and McCown (8) argue for this shift on the basis of historical reflection and logical progression. This paper has added experience from two case studies which demonstrate personal and real-life benefits from PAR activities. The key to researchers and farmers accepting a participatory research paradigm depends on providing both sound theoretical basis and practical case experiences. Just as farmers are unlikely to adopt a new strategy based solely on acclaimed benefits, likewise researchers need to experiment themselves with PAR processes to gain experience with this approach and confidence that it can deliver against both client and personal expectations.

In cautioning against farmer-driven research, what I am <u>not</u> saying is that farmers or agribusiness should not have an important role in research. A well functioning, coordinated farmer group interested in participating in research is to be welcomed and encouraged. Such groups provide wonderful opportunity and rewards to those who engage them in any activity. Whether such groups need to carry the responsibility and infrastructure for research when these already exist in institutions with the explicit mandate to serve these same farmers is a reasonable question worth addressing. Public research institutions have the benefit of a history that has fostered a research ethos resulting in critical masses of disciplinary peers, career and reward structures for employees, contingency plans for pressing problems, and balanced investments in short versus longer time issues. Unfortunately, such institutions also find it very difficult to implement organization change (3) and thus be responsive to changing client and community needs. If farmer groups want to replicate the duties of these institutions they had better not bemoan the certain loss of capacity of these institutions. Likewise, if public research institutions continue to ignore client and community needs, researchers should not be amazed at their increasing irrelevance and insolvency.

The FARMSCAPE project has demonstrated that science and industry benefits can accrue from participative research. The Eastern Farming Systems project (along with its sister projects in the north-west NSW/Qld (35) and central Qld cropping zones) is an attempt to institutionalise participatory research approaches within those agencies with the research mandate for improved management of dryland farming systems in northern Australia. In this light, Lawrence *et al*. (32) report factors which the participants in these three northern systems projects suggest may contribute to their success. Experiences from the Shared Solutions concept of farmer groups running research programs in southern and western Australia also contribute to the question of how to improve impacts of research. However, in reviewing the emergence of these varied farming systems programs in Australia, Petheram and Clark (46) observed that there was little uniformity in their approaches and

little evidence of reference to past learnings and experiences in systems research. As a distinguishing feature of systems research is reflection on the research process itself, we need to capitalize on the opportunity to learn from our varied experiences. Farmers in Queensland, for instance, have shown little motivation to date in establishing the research infrastructure evidenced with the farmer groups in the Shared Solutions program. Has the strong systems focus of many researchers in Queensland – evidenced in the work of APSRU (www.apsru.gov.au), the Rural Extension Centre (www.ruralextension.qld.edu.au), the DPI Systems Study Group (54) and the northern systems projects (32) – provided farmers and agribusiness with levels of research participation that meet their needs?

In advocating participatory action research as a preferred research paradigm, a number of issues require resolution, including the need to:

- maintain research investment in our disciplinary sciences and on strategic research issues. Maxwell and Randall (36), while arguing for science to embrace a pluralistic participatory process, warn against solely focussing on the immediate value of research, a course of action that will eventually exhaust knowledge capital and so our capacity for evolution.
- develop appreciation for and methodologies in quantitative and qualitative evaluation processes. One of the key components of FARMSCAPE has been its strong emphasis on evaluation to enable documentation and reporting of industry impacts and also reflection and planning within the action research process (17). Lawrence *et al*. (32) report on such efforts for the northern systems projects and the difficulty in evaluation processes gaining priority amongst participants.
- develop sampling, statistical and modelling techniques to facilitate analysis of on-farm experiments. Martin and Sherington (34) suggest that modern computing can overcome many of the limitations of traditional statistical techniques. Precision agriculture tools such as yield monitors and systems simulation models such as APSIM provide alternative and powerful analysis procedures (15, 47).
- encourage our agricultural science journals to publish systems studies that may consist of qualitative data or commercial-scale trials. In this regard, the recent initiative of the Australian Journal of Experimental Agriculture to publish a special issue on extension practices (1) is applauded.
- develop career and reward structures for research practitioners of PAR. Participatory research processes are time-consuming and dependent on skills somewhat different to those required traditionally in science. Researchers now need to be assessed against and rewarded for realised benefits in addition to attributes such as publication record and peer review (25).

