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FARMSCAPE Online

Interactive internet support for farmers' situated learning and planning

A report for the Rural Industries Research and Development Corporation

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Foreword

Farming in many parts of Australia is characterised by a high degree of climatic variability. This creates an environment of significant management uncertainty. An integrated set of tools and techniques known as FARMSCAPE has demonstrated effectiveness in helping reduce this uncertainty by the use of climate and soil monitoring together with crop simulation in face-to-face interactions.

This publication reports on a research program connecting farmers, their advisors and researchers in online workshops across Australia. These Internet-enabled workshops used low-cost, low bandwidth Internet video-conferencing in which computer-based crop simulation was the basis of discussions concerning alternative management practices.

When FARMSCAPE researchers used crop simulation in these workshops farmers often asked questions such as: 'What yield would I have achieved if I had planted on this date?', 'What if I changed the rate of Nitrogen fertiliser I applied?', or 'What is my yield outlook given my current stored soil water?' The workshops provided opportunities for farmers, their advisers and researchers to jointly learn about the performance of farming systems under a range of potential management alternatives. An 'interested observer' programme actively demonstrated this approach to other researchers and stakeholders.

This research successfully demonstrated the *practicality* and *feasibility* of 'sharing', in real time, simulation outputs via the internet - using readily available low cost software and hardware. It was possible to successfully deliver FARMSCAPE interactions via the Internet using low speed (>20Kb/s) Internet connections, over often unreliable rural phone lines. During the course of this research there were more than 35 interactions with 8 farmer groups, directly involving 120 farmers from 4 states, with 20 interested observers. This report provides analysis of data collected through interviews and external evaluation of interactions with these farmer groups and through video analysis of taped workshops.

Information derived from online workshops was also received by some 500 farmer members of the Birchip Cropping Group through a monthly 'Yield Prophet' fax during the 2002 crop growing season. A further 6000 stakeholders received information derived from activities within these workshops as part of the quarterly BCG's annual production manual, the 'FARMSCAPE Insights' newsletter and the FARMSCAPE website.

This project was funded from RIRDC Core Funds which are provided by the AustralianGovernment.

This report, a new addition to RIRDC's diverse range of over 1000 research publications, forms part of our Human Capital, Communications and Information Systems R&D program, which aims to enhance human capital and facilitate innovation in rural industries and communities.

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- purchases at www.rirdc.gov.au/eshop

Dr Simon Hearn
Managing Director
Rural Industries Research and Development Corporation

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We would like to acknowledge the generous support of farmers from the Moonie Management Group, Birchip Cropping Group, Brim Technology Group, Liebe Farmer Group, Mingenew-Irwin Farmer Group, and the Special One Research Company.

We would also like to thank the tireless support of our fellow researchers Peter Carberry, Bob McCown, Neal Dalgliesh, Perry Poulton, and Jeremy Whish.

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Executive Summary

The Internet and associated Information and Communication Technologies provide a challenging frontier for exploring new modes of communication between scientific and the farming communities. This report describes a research and development project that explored the possibility of connecting farmers and their advisers with research scientists through Internet enabled online workshops across Australia. Workshops were mediated through low-cost, low bandwidth Internet video-conferencing. Interactions were based on the FARMSCAPE (Farmers', Advisers', Researchers', Monitoring, Simulation, Communication And Performance Evaluation) approach to supporting farmers learning about crop management under climatic uncertainty. The workshops featured discussions about alternative management practices for cropping. Discussions were aided by simulation using a computer-based cropping systems simulator (APSIM).

Fifteen online workshops were conducted between 2000 and 2002 with 6 groups of farmers. The Microsoft NetMeeting™ (www.microsoft.com/netmeeting) 'application sharing' feature was deployed for sharing graphs and other digital images. A separate phone line was used for audio communication. Researchers participated from Toowoomba, Rockhampton and Hobart, while farmer groups were located at Moonie (QLD), Birchip and Brim (Vic), Walgett (NSW), Mingenew, and Buntine (WA). Another 20 researchers and extension specialists participated in an interested observers program. During workshops farmers often asked researchers to use the simulator to address questions such as: 'What yield would I have achieved if I had planted on this date?'; 'What if I changed the rate of Nitrogen fertiliser I applied?' or 'What is my yield outlook given my current stored soil water?' The virtual workshops provided opportunities for farmers, their advisers and researchers to jointly explore the actual and potential performance of individual farming systems.

A variety of methods were employed for participant evaluation: an independent evaluator conducted 4 clusters of interviews based on semi-structured interviewing techniques; data were collated from farmers' and interested observers' pre and post-workshop questionnaires; post-workshop farmer and researcher interviews; and individual researchers' post-workshop notes. Other data used in this report includes research facilitators' presentations, primary researchers' field notes, and other corroborating data. Workshops were recorded by video at both the researcher and farmer group nodes. Video Interaction Analysis techniques were employed to analyse interactions at these workshops.

Replacing face-to-face FARMSCAPE workshops with Internet enabled online workshops proved to be cost effective and time efficient while delivering comparable measurable impacts on farmers' management practice. We observed that for Internet interactions to be successful certain conditions must be met. There must be opportunities provided to build sufficient mutual understanding between farmers, advisers and researchers. The key components of mutual understanding are mutual respect and responsiveness to each other's expressed issues. Scientists, who expect to have an impact on farming practice, need to have respect for farmers' expert farming knowledge, and demonstrate their willingness and capacity to respond to farmers' expressed problems. There must also be effective interaction between participants. Some dimensions of effective interaction are: good local and remote facilitation, common understandings about interpretation and meaning of shared representations and reliable functioning of the underling communication technology.

The project demonstrated a commercially feasible methodology for using internet enabled virtual workshops to facilitate learning programs for farmers within their own farming situations. Further work is needed to discover the many other possibilities and opportunities for appropriating this emerging technology in the service of sustainable agriculture.

1. Introduction

This publication reports on research that successfully delivered FARMSCAPE interactions via the Internet. These interactions feature the use of computer-based crop simulation as the basis for *facilitated discovery learning* (Veenman *et al.* 2002) situated within farmer's practice- in participant farmer's commercial crops using their actual soil and weather data.

This project was stimulated by and is based on a research approach that has become known as FARMSCAPE (Farmers', Advisers', Researchers', Monitoring, Simulation, Communication and Performance Evaluation). The initial focus of FARMSCAPE was to establish if 'any farmer' could value computer based crop simulation as an aid to their management, and if so under what conditions. To this end CSIRO researchers worked directly with farmers and their advisers, both private and public, on individual farmers' properties in Australia's northern-cropping region. (Hochman *et al.* 2000, McCown 2001, Carberry *et al.* 2002)

Stretching from northern New South Wales to Central Queensland, Australian's northern cropping region is characterised by high climatic variability, creating an environment of extreme uncertainty for farm management decision making. Farmers are required to make such decisions relating to when to plant, how much fertiliser to apply and what crop to plant amongst other things.

At the core of the FARMSCAPE approach is a versatile cropping systems simulator, APSIM (Agricultural Production Systems sIMulator) that, together with locally collected soil water and nitrogen data, enables simulation of a given paddock/crop for specified management. It is this ability to readily customise the simulation that makes this approach so valued by clients, partly because contextualisation adds relevance and partly because it provides a ready means to test the simulator against real world production system performance. When the simulator, customised for a client, is run with long-term rainfall inputs, it provides the client with a means to experiment with changes in farming practices by asking relevant 'what if I had done…?' questions and examining the simulated consequences, including frequencies of various outcomes and long term trends. This process, often involving a small group of farmers and consultants/advisers, is characterised as facilitated discovery learning.

From this research emerged an approach for face-to-face simulation-aided discussions between farmers, their advisers and researchers about management issues expressed as important by participant farmers. This research demonstrated the effectiveness and value of simulation aided discussion sessions (Carberry *et al.* 2002), as judged by participant farmers and their commercial advisers. Farmers often attributed significant management changes to their involvement in such sessions (Van Beek 2003).

Once this approach had demonstrated value, the researchers expanded trials nationally in a phase that effectively attempted to test and subsequently develop a market for FARMSCAPE tools and techniques more broadly.

Such was the demand among farmers for FARMSCAPE based services that CSIRO researchers no longer had sufficient capacity to supply.

> "…the FARMSCAPE team serviced requests for soil data and simulations for a significant number of farmers, mainly via collaboration with agribusiness but also on an individual request basis - over 100 simulation scenarios were conducted and delivered in one year. In fact, the demand for APSIM simulations by 1998 had increased rapidly to the point where demand could not be met nor could an 'at-call' delivery service be justified by CSIRO." (Carberry *et al.* 2002 p148)

Researchers soon turned their attention to ‘how to deliver FARMSCAPE tools and techniques in a cost effective and commercially sustainable manner?’ The researchers responded by initiating two complimentary activities: a) develop a training program to accredit a network of commercial agricultural consultants to deliver FARMSCAPE based services, and with them assess the sustainability of commercial delivery, and; b) research the use of the Internet as a way to reduce costs and increase efficiency and access to FARMSCAPE tools and techniques by reducing the requirement for travel and increasing timeliness of such sessions to farmers.

The current FARMSCAPE Online project is designed to be analogous to the previously-successful face-to-face on-farm collaboration focused on learning about crop and cropland management which capitalises on (1) additional soil and climate information and (2) the value of interactive, facilitated, simulation of production systems in planning and decision making. It attempts to invent a program and a facilitation method for online interactions between scientists, advisers, and farmers that directly supports farmers’ experiential learning in their own farming operations.

The research presented here directly addresses the second possibility and, in doing so, discusses the following questions.

1. Did online workshops lead to the development of shared representations, language and understandings between farmers and researchers?
2. What does the evidence suggest about the impact of FARMSCAPE Online on participant farmer’s learning and practice? Was it comparable to the impact of face-to-face FARMSCAPE interactions?
3. What is required for a successful online interaction?
4. Can sufficient trust be established between participants when the primary mode of interaction is online?
5. What is *mutual understanding* and why is it important for a successful online interaction?
6. What is *effective interaction* and why is it important for successful online workshops?
7. What are the important dimensions of *facilitating* online interactions?
8. What can we learn from how online interactions *breakdown*, and what are possibilities for *repair*?
9. How does the fidelity of shared applications, audio and video affect the interaction?

2. Objectives

This project aimed to conduct programs of Internet-based interactions between farmers and professionals to develop:

- a practical and commercially-feasible methodology for facilitating learning programs for farmers within their own farming situations;
- an interactive online method for consultants to provide farmers with customised soil monitoring and simulation support for timely planning and decision making.
- online multimedia resources to aid farmers' learning about key soil processes and agronomic practices that provides insights for better crop and soil management.
- an 'interested observers' program, whereby other researchers and interested parties will be actively invited to observe the running of these sessions.

3. Methodology

The methodology is based on the FARMSCAPE approach (Carberry et al 2002). FARMSCAPE consists of a set of tools and techniques that facilitate face-to-face simulation aided farm management discussions between farmers, their advisers and researchers. The theory and practice of action research was central to developing the original FARMSCAPE activity, and subsequently for 'FARMSCAPE Online'.

The methodology used in this project needed to satisfy two primary research aims: to demonstrate influence on farmer practice, by researchers acting as facilitators for *discovery learning* opportunities, and to act in a role of commercial service provider delivering this service via the Internet with evaluation of impact (or otherwise) of these interventions.

> "In this paradigm the problem of 'implementation' gives way to the problem of how to achieve 'mutual understanding' between interventionists and practitioners and to 'intervention' that is less about recommendation that by-passes a farmer's decision process and more about facilitation of decision process adaptation." (McCown 2001)

3.1 FARMSCAPE as an Information System

'FARMSCAPE Online' is conceptualised as an Information System with individual managers using various sources of information to make decisions. This typically occurs in idiosyncratic ways and in relation to actor's goals. An early activity was to describe an appropriate research methodology that adequately deals with both the social and technical sub-systems.

Information Systems (IS) is a relatively new field and is described by Hasan et al (1998) as follows: "In the context of an organization, information systems are artefacts or tools used by people to monitor, plan and carry out the business of the organization more efficiently and effectively." The tools that the authors refer to here are typically information technology, executive information systems, decision support systems, and management information systems. Checkland describes Information Systems "…as being centrally concerned with the human act of creating meaning, and relates experiences based on a mature use of SSM to a fundamental conceptualisation of the field of IS/IT…" (Checkland 2000:12)

Interestingly like several other disciplines, including: 'systems', social science, artificial intelligence and psychology- IS has experienced it's own paradigm shift from *hard* / *positive* approaches based on the view that "… computerised information systems and decision makers as comparable information processors, where the output from the computer is the input to the decision making process." (Hasan *et al.* 1998) to approaches rooted in *interpretivism* and *phenomenology*, with an emphasis on understanding how managers use information, knowledge and experience to make meaning and sense of their environment and decisions about action within that environment *in situ.*

In conceptualising FARMSCAPE as an information system (with an interpretive underpinning) the focus becomes not a study of the technology (or tools) but a study of the *use* of tools in the context of performing an activity (eg. What If Analysis And Discussion Session (WifAD), APSIM, soil monitoring) to aid participants *sense making* of the environment with the aim of purposeful action. This is supported by Hasan and Gould (2001) who state "… the real phenomenon of interest is not information technology but the idiosyncratic way that individuals derive meaning from data available through information systems."

The epistemological foundations of this research are essentially interpretive, within a broader context of methodological pluralism. Action Research (AR) (Checkland 1981) is used to develop a methodology, provide a practical means of engaging in the situated practice of farmer's real world activities, and for data collection. The data are then analysed using the framework of activity theory (Nardi 1996; Hasan and Gould 2001).

3.2 Action Research

We used Action Research (AR) as a means to engage practitioners *in situ* within their real world problems. AR is used to provide a means to structure data collection and to iteratively develop an approach to engaging farmers, within their own practice, about pressing management issues via the Internet. AR is used within this research as a cyclical process of: i) formulation of joint plans between farmers, their advisers and researchers; ii) implementation of those plans; iii) formal observation / data collection processes; iv) reflection informed by the data; v) joint reformulation of plans for future cycles of action.

3.3 Cultural Historical Activity Theory

We adopted Cultural Historical Activity Theory (CHAT) as a theoretical framework for analysis. CHAT takes *activity* as its basic unit of analysis. Simulation supported discussion sessions on the Internet are conceptualised as sets of 'activity'. According to Hasan & Gould (2001) CHAT provides "…a theoretical framework that has structure and substance, while at the same time providing a holistic view of the problem and allowing for the messiness of context…".

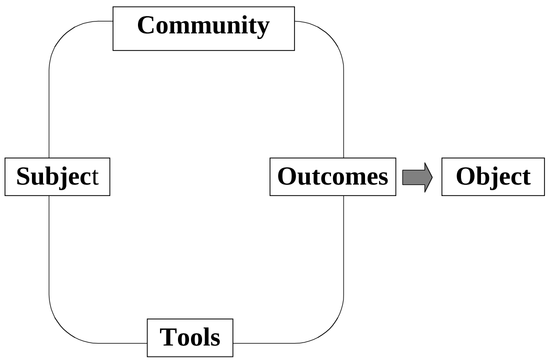


Figure 1. Cultural Historical Activity Theory (Hasan & Gould 2001)

Table 1 illustrates how our case overlays the theoretical CHAT framework. Entries under each heading are not comprehensive but rather illustrative.

Subject	**Tools**	**Community**	**Outcomes**	**Objects**
Farmers	APSIM, NetMeeting, personal computers, facilitation.	•community of farming practice. •community of research practice •both above are involved in a community of inquiry.	•modified farmer understanding of soil water environment •changed farmer soil monitoring practice. •enhanced researcher appreciation of farmers *felt* problem •more efficient N fertiliser application	•improved farm profitability •reduced operating costs •improved productivity •positive environmental outcomes

Table 1 Conceptual CHAT framework applied to online farmer meetings.

The question that concerned us was: 'What happens between when a farmer (*subject*) initially agrees to participate, their decision to alter their management practice (*outcomes*)?' 'What was causing farmers to change their practice?' It seemed to us that the space at the centre of Fig. 1, that is, the nexus between *subject*, *community*, *tools*, and *outcomes* was a promising place to start this search.

3.4 Video Interaction Analysis (VIA)

Video Interaction Analysis is an interdisciplinary method for the empirical investigation of the interaction of human beings with each other and with objects in their environment. Human activities (e.g. talk, nonverbal interaction, use of artefacts and technologies) are investigated, identifying routine practices and problems and the resources for their solution. Only videotape recording produces the kind of data corpus that allows the close interrogation required for VIA (Jordan and Henderson 1995)

> "Video technology has been vital in establishing Interaction Analysis which depends on the technology of audiovisual recording for its primary records and on playback capability for their analysis. Only electronic recording produces the kind of data corpus that allows the close interrogation required for Interaction Analysis. In particular, it provides the crucial ability to replay a sequence of interaction repeatedly for multiple viewers, and on multiple occasions." (Jordan and Henderson 1995)

Video provides access to conversation, gestures, expressions, actions and the immediate workplace context. It allows repeated viewing of the original data to examine consistency and generality of observations. Textual accounts, ethnographic field notes, or interview responses, by themselves would be inadequate for communicating the dynamics of the work setting and the complexity of the interaction. (Jordan and Henderson 1995)

In VIA, an interdisciplinary team typically view segments of tapes selected by the primary investigator and identifies routine practices, routine problems and resources for their solution. Only those practices confirmed by the raw data that occur repeatedly in different parts of the tape are considered admissible in the analysis. This exploratory research technique is used because it supports formulation of our understanding of natural activity. (Jordan and Henderson 1995)

4. Methods

The AR program was manifest in practice as described below:

1. *Recruitment of participant farmers.* Proactive learning farmer groups were invited to participate actively for the duration of one season, during which support was provided for characterising and monitoring soils in individually negotiated projects; a reduced level of support was provided for a further season, and evaluation continued for the duration of the project.
2. *Negotiate individual projects* on management issues within the farm on the grounds of relevance/interest to farmers and feasibility of conduct.
3. *Negotiate with 'interested observers'* with respect to the bounds and type of participation. An integral part of this activity is the invitation to other researchers and interested stakeholders to observe the online workshops and to evaluate them in terms of process, content, and their perception of farmer involvement. Their evaluation data are included throughout this document.
4. *Trials in commercial crops* conducted by a farmer (with their consultant) and supported by the project team
5. *Provide training to farmers and consultants* in setting up and using of Microsoft® NetMeeting®.
6. *Internet-based discussion* of issues of significance to farmers, findings, and implications.
7. *Collaboration via synchronous Internet conferencing*, on using APSIM to simulate results of trials to 'validate' simulator and demonstrate its flexibility to the farmers' soil, seasonal conditions, and management practice.
8. *Joint interpretation* between group members *via* synchronous Internet conferencing using APSIM and including 'virtually conducting' trials in past years for which climate records are held.
9. *Online workshops* using APSIM to explore issues beyond the trials.
10. Researchers document changes in views, intended actions, and actual management.
11. Researchers *document new insights* into farming within these contexts.
12. *Evaluate the research practices* outlined above and make changes to improve it.
13. Loop to step 1 or 2 for subsequent season.