Andrew Borrell (7) has suggested that "*scientists … suffer from the 'Can't wait 'til Monday syndrome' … (as) most scientists actually enjoy going to work on a Monday morning because they can't wait to discover something else!*". Let's hope that the future remains as bright for agricultural research professionals. Participatory Action Research provides a vehicle for researchers, farmers and advisers to not only meet their own personal aspirations but also to address the future challenges facing agriculture's goal of economic and environmental sustainability.

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References

1. Anderson, C. (Ed.), 2000. Special Issue: Improving agricultural practices and decisions. *Aust. J. Exp. Agric.* **40**, 493-642
2. Angus, J.F., Gault, R.R., Good, A.J., Hart, A.B., Jones, T.D. and Peoples, M.B., 2000. Aust. J. Agric. Res., **51**, 877-90.
3. Argyris, C. and Schön, D., 1978. Organisational Learning (Addison-Wesley, Reading, MA)
4. Ashby, J.A, 1987, *Agric. Admin & Extension*, **25**, 235-252.
5. Biggs, S.D. 1995. Proceedings of a Workshop April 3-7, 1995, Tune Landboskole, Denmark
6. Bonoma, T.V., 1985. *J. Marketing Res*. **22**:199-208.
7. Borrell, A., 1999. *Agric. Sci.* **12:4**, 21-23.
8. Brennan, L, McCown, R.L. and Pannell, D., 2001. Proc. 10th Australian Agronomy Conference, Hobart, (this volume)
9. Butler, G., Christian, T., Schwenke, G. and Herridge, D., 2001a, Proc. 10th Australian Agronomy Conference, Hobart, (this volume)
10. Butler, G., Hayman, P., Herridge, D. and Christian, T., 2001b. Proc. 10th Australian Agronomy Conference, Hobart, (this volume)
11. Butler, G., Cawthray, S., Castor, M., Yeates, S. and Christian, T., 2001c, Proc. 10th Australian Agronomy Conference, Hobart, (this volume)
12. Carberry, P.S. and Bange, M.P. 1998. Proc. 9th Aust. Cotton Conf. 10-14 August, Gold Coast. (The Aust. Cotton Growers Research Organisation) p. 153-160
13. Collinson, M.P., 2000. A History of Farming Systems Research. (FAO and CABI Publishing, Wallingford).
14. Collis, B., 1997. *The Bulletin*, Nov 1997, p. 32-33.
15. Cook, S.E. and Bramley, R.G.V., 1998. *Aust. J. Exp. Agric.*, **38**, 753-63.
16. Cornwall, A. and Jewkes, R., 1995. *Soc. Sci. Med.*, **41**: 1667-1676.
17. Coutts, J.A., Hochman, Z., Foale, M.A., McCown, R.L. and Carberry, P.S. (1998) Proc. 9th Australian Agronomy Conference, Wagga Wagga, p.681-82.
18. Crookston, R.K., 1994. Proc. Systems-oriented research in agriculture and rural development: international symposium. Monpellier, France, p. 803-806.
19. Dalgliesh, N.P. and Foale, M.A. (Eds.), 1998. CSIRO. Australia. 122pp.
20. Dalgliesh, N.P., Tolmie, P.E., Probert, M.E., Robertson, M.J., Brennan, L., Connolly, R.D., Sutton, G., Hole, S., Taylor, R., Grant, J. and Milne, G., 2001. Proc. 10th Australian Agronomy Conference, Hobart, (this volume)
21. Dillon, J.L. and Virmani, S.M., 1985. In: Agro-Research for the Semi-Arid Tropics: North-West Australia. (Ed. R.C. Muchow) (University of Queensland Press, St Lucia) pp. 507-532
22. Falvey, L., Forno, D. and Srivastava, J., 1998. *Agric. Sci*. **8**, 41-44.
23. Foale, Mike and Good, Tony, 1998. Farming Ahead – Kondinin Group, Sept 1998, No. **81**, p. 54-56
24. French, V., 2001. Proc. 10th Australian Society of Agronomy Conference, Hobart (this volume)
25. Gibbons, M, Limoges, C, Nowotny, H, Schwartzman, S, Scott, P, and Trow, M. 1994. The new production of knowledge: The dynamics of science and research in contemporary societies. (Sage: London) 179 pp.
26. GRDC Research Prospectus 2000-2001. (GRDC, Kingston) p. 66-68
27. GRDC Ground Cover, 2000. Issue 32, Spring 2000. (GRDC, Kingston)
28. Hochman, Z., Coutts, J.A., Carberry, P.S., and McCown, R.L., 2001. In: Learning and knowing processes for change in agriculture in industrialised countries (Eds. B Hubert and R Ison) (INRA Versailles) (in press)
29. Ison, R.L., Maiteny, P.T. and Carr, S., 1997. *Agricultural Systems*, **55,** 257-272.
30. Jiggins, J., 1993. *Proceedings of the XVII International Grassland Congress*, 615-622.
31. Lawn R.J., 1979. *Aust. J. Agric. Res.* **30**, 855-70
32. Lawrence, D.N., Carberry, P.S., Cawley, S.T., Doughton, J.A. and Herridge, D., 2001. Proc. 10th Australian Agronomy Conference, Hobart (this volume)
33. Malcolm, L.R., 1990. *Review of Marketing and Agricultural Economics*, **58:1**, 24-55.