The project team included:

Name	Role
Dr Zvi Hochman	Project leader and primary researcher and facilitator of Internet workshops. Zvi managed the relationship with farmer and adviser facilitators, ran APSIM, and presented at face to face meetings and field days.
Dr Peter Carberry	Primary researcher and facilitator, filling in for Zvi when required, running APSIM, establishing and maintaining relationships with farmer groups and the farmer facilitators.
Neal Dalgliesh	Neal managed the soil monitoring programme for all groups, and maintained relationships with the farmer groups.
Perry Poulton	Perry provided APSIM support and technical support for the Internet meetings.
Dr Bob McCown	Provided intellectual input to the research process.
Dean Hargreaves	Primary researcher engaged in investigating the phenomena of groups of farmers and researchers interacting via the Internet.

Researchers undertook more than 35 activities with farmers, including preliminary meetings, soil training field days, face to face workshops and 15 online workshops. Data were collected from these workshops by video recording the interaction (often at both the farmer and researcher end), pre and post workshop questionnaires, and post workshop farmer and researcher interviews. An external evaluator (SyTrec Pty Ltd) was engaged to conduct longitudinal evaluations, both to benchmark and assess impact.

The data we collected were extremely rich, particularly the data contained within the videotapes. Effectively managing and using this data proved to be a challenging experience. To deal with this we developed a set of filters though which we would pass the data- we used these filters together with 'HyperRESEARCH' (http://www.researchware.com/) social research software to lump the data under broad categories within the framework.

The following framework was developed using *activity theory*- with the conditions / variables situated vertically between *community* and *tools* and horizontally between *subject* and *object*. Those variables are then used to *filter* the data into appropriate categories using qualitative research software. The framework is used to structure discussion.

1. *Evidence of impact*- what was the consequence of online interactions?
2. *Farmer understanding of system function*- what did farmers learn about the 'science' of their farming system?, and
3. *Mutual understanding*- was there a 'meeting of minds' between participants?
4. *Effective interaction*- what was the experience of interacting via the Internet?

4.1 Research process

In practice The AR program progressed as follows:

1. **Participant recruitment**. Recruitment of farming groups was based on: i) genuine remoteness; ii) Internet connection, and; iii) evidence of being proactive 'learning farmers'. An Australia wide network of farmers was recruited including groups at Moonie (QLD), Birchip, Brim (Vic), Walgett (NSW), Mingenew, and Buntine (WA).
2. **'Face-to-face' orientation workshop (not conducted for all groups).** This featured an introduction to monitoring soil water and nitrate under a crop and a demonstration of how APSIM might be useful if properly situated for participant farmers. This session is also used to demonstrate the plausibility of simulated results and flexibility of the simulator to be relevant by dealing effectively with farmers felt problems.
3. **Provide participant 'kit'-** We left a 'participant kit' with the group designed to support them in conducting their own experiments. This 'kit' included:

Item	Approximate cost
Hydraulic soil corer	$4000
Hand corers	$100 /each
Speaker telephone	$160
Kodak DC325 web cam for use with the Internet workshops. As of writing Kodak have ceased selling web cams. However we suggest that good alternatives are Logitech QuickCams®. Both pricing and performance are similar.	$350
'Soil Matters'- a guide to best practice for soil monitoring.[1]	$20
Electronic temperature recorder	$50
Plan for fabrication of a utility mounted soil rig.	Free

4. **On-line workshops.** Within the context of a farmer workshop the following issues were typically covered in the sequence described below. The actual sequence and nature of content was varied in response to farmers' existing knowledge, experience, skills and interests. However the following sequence provided a helpful starting point for our engagements with new farmer groups.

[1] Dalgliesh, NP and Foale, MA. 1998. Soil Matters - monitoring soil water and nitrogen in dryland farming. CSIRO Australia.

1. General issues were covered such as the nature of the soil water balance, simulating soil water and crop yield from weather data and soil characteristics. This also included use of historical rainfall records to get the 'odds' for the outcome of a range of potential management actions.
2. Discussion of early stage of field projects centred on exploration of system resources: i) soil type in relation to soils of the region; ii) nature of soil throughout the crop root zone based on soil cores taken by participants. This includes: a) visual description and 'feel' of the soil; b) presence of roots; and c) chemical analysis of layers; iii) soil water storage capacity.
3. Organisation of historical climate records of farm (or nearby farm or town) with long-term records.
4. Demonstration of APSIM's ability to simulate results of these trials.
5. Long-term simulated yields: yield probability distributions based on the full climatic history and when there was indication of skill in climate forecasting using the SOI Phase system (Stone *et al.* 1996).

4.2 Microsoft NetMeeting®

Graphs are shared via Microsoft NetMeeting® software using its 'application sharing' functionality. Application sharing allows a number of users to see the contents of one or more participant's screens. Users can share any open application on their PC individually, or in any combination. Users can allow other participants to take control of their open applications, or otherwise choose to restrict access. NetMeeting® shares applications in a remarkably efficient fashion- it only updates those areas of the screen that have actually changed. Our experience has been that NetMeeting's® sharing efficiency is greater than that of a second major category of application sharing technologies, based on the Virtual Network Computing (VNC) standards. NetMeeting® is usable over low speed Internet links (<28kb/s).

Users can connect two or more NetMeeting® endpoints by one of three methods: i) Internet Locator Server (ILS); ii) direct IP connect, or; iii) a Multipoint Conference Unit (MCU). We started this research using an ILS- this proved intuitive as users full text names are displayed on a central list, viewable by all participants. However use of an ILS is dependent upon the service being available on an ongoing basis to participants, and that the service is reliable. The Direct IP connection is now the dominant mode and only requires two or more NetMeeting endpoints to connect directly to each other; using each PC's IP number, which is easily obtainable within NetMeeting®. We have only run limited trials of NetMeeting® together with MCU's; largely due to the fact that MCU's have only recently become affordable and reliable. The use of an MCU for interactions between farmers, researchers and other stakeholders is the focus of a proposed initiative currently under consideration by RIRDC.

NetMeeting's® video and audio functions are limited to point-to-point meetings (ie. only two participants). Application sharing and whiteboard functionality are available in both point-point and multi-point (ie multiple endpoints all sending and receiving) configurations.

Microsoft NetMeeting® is distributed without charge by Microsoft from their website (www.microsoft.com/netmeeting). It is pre-installed on Windows 2000/XP and must be downloaded for Windows 95/98/NT. NetMeeting® operates on the International Telecommunications Union (ITU) standards of H.323 for voice and video communication, and T.120 for data sharing. This makes NetMeeting® interoperable with a range of other clients; and additionally Multipoint Conference Units (MCU's), for conferences with multipoint audio and video.

4.3 Data collection for Video Interaction Analysis

Eight video recordings were made of four separate farmer groups over a period of two years (2000 – 2002). Three of these video tapes were selected based on their amenability for analysis which included completeness of record, quality of audio and video, and relevance of content to the research questions.

These tapes were logged which involved the recording of 'timecode' data with notes describing the video and audio content in tabular form. A subset was then selected from this log that comprised 'video segments of particular interest'. These segments were then viewed by combinations of seven researchers over a period of three (3) weeks in six (6) separate Interactive Analysis Laboratory (IAL) sessions.

The researchers viewed selected video segments from three video tapes- recorded at Internet workshops between CSIRO researchers and farmers at: i) Moonie, Central QLD on 19/04/00; ii) Moonie on 16/10/00; iii) Walgett, Northern NSW on 04/07/02.

IAL	Researchers
1	Zvi Hochman[a], Dean Hargreaves[a]
2	Dean Hargreaves
3	Bob McCown[a], Dean Hargreaves
4	Neal Dalgliesh[a], Zvi Hochman, Dean Hargreaves
5	Peter Carberry[a,] Tom Gerrick[c] Bob McCown, Dean Hargreaves
6	Margot Brereton[b], Peter Carberry, Dean Hargreaves

a = CSIRO, Sustainable Ecosystems, Toowoomba.
b = University of Queensland, Department of Information Technology and Electrical Engineering, Brisbane.
c = Texas A&M University, Texas, USA.

4.4 Data collection for external evaluation

Peter van Beek of SyTrec Pty Ltd conducted four (4) external longitudinal evaluations that consisted of two (2) benchmark evaluations, one each of the Brim and Birchip farmer groups, and two (2) impact evaluations for Birchip and Moonie groups respectively (Van Beek 2000, Van Beek 2001, Van Beek 2002). A benchmark evaluation aims to document farmer participants' current knowledge and practice and opinions in terms of key management variables. This 'benchmark' then provides the baseline data that are compared to the results of future evaluations. Impact evaluations provide opportunities to document changes (or lack thereof) in management practices over time. Researchers use impact evaluation as a tool to inform and guide future engagement with farmer groups, and as a means to provide data for reporting purposes.

5. Results and Discussion

During the course of this research we have had more than 35 interactions with eight (8) farmer groups, directly involving 160 farmers from four (4) states, with 20 interested observers and stakeholders. Some 500 farmers received information derived from Internet workshops via the Birchip Cropping Groups regular 'Yield Prophet' fax. A further 6000 stakeholders received information derived from activities within these workshops as part of the quarterly 'FARMSCAPE Insights' newsletter. Farmer groups were based in Western Australia, New South Wales, Victoria and Queensland.

The table below lists interactions with groups during the course of this project.

Group	**Date**	**Activity**
Moonie (QLD)	22/07/99	Initial face to face workshop and online session
	21/12/99	Online workshop – "wifad"
	19/04/00	Online workshop - rotations
	06/08/00	Online workshop - drainage
	25/08/00	Face-to-face workshop in Moonie
	06/10/00	Online workshop
Theodore (QLD)	30/10/00	Preliminary field visit
Banana (QLD)	30/10/00	Preliminary field visit
Birchip (Vic)	26/03/01	Face to Face workshop and field visit
	04/06/01	Online workshop
	04/07/01	BCG Expo
	19/09/01	Online workshop
	25/02/02	Researchers Neal Dalgliesh and Zvi Hochman were invited to present at the regular 'Birchip Research Update' field day.
	22/03/02	Online workshop
	11/07/02	Birchip Expo
	21/08/02	Online workshop
	09/04/03	Online workshop
Brim (Vic)	27/06/02	Online workshop
	28/08/02	Online workshop (researchers located at sites in Toowoomba, Rockhampton and Hobart, while farmers were at three separate sites in northern Victoria.)
	21/10/02	Online workshop
	09/04/03	Online workshop
Liebe (WA)	10/04/02	Online workshop
	11/08/02	Online workshop
	02/09/02	Online workshop
	April	Field visit
	September	Field visit
	October	Field visit
MIG (WA)	09/04/02	Online workshop
	25/07/02	Online workshop
	April	Field visit
	September	Field visit
	October	Field visit

Group	Date	Activity
Walgett (NSW)	21/03/02	Field visit
	26/03/02	Online workshop
	29/05/02	Field visit
	July	Field visit
	August	Field visit

There was no shortage of data to support the proposition that the project was successful in delivering a satisfying and highly valued online workshop experience for participating farmers:

> 'Communication was instantaneous; the technology has come a long way. The Internet is quite good. The idea of this delivery system is excellent; it gives us access to best people virtually on an intimate basis.' (Birchip Farmer, 2003)
>
> 'The latter sessions worked really well, greatest thing since sliced bread. They are getting the technology right in terms of delivery and telephone hook- up; the graphs are coming on screen reasonably well…' (Birchip Farmer, 2003)
>
> 'Pretty dramatic talking from Birchip to Tasmania, Toowoomba, Rockhampton, with telephone connections to Horsham and Quambatook.' (Brim Farmer, 2003)

The main attention of this report is therefore focused on understanding the conditions that need to be satisfied for an online interaction to be considered successful. Results of this research are discussed with this focus in mind.

5.1 Evidence of impact of online workshops on farmer learning and practice

Earlier research has provided evidence that the FARMSCAPE approach delivered face to face has achieved significant impacts. Carberry *et al.* (2002) reported impacts through:

i. establishing soil monitoring as a key management practice
ii. altered view of soil resources
iii. increased acceptance of modelling
iv. acceptance of seasonal climate forecasting
v. changed production expectations
vi. innovative changes to farming practice, and
vii. commercial demand for FARMSCAPE tools.

The issue for this research was to see if similar impacts could be achieved when a significant part of the interactions is conducted online. The data used to confirm this proposition have been extracted from external evaluations, interviews, participant observation, and pre and post-workshop evaluations.

5.1.1 Learning about soil and soil water environment

There was ample evidence that farmers changed the way they think about their soils. Many farmers have adopted the scientists' concept of 'plant available water capacity', which they expressed by using terms such as 'bucket', 'lower limit' and 'upper limit' and by talking about subsoil moisture and where the water is in the profile.

> 'Changes in understanding included becoming aware of what was below the surface (and starting to use corers and micro-wave ovens), and the importance of minimal and zero till. There appears to have been the same development in thinking about soils as noticed in earlier evaluations [a comparison with groups that experienced only face to face interactions with FARMSCAPE researchers]. That change is from thinking in terms of depth of wetness, towards thinking of rain,

stubble, soil and limitations such as salt as a system, a bucket. This change rapidly leads to thinking about how this system can be managed to capture and, if possible, hold more water or use it more profitably.' (Van Beek 2001)

'Instead of wandering around after rains with a probe, we now use the corer and measure; before we used a shovel and it was not well done.' (Moonie farmer)

'Participating non-farmer interviewees had learned about the critical importance of sub-soil moisture and that the region (around Birchip) is probably not as rainfall dependent as was generally thought. Also new to some was the importance of where the water is in the profile. Two had changed their thoughts and advice about what crops to grow under what conditions.' (Van Beek 2002)

'They had learned about soils and the 'bucket' concept, upper and lower draining limits, depth of root penetration, the importance of where the water is in the profile.' (Van Beek 2003)

'The comparison of lower limit for wheat, canola and pulses and the implications of the different bucket sizes.'

'I understand the 'bucket' better; that concept came from [local consultant] – wetting up and drying down of soils.' 'I had no idea of bucket before, (but) now I will adjust fertilizer. I did not listen that we did not have enough in the bucket to grow canola; I planted anyway and lost.'

'We got a better understanding what makes good soils, how to get more water into the soil … learned about soil fertility.'

'The characterisation and modelling confirmed a lot of learning. I was trying to find things about the soil; APSIM gives a framework to hang info about soil. It also showed a lot of gaps in our knowledge.'

'Soil tests are needed to tell where the moisture is and then APSIM knows what to do with it.' 'The difficulty now is mapping the soil types. We can map the surface soils but mapping the sub-soils is the real difficulty. I hope to map by yield and that will tell us the soil type plus each bucket.'

'If we get a big early rain in summer, we got to know *where* the water is…. 'Yield Prophet' is fantastic in getting to know our soils – the upper and lower limits – plus wilting points. It explains why soils yielded as they have.'

5.1.2 Learning about rooting depth and crop physiology

Participant farmers have demonstrated learning about rooting depth of several crops on a variety of soils and that different crops have different capacity to extract moisture from a soil.

'Rooting depths of canola and legumes etc. are not as vigorous as cereals given subsoil constraints.'
'The surprise was that canola did not root to depth, especially on Gilgai country.'
'Our knowledge of soil types is improving as well.' 'I have more understanding of for instance how far roots go down.' 'It helped us to understand … how much water there is and how much is being used. We need to know more about rooting performance, and also about roots' interactions with soil and micro flora.'

'The notion that wheat can still grow roots after anthesis.'

> 'Educating farmers to know how plants operate is very important, including the differences in varieties, when they need moisture. But we still don't fully understand the importance of flag leaves, or when moisture is used etc.'

5.1.3 Learning's about crop choice

The data provides evidence for changed farmer intentions in relation to tactical crop choice. This was expressed in terms of thinking about growing crops they have not tried previously, or matching crops to soils, or being more responsive to seasonal indicators when making a decision about which crop to grow.

> 'I would never have thought about planting chickpeas or mungbeans, now I may do that.'

> 'I will test APSIM for chickpeas. We got a good profit out of it, and then measured 197 kg N / ha in the soil after the chickpeas, worth $120 per ha.'

> 'One of the days the simulation was here, we were looking at putting mungbeans as a double crop into wheat stubble. The simulation suggested not, we did not do it and saved money.'

> 'We wanted to plant cotton, but looked 12 months ahead. Model said it depends on the year (rain) and price of cotton. The GM looked OK, but the price dropped and we did not plant.'

One interviewee said that in future he would change crop types in response to APSIM predictions of yield prospects: 'I did a crop plan in September, had it locked in and did not change it. I worked on average seasons and it cost a lot of money. This year when we'll come to 1st April I will look at what APSIM says, make a decision then and adjust e.g. fertilizer and certainly the crop varieties'.

5.1.4 Learning's about crop rotations

Evidence is provided here for changed farmer practice in relation to designing better crop rotations: Farmers learned from simulations about the relative performance of different crop rotations. Others saw value in using the simulator to look at the value of fallows and to re-consider the balance between cropping and grazing.