34. Martin, A. and Sherington, J., 1997. *Agricultural Systems*, **55:2,** 195-216.
35. Martin, R.J., Cornish, P.S. and Verrell, A.G., 1996. Proc. 8th Australian Agronomy Conference, Toowoomba, p 413-416
36. Maxwell, J.A. and Randall, A., *Ecological Economics*, **1**, 233-249.
37. McCelland, I., 2000. In: Shared Solutions Manual 1999-2000. (Australian Grain, Toowoomba, Qld). pp. 2, 21-22.
38. McCown, R.L., 1990. Proc. 5th Australian Agronomy Conference. Perth, pp. 221-234.
39. McCown, R.L., 1991. In: Dryland farming - a systems approach: An analysis of dryland agriculture in Australia. (Eds. V. Squires and P. Tow) (Sydney Uni. Press, Sydney) p.241-249
40. McCown, R.L., 2001. Proc. 10th Australian Agronomy Conference, Hobart (this volume)
41. McCown, RL, Carberry, PS, Foale, MA, Hochman, Z, Coutts, JA, and Dalgliesh, NP., 1998. Proc. 9th Australian Agronomy Conference, Wagga Wagga. p.633-636.
42. 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. Goldworthy & F.W.T. Penning de Vries) (Kluwer Academic Publishers, The Netherlands) p. 81-96.
43. Norman, D.W., 1992. *Proceedings SADCC/ICRISAT Research Planning Meeting*, Bullawayo, Zimbabwae, 21 – 26 September, 1992.
44. Oquist, P., 1978. *Acta Sociologica*, **21** No.2, 143-163
45. Peart, G., 1995. *Australian Farm Journal*, July, 14-16.
46. Petheram, R.J. and Clark, R.A.,1998. *Aust. J. Exp. Agric.*, **38**, 101-115.
47. Robertson, M. J., Carberry, P. S., and Lucy. M., 2000. *Aust. J. Agric. Res.*, **51**:1-12
48. Rowlings, S.J., Strong, W.M., Cameron, J. and Carter, R.J., 2001. Proc. 10th Australian Agronomy Conference, Hobart (this volume)
49. Schwenke, G., Butler, G., Christian, T., Nixon, J., Hayman, P., and Herridge, D., 2001. Proc. 10th Australian Agronomy Conference, Hobart, (this volume)
50. Shared Solutions Manual 1999-2000. (Australian Grain, Toowoomba, Qld). p. 116.
51. Stone, R. C., Hammer G. L., and Marcussen, T. 1996. *Nature* **384**, 252-55
52. Taggart, S. 2000. *Australian Geographic*, Apr-Jun 2000, Issue **58**, p. 72-85.
53. Twyford, J., 2000. Priority issues paper for the Northern Region Grains Industry. (GRDC)
54. Van Beek, P. (Ed.), 1993. DPI Systems Study Group: selected papers, volume one. (DPI Conference & Workshop Series QC93006) 79pp.
55. Woods, E.J., Cox, P. and Norrish, S., 1997. In: Intensive sugarcane production: meeting the challenges beyond 2000. (Eds. Keating, B.A. and Wilson, J.R.) (CAB International, Wallingford, UK) p. 469-490.
56. Wylie, P., 1992. *Agric. Sci*., **5:5**, 26-28.
57. Zuber-Skerritt, O., 1993. *Higher Education Research and Development* **12**, 45-58.