> 'Several participants were surprised to learn that the most intensive crop rotations were also the most financially rewarding ones. This strengthened the preference of some participants for shorter fallows and more opportunity cropping. It also led some to selecting crops based on the amount of water stored (and prices), away from having standard long fallows and crop rotations. Other changes were that interviewees became aware of potential yields (and started to chase these), and of the damage done by weeds (and started to control these much better).' (Van Beek 2001)

> 'What we thought was right was not. Wheat, short fallow, sorghum, wheat showed how far behind the potential we are.'

Interviewees expected APSM to influence decisions about crop rotation and selection, and whether to fallow or not fallow: 'This region depends on fallow and ASPIM will substantiate the value of that'. It may also help to decide on the proportion of the farm to crop: We are opportunity croppers and normally have 60-75% cropped' or to 'expand or contract our livestock. Our wool clip was worth more last year than the crops while we are in a drought, and it is a lower-risk enterprise'.

5.1.5 Learning about fertiliser application

Exposure to "what if" simulations about crop yield responses to rates of N with different starting conditions over a range of seasonal conditions has had a strong impact on farmers' thinking about application of nitrogenous fertilisers.

> ‘Decisions effected by the interaction through FARMSCAPE and running the model farm through APSIM included substantial increases in fertiliser, split application of fertiliser, and investing in side dressing equipment.’ (Van Beek 2002)

> ‘When we ran it through the program we changed fertiliser rates.’

> ‘It led me to invest in a spreader to put urea on as the crop is growing, in stead of heavy early applications and then getting low rain. I will now try to fertilise according to the rain, alter the rate in accordance with the season.’

> ‘Once I saw the yield potential we increased fertiliser usage. I had the idea that legumes supplied enough, but we went from 0 to100 kg Urea per ha. We match urea better to the crop, are setting up for side dressing. In a trial paddock I did we went from 2 to 3 tonnes per ha and from ASW to AH grade, a 50% increase in yield and $30 per tonne premium: 2 t @ $110 gave $220, with a gross margin of $5 per ha. 3 t @ $140 gave $420, with a gross margin of $200 per ha. On a total of 430 ha wheat that would have meant about $83,500 extra Gross margin from wheat. Now everything gets fertilised. That was all due to a change in my thinking, and that is what APSIM does. Fortunately the season was good and showed the education benefit.’

The same interviewee had a similar response in chickpeas due to starter fertiliser on 170 ha.

> ‘We got nearly twice the crop on fertilised as on non-fertilised areas, it went from 4.2 to 7.2 bags per ha @ $33 per bag, and it was extremely dry. That is $99 per ha over 170 ha, or $16,800. Overall APSIM is a valuable management tool.’

> ‘Main thing I got out of it was an analysis why in particular years when there was plenty of moisture, the crop did not use all the Nitrogen. That was all about timing of application of N to be used by the plants.’

5.1.6 Changed production expectations

Farmers’ response to benchmarking crops against the potential calculated by APSIM was often rejected initially, but as the simulator gained credibility farmers upgraded their yield expectations.

> ‘With sorghum, the model says we can grow some up to 9.5 t per ha, the [long term] mean was 6 t per ha. Did not believe it, has never been done before. But we tried it on a fallow, and it is looking a reasonable bet.’

> ‘It gave potential yields, about double of what we thought and get, due to soil types, compaction etc.’

> ‘We need to go back and find out what we do wrong. The model challenges our benchmarks.’

5.1.7 Putting it all together – developing a new appreciation of their farming system

The large number of quotes presented in this section indicate that farmers were combining the individual insights listed in the sections above to derive a more systematic understanding of the functioning of their biophysical system and that this impacted on their thinking about their management system.

> ‘I was not aware of a lot of the detail about soil characterisation, rotational program, and the bottom line.’ ‘We got a better understanding what makes good soils, how to get more water into the soil … learned about soil fertility.’

One interviewee expected APSIM to ‘help to substantiate/quantify soil limitations; combining those with crop and variety selection can be very significant’. He emphasized that ‘it is important to realize that bad years hurt more than the good years can benefit. So if we can reduce bad years, we benefit most. That is why this program is really critical'. He also was aware that APSIM 'really needs good weather data, and good knowledge of soils'. And he wanted to do his own soil characterization. He saw a capacity for an oaten hay industry 'but no one is doing it. APSIM may help with that'. Another interviewee said, 'I want to be reactive to the weather'. A third saw advantages in early decisions: 'for instance when looking at markets. We can then move in and out of livestock earlier'.

> 'The characterisation and modelling confirmed a lot of learning. I was trying to find things about the soil, APSIM gives a frame work to hang info about soil. It also showed a lot of gaps in our knowledge.' 'What we thought was right was not.'
>
> APSIM made it all fall into place. It shows chances to get yields at different combinations of subsoil and SOI and it tells when to sit on our hands. Farmers turned back to fallow as they understand depth of rooting etc, and the presence of subsoil moisture.' 'We understand the region better.'
>
> 'The farmers appear to be steadily thinking more systematically about their management decisions. They are also becoming more objectively critical about the outcomes.'
>
> 'Three interviewees mentioned that APSIM had confirmed ideas about soils, water leaching and infiltration, set rotations versus opportunity cropping, zero-till, and GPS controlled traffic. APSIM was credited with providing the economics behind these technologies.' (Van Beek 2002)
>
> 'APSIM itself provided unique benefits in its own right in areas such as changing from set rotations to opportunity cropping, seasonal crop selection and decisions to plant or not to plant, or optimal use of irrigation water. I do not know of other programs that can deliver the same benefits.' (Van Beek 2001)
>
> 'In addition APSIM seems to have provided powerful facilitating benefits in the adoption of already existing extension messages about husbandry practices such as fertilising, minimal and zero till. As said, it does so by quantifying their benefits over a longer period.' (Van Beek 2001)

5.1.8 New 'rules of thumb'

For new knowledge to impact on management it must first be translated into rules for action. Such rules are commonly described as 'rules of thumb'. Data presented showed that farmers were learning rules for moving away from basing yield expectations, crop choice and fertiliser application on average conditions to being responsive to soil and weather conditions in making these decisions.

> 'They had learned …. when to top-dress and 'when to sit on our hands'. One had made changes in crop selection and in the balance between crops and livestock, while another will change from basing his decisions on averages for the last five years to looking what 'APSIM will say on 1st April'.' (Van Beek 2002)
>
> 'I worked out: no canola unless subsoil moisture and an autumn break in March/April. If we get no rain, we replace canola with wheat'.
>
> 'Several interviewees said or implied if they only had followed APSIM they may have saved a lot of money. Helping to avoiding disasters such as failed crops may become one of the main benefits of APSIM (even though it is difficult to measure in actual dollars; one cannot count what has not been spent or gained).' (Van Beek 2003)
>
> 'APSIM will also set target yields and thus inputs. We now target average yields. Farm 500 in NSW goes on average over last 5 years, but the key here is the weather'

One interviewee said that the group had started late in the year with it [Online workshops and simulation] and did not have accurate soil data: 'It was their best estimate'. Notwithstanding that, another interviewee said, 'After this year I will take notice of it. In June/July it was forecasting zero-yield. We all thought "oh yeah" but it was right. With the first prediction we said "You have not allowed for this or that e.g. rainfall during growth". They put some rain in, but still it gave almost no yield.' Another said, 'If they forecast low deciles I will adjust my planting; I can't risk a failure. It has made me stop and think'. A third interviewee said, 'We will be reluctant to sow a crop without stored soil moisture. As a result of APSIM I am a bit wary of next year's potential. If there is no subsoil I will not plant. I cannot afford the loss of inputs, but I can survive a year with no crops'.

In May 2002 the BCG initiated a new service to its 500 members by faxing a monthly one page report of the yield outlook for wheat crops in Birchip, Berriwillock, Warracknabeal, and Rupanyup. This report was named the 'Yield Prophet' and it has had a significant impact on many BCG members' thinking about managing production risk in a highly variable rainfall environment (Van Rees 2003). In 2003 a new 'Yield Prophet' product, based on each farmer's individual soil and weather data, was offered on a fee for service basis. The individual 'Yield Prophet' was immediately taken up by 30 farming families.

5.1.9 Innovative changes to farming practice

Given the relative brief period of engagement with the farmers there was significant evidence of changed management that farmers attributed to these interactions. Reported changes in farm practices were in response to researchers' predictions of a poor season in northern Victoria for 2002, to predicted responses to fertiliser, and to comparative crop performances given pre-season conditions and price variables.

> 'This year [ref. to 2002 drought] was the first time that I have not sown field-peas. I also decided not to sow canola. I planted only cereal and less of it. I looked more after the livestock to balance the economics of fewer crops. And we carried feed grain through.'
>
> 'When we ran it through the program we changed fertiliser rates.'
>
> 'One of the days the simulation was here, we were looking at putting mungbeans as a double crop into wheat stubble. The simulation suggested not, we did not do it and saved money.'
>
> 'We wanted to plant cotton, but looked 12 months ahead. Model said it depends on the year (rain) and price of cotton. The GM looked OK, but the price dropped and we did not plant.'
>
> 'The last interviewee estimated that changed decisions, due to APSIM, could increase his farm Gross Margin by $100,000 on 430 ha wheat and 170 ha chickpeas.'
>
> 'They [local consultants] confirmed that a number of farmers had made changes in inputs, crops and varieties.' (Van Beek 2002)

5.2 Mutual understanding and why is it important for a successful online interaction

Mutual understanding is a necessary condition for the relationship between farmers, advisers and researchers for online workshops to achieve the desired *objects* and *outcomes* (eg changed farming practice).

> "In this 'mutual understanding' relationship, intervention intent shifts from educating and persuading to recognition of and respect for other ways of viewing the world. This opens up the opportunities for co-creating information systems that utilise the comparative advantages of both practical and scientific knowledge. Intervention emphasis shifts from prescribing action to facilitating learning in actions." (McCown, R.L. 2001)

The selected quotes and discussion in this section are based on the data recorded through the semi-structured interviews conducted by Peter van Beek in his longitudinal evaluation. Variables that appear to impact the degree of mutual understanding that exists between researchers and farmer groups include: i) farmer trust of researcher intent within the broader series of engagements; ii) evidence that researcher analysis of farmers felt problem is accurate (both *relevant* and *significant*); iii) evidence of researcher commitment to farmers felt problem, and; iv) evidence of mutual respect between participants. The selected quotes below exemplify the existence of mutual understanding and the value that farmers place on it.

> 'Knowing a person is always nice.' 'It helped that we knew them, makes it flow a lot better, gives credibility. They were known, not unknown academics. Their opinions are widely tested, not something from the office.' 'In one-to-one talks I got to understand where they are going. They got us all thinking.' (Birchip Farmer, 2003)
>
> 'We know them, and that created an easy flow both ways. It would be more difficult without knowing them.' (Birchip Farmer, 2003)

5.2.1 A 'trust threshold' must be met

It is argued here that a 'trust threshold' needs to be met in terms of the relationship between farmers, their advisers and researchers in order to have successful interactions. The quote below was in response to researchers' prompting the Moonie farmers group to use accredited consultants for future FARMSCAPE interactions:

> 'It will be a new ball game when we deal with new people. People may have their own vested interests, it is important to know the person at the other end.' (Moonie Farmer, 2001)

Participants must be provided with sufficient opportunities to build their relationship in terms of:

- *Trust* that researchers will use data provided by farmers in appropriate ways.
- *Commitment* demonstrated by researchers to farmers felt problems and the relationship between this and their commitments to 'formal project objectives'. Another dimension to this is the researchers' orientation to a 'problem' rather than 'process'.
- Reciprocally, researchers trust that farmers will be open to new ideas, respond frankly to researchers' contributions, and contribute their local and systemic knowledge to the exchange.

A farmer's *felt problem* is referred to here as the primary issue/s facing one or more farmers within a group as stated by those farmers. Identification of farmers *felt problem* is seen as crucial by participating researchers and involves a process of active elicitation over time on the part of researchers. The concept of *felt problem* is contrasted to a process where researchers use a functionalist analysis of farmers' problems as the basis for the use of simulation and subsequent discussion.

> 'We have seen their sincerity and passion for the work they do. They convinced us.' (Birchip farmer, 2003)

An example of this exists with our engagement with the Birchip Cropping Group. A number of farmers in Birchip had raised the issue of subsoil constraints associated with high levels of salt, sodium and Boron that are endemic to the Mallee soils. CSIRO researchers were able to respond to these issues through specification of APSIM to farmers' local conditions (Hochman and Dalgliesh 2002, Hochman *et al*. 2002). *Willingness* and *ability* to respond to local issues, to farmers' felt problem, is seen as a key issue in establishing mutual understanding.

> 'The [CSIRO researchers] have been using our data to localise APSIM, looking at the yields of various crops that we grow - starting with wheat. It's a new geographic area for them and we have some particular subsoil limitations' (Birchip farmer. FARMSCAPE Insights. 2003).

Often when researchers work with farmer groups over extended periods, with numerous face-to-face interactions, participants often described the relationship in terms of 'friendship'. While both farmers and researchers indicate that a relationship with the status of 'friendship' is enjoyable, personally rewarding and desirable, there is evidence that 'friendship' is not required for a successful interaction- only that the 'trust threshold' be met.

> 'Knowing the APSRU staff had been helpful for some interviewees. However, not all had met them in person while the oceanographer from Tasmania had been unknown but still made a strong impression. Familiarity had thus been helpful but not essential. The fact that a trusted and knowledgeable local person respected the scientists and ASPIM had been important to some interviewees. This indicates that initial credibility is transferable to some degree.' (Van Beek 2003)

5.2.2 Mutual understanding can be achieved when the primary mode of interaction is via the Internet

This research demonstrates that sufficient mutual understanding can be achieved to effect changed farmer practice when the primary mode of interaction is via the Internet. For all groups the default mode of interaction was via the Internet. In general farmer response could be summarised as:

> 'Online meetings are good … as long as we see them [researchers] once or twice a year for a drink … to keep the relationship going …' (Bongeen Farmer, 1999).

> 'Felt comfortable [meeting online], especially seeing we knew them, and what they are on about; it might not be quite as easy if we went in cold, not knowing them.' (Birchip Farmer, 2001)

Each of the farmer groups we worked with had a different mix of online and face-to-face interaction. The Birchip group started with an intensive series of face-to-face meetings, which blended both formal project commitments and social activities. With both the Birchip and Moonie groups there was substantial face-to-face interaction during the period of engagement. The nature of these visits often involved: field visits by researchers to collect soil and weather data; invitations for researchers to participate in field days; or where researchers were in the region for work activity not directly related to this project.

At the other end of the spectrum the Brim group has had only limited face-to-face interaction directly with CSIRO researchers. However there has been face to face meeting of researchers with some individuals due to the close proximity of this group the Birchip Group and there is evidence that this group has been exposed to discussions with farmers from Birchip about their experiences in Internet meetings. The Walgett group had no face to face workshops but had several field visits to support their soil monitoring activities. Comparisons between the Birchip/Moonie experience and the Brim/Walgett experience are therefore somewhat tentative.

> 'The joint meeting with the guy from Tasmania was good. This technique extends the network of people farmers can contact' (Brim Farmer, 2003)

> 'It allows a group of locals access to world-class scientists' (Brim Farmer, 2003)

> 'It was brilliant, the video and phone worked really well. The Internet really brings us closer … gives people access to people in Toowoomba who won't come to us' (Brim Farmer, 2003)

These data were collected in farmer interviews with the Brim group. The nature of the data collected in these interviews is comparable to farmer's responses from Birchip and Moonie at similar stages in their engagement. Farmer response is positive in terms of their experience of interacting via the Internet.

What emerges here is that farmers whose only interaction with CSIRO researchers has been online value that engagement in terms of the positive effects of obtaining access to remote researchers, whose time they might not otherwise be able to access. Whereas farmers who have experienced face-to-face engagement tend to prefer face-to-face but are willing to accept online engagement when the alternative is either reduced access, less-timely access, or no access at all.

5.2.3 The local intermediary / facilitator's role in establishing mutual understanding

Where there is little or no face-to-face interaction the role of a trusted local intermediary becomes critically important. The most striking example of this is evidenced by interactions with the Brim and Walgett groups. In the absence of direct face-to-face interaction with researchers, the local facilitator becomes important in terms of: i) the acceptance of simulation and soil monitoring by farmer participants, and; ii) building and maintaining relationships between researchers and farmers.

> 'I hold [local farmer adviser] in high regard. He came a long way in accepting it and you have to take notice then.' (Farmer Brim Farmer group)
>
> 'We do need a facilitator (who) needs to know the persons at the other end so that they are comfortable, talk freely, cut them off if necessary, make it flow better. The facilitator also needs to know us…' (Brim Farmer, 2003)

It is evident that a local farmer facilitator who has good established relationships and a history of good performance with a local farmer group supports the establishment and maintenance of a good working relationship between farmers and researchers. This is particularly evident in our interactions with both Brim and Birchip farmer groups. Priority should be given to providing opportunities to establish mutual understanding with a local trusted intermediary.

5.2.4 Video is regarded as positive for establishing and maintaining mutual understanding

An important role of video is for the establishment and maintenance of the relationship between remote participants. While most interactions involved only *application sharing*, the addition of video is generally regarded by participants as positive in terms of the establishment and maintenance of good relationships. However video is neither a necessary nor sufficient condition of success.

> 'A telephone hook-up is ok, but is poor in relation to an Internet meeting. It is fantastic being face-to-face [using video] when asking questions, plus their live computer screen is on the wall. That presentation was excellent and the stuff was very interesting' (Brim Farmer, 2003)
>
> 'Some of the interviewees who had participated only by phone regretted the absence of visual images and had felt less closely involved. For one the combined telephone-video connections had been the only way he could have participated. That interview highlighted the growing isolation of sole-farmers whose wives are working. They increasingly have to look after the home and children as well as the farm, and are less able to attend 'distant' daytime meetings.' (Van Beek 2003)

Even though there is evidence that video does have beneficial effects for the relationship between participants, video is not required for mutual understanding. Researchers indicate that their ability to effectively facilitate, and engage with a farmer group is improved with the addition of video.

5.2.5 How does the length of participant involvement affect the success of the interaction?

Most, but not all, farmer groups we worked with during this research were involved in an initial face-to-face workshop with researchers. This workshop had the dual role of providing an overview of the possibilities in terms of use of FARMSCAPE tools, technologies and potential activities, and to provide an environment where farmers and researchers could engage socially.

> 'Social interactions are part of the value of meeting and you don't get that by Internet. (But) once you know people, video-conferencing is fine.' (Birchip Farmer, 2003)

Farmers felt that the need to meet face-to-face with researchers generally diminished over time. As farmer participants gained experience in interacting via the Internet, given there was good local facilitation, they became increasingly positive about the potential for Internet workshops. Farmers with experience with both face-to-face and online meetings indicated that their felt need for face-to-face meetings diminished over time, once good relationships have been established.

5.2.6 A social 'bet' builds mutual understanding.

The acceptance of a 'betting challenge' proved helpful in establishing trust between farmers and researchers. Researchers accepted two (unrelated) 'bets' with farmer participants who challenged the validity of the researcher's calculations involving probabilities of yield outcomes. These bets effectively demonstrated researcher commitment to the information they were providing, a small step toward 'putting their money where their mouth is' as one farmer put it. Farmer participants indicated that this positively influenced participant relations.

> 'That bet about a box of beer was… much better than any handout.' (Brim farmer 2002)

5.3 Effective Interaction

The second broad category that helps explain the success of online interactions was *effective interaction*. In this section we examine the data under the broad categories of: What is effective interaction? What is required to achieve *effective interaction* between farmers, advisers and researchers during online workshops?

> 'I participated from home and it was fantastic to be involved without having to travel. It was easy to be involved, not terrifying, and networking was very easy. I had the PowerPoint presentations right in front of me, and had every opportunity to ask questions.' (Birchip Farmer, 2003)

This section features selected transcripts taken from the segments of video viewed during the IAL's. Each transcript was selected for being 'typical' or 'illustrative' of a broad 'category' of issue- which aligns with the *effective interaction* part of the framework outlined earlier. Specifically this section discusses the following questions:

- What are some indicators of effective interaction: breakdown and repair?
- What are some dimensions of facilitating effective interactions?
- What evidence is there for development of shared representations?
- How does the variable of *fidelity* affect the interaction in terms of video, audio and application sharing?

5.3.1 What are some key indicators of effective interaction and how do online workshops breakdown?

The following interactions illustrate 'classes' of activity that reoccurred during online workshops. These 'classes' could also be described as conditions for success. These are: i) 'are you seeing what I'm seeing?'- ensuring all participants are looking at the same physical representation; ii) is there common understanding about how to interpret a representation?; iii) is there common understanding about what a representation means, and; iv) correct technical function eg. does the Internet connection remain ‘up’ during the interaction? To the degree to which any of these conditions are not met during an interaction- ‘breakdown’ can be said to occur. (Winograd & Flores 1997)

> ‘Breakdowns serve an extremely important cognitive function, revealing to us the nature of our practices and equipment, making them "present-to-hand” to us, perhaps for the first time. In this sense they function in a positive rather than a negative way.’
>
> ‘New design can be created and implemented only in this space that emerges in the recurrent structure of breakdown. A design constitutes an interpretation of breakdown and a committed attempt to anticipate future breakdowns.’ (Winograd and Flores 1997:78**)**

If any of the four criteria discussed in the following section are not met, then ‘breakdown’ is said to occur in the sense described by Winograd and Flores above. We are choosing to study instances of *breakdown* for two reasons: i) to learn about the structure of effective interactions; and ii) to learn about ways to anticipate and minimise the potential for future breakdown.

5.3.1.1 Description of an Internet workshop

The following data, including transcripts and participant observation, were extracted from the use of video analysis and field notes of an Internet workshop between CSIRO researchers and farmers from the Moonie Management Group on 19/04/00. Some initial description is provided about the ‘setting’, the transcripts are then presented as data followed by some interpretation and analysis that attempts to address the above questions. Participant farmers have been given codes (eg M2F, M4F etc) to protect their identities. Each line within the transcript is referred to as a line number surrounded by square brackets eg. [Line 1]

Key to symbols used to specify crop rotations:

W= Wheat
S= Sorghum
C= Chickpea
M= Mungbean.
_ (Single underscore) = fallow (~6 month).
__ (Double underscore) = long fallow (~12 month).

Six farmers are sitting in a small sitting room in the home of one of the farmers. They are looking at projected graphs. The graphs are being projected onto a white bed sheet suspended over a window with its curtains drawn at one end of the room. The bed sheet is both stripped and uneven, which causes the projected image to be somewhat distorted [Image 2, B1]

The voice of researcher Zvi Hochman (ZH) is heard on a speakerphone sitting on a small wooden table in the centre of the room.

Farmer participants can be seen with printed copies of the graphs ZH is presenting in booklet form resting on their laps. All have pens poised [Image 1, B1, B2, B3] and some are making notes. Farmers frequently look between their printed notes and what is being presented via the Internet.

Two farmers are sitting on a couch against a wall on the LHS of the room, with another on a chair. A further two farmers are sitting on a similar couch on the RHS of the room. A sixth farmer is sitting behind a computer projector to the left of camera.

Dean Hargreaves (DH) is present with the farmer group video recording the session and providing technical support in terms of the Internet connectivity.

A crop rotation (W_W__SC) is displayed in graph form. The graph represents the simulated contribution of each of three crops to gross margin during the period of 1976-1999. The simulation displayed was a one of a number of simulations that farmers requested prior to the day. This process included farmers presenting ZH with a list of 'crop rotations of interest'. ZH then used judgment and experience to narrow the list to a subset that could be run using APSIM in time for the next meeting.

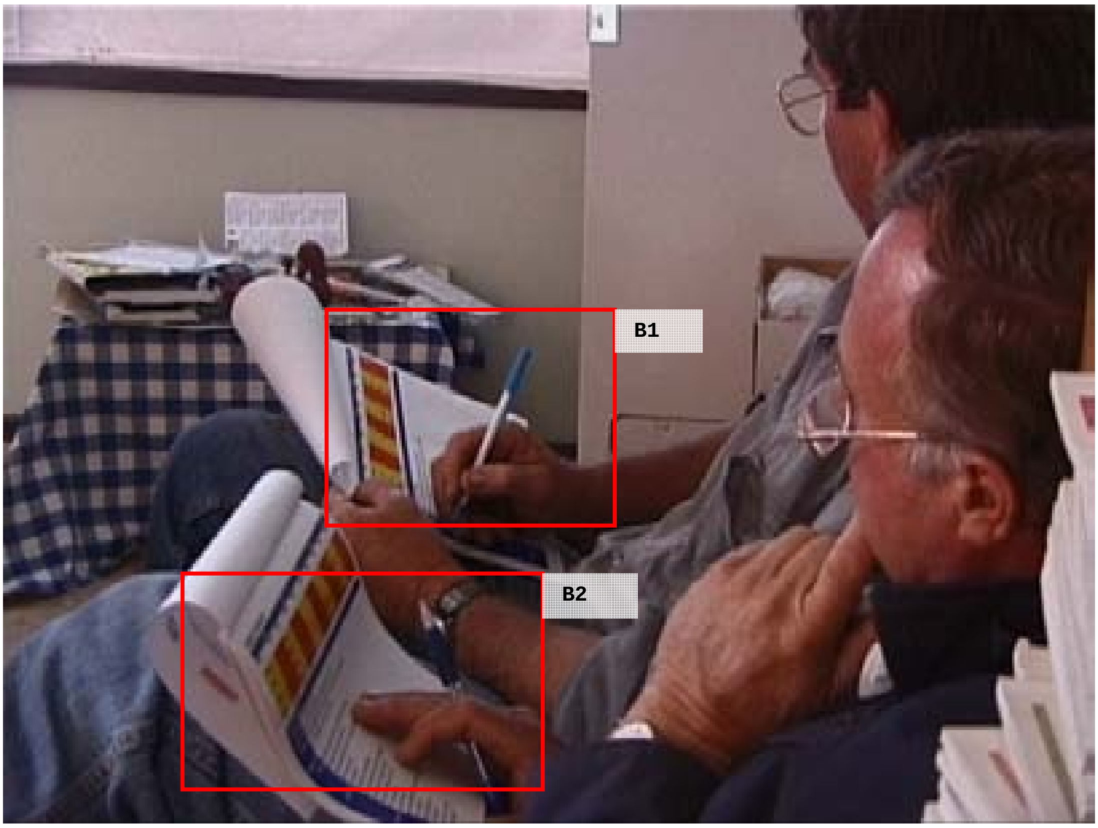


Image 1

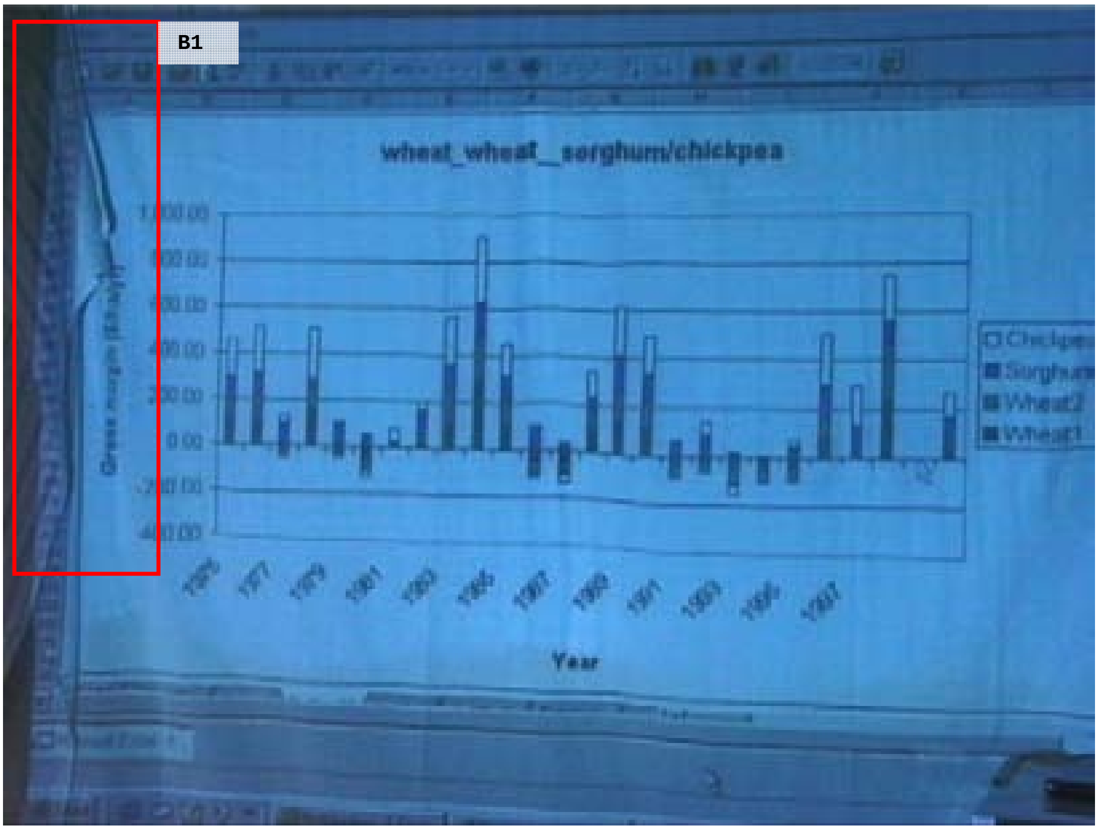


Image 2

5.3.1.2 'Are you seeing what I'm seeing?'

When the W_W__SC graph is displayed (Image 2) a clarifying interaction occurs between [M4F] and ZH

Transcript 1

Line 1 [MF4]:	"Yeah… and the cash flow one…"
Line 2 ZH:	"Sorry… that was…"
Line 3 [MF4]:	" ...oh… that is the cash flow one… yeah… gross margins… you're right…"
Line 4 ZH:	"This is the grain yield… this is a 40 year run…"
Line 5[MF4]:	"Yep" (pause) "…next…"

Farmer [MF4]'s first statement appears to be indicating to ZH to progress to the next graph- that he believes will be a graph displaying cash flows. ZH provides clarification that the current graph is in fact displaying a series of Annual Gross Margins, [M4F] interprets these as cash flow over the whole period but after ZH clarifies (or starts to clarify) [M4F] quickly realises this. ZH moves on to describe the next graph which is a 40 year run of grain yields. This is possibly not visible at the farmers' end which is why, after a slight pause [M4F] indicates to ZH to progress to the next graph.

Both farmers and scientists need to be confident that they are seeing the same representation for an interaction to be successful. The nature of 'application sharing' over slow Internet connections (ie <28 kb/s) means that there is often a measurable delay between when a researcher displays a new representation on his/her computer and when that representation is visible at the farmer end; sometimes this delay is >5sec. Using Microsoft NetMeeting's® 'application sharing' there is no way for the research facilitator to know what farmers are actually seeing without asking. At more than one point during this interaction ZH can be seen to change between graphs rapidly. This updates as expected on the researcher's screen, however, over slow Internet connections, the farmer end often receives a partial or incomplete image (see Image 3) until after a period (usually between 5-10 sec) the image settles on the researchers selected image.

Image 3

In the situation depicted by the above transcript, there is a high degree of uncertainty expressed as to which representation is being discussed. When ZH makes the statement in [line 5] the graph he is referring to is not yet visible to farmers –a graph is visible depicting gross margins for the W_W_SC rotations. In this case the researcher is actually describing a graph that is not yet displayed.

Transcript 2

Line1. ZH: "So the next one is wheat, wheat, double crop sorghum and then back to sorghum again…"

Line 2. ZH: "And you're looking at a single paddock run here…"

Line 3. [M2F]: "Not there yet Zvi…"

Line 4. [M4F]: "Are we still with you?"

Line 5. ZH: "I don't know…"

Line 6. [M4F]: "We haven't changed we're still on the last one…"

This interaction is a second example of an instance of where participants are attempting to establish 'if they are seeing the same thing'.

By implication ZH indicates in line 1 that the graph has been sent. In [line 2] ZH begins to speak about a graph, as if it is already being viewed by farmers. In [line 3] farmer [M2F] cuts ZH off mid sentence indicating that the graph has not yet been received. In [line 4] farmer [M4F] checks if the Internet connection is still active and ZH replies [line 5] that he does not know. Farmer [M4F] then looks toward researcher DH (who is operating the video camera) as he speaks [line 6] again confirming that the graph he is seeing has still not changed.

ZH could not determine (without directly asking) if what is projected at the farmer end is what appears on his screen in Toowoomba. In this example, the farmer group have no way of determining what ZH has actually sent. There is no easy way for participants at either end to determine if the Internet connection is still active. There is no functionality within Microsoft NetMeeting® to indicate if the Internet connection is still active, or if the data have been displayed at the receiving end. If the Internet connection is dropped it often takes several minutes for Microsoft Windows® on the farmer PC to indicate this.

Learning / Repair: To provide confidence and increase efficiency in establishing that all participants are viewing the same graph, we recommend that each graph be labelled with a large sequential number in the same location on each page. Often when there is breakdown participants attempt to describe the graph by a combination of title, content and axis. This is often time consuming and potentially confusing, given that these are often very similar for several graphs within a session. When the researcher changes the graph they should as a matter of course read the sequential number and ask for specific confirmation from farmer participants. This provides increased confidence that all participants are seeing the same representation.

5.3.1.3 Is there common understanding about how to interpret a representation?
For the interaction to be considered successful all parties need to interpret the representations correctly. This includes correctly understanding the graph title, 'x' and 'y' axes and the 'graph type'. During an online workshop often more than 5 types of representations are used.

Transcript 3- from Moonie online workshop on 16/10/00

Line 1 ZH: "The opportunity cropping hasn't really changed your gross margin… it's reduced the contribution of sorghum because there are less sorghum crops… um… and it's increased the contribution of wheat… more than anything else…"

Line 2 M2F: "It's slightly less variable though Zvi…"

Line 3 ZH: "Um…. yes it looks like the one on the right is slightly less variable and it actually misses out more on the upside than it gains on the downside…"

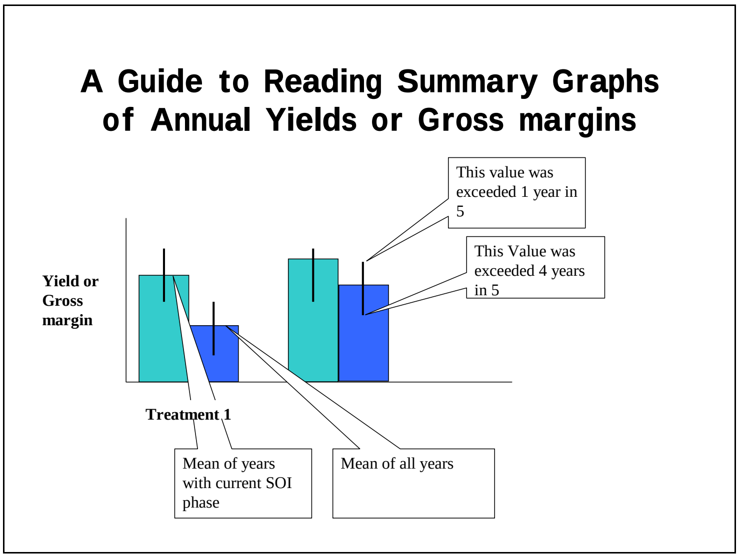
Line 4 ZH then proceeds to describe the role of the 'error bars' on the graphs…

This transcript was taken from an Internet workshop held on 16/10/00. This is a discussion about comparative gross margin distributions for seven rotations (Image 4). In [line 1] ZH makes a statement comparing mean gross margins of two rotations that are the same except that in one an 'opportunity cropping' rule was applied - that is some crops in the rotation will only be planted subject to the environmental conditions at the time, as opposed to always planting every crop according to a pre-planned sequence within a rotation.

Image 4

The graph that is displayed to represent this is a standard histogram with vertical lines ('error bars') in the centre of each bar in the histogram (Image 4, right hand side). The top of each vertical line represents the 80% percentile of the distribution of annual results, while the bottom represents the 20% percentile. In [line 2] farmer [M4F] provides an interpretation about the relative variability of the two rotations being discussed. This is a clear indicator that farmer M4F has correctly interpreted the role of the 'error bars' in this representation. In [line 3] ZH then goes on to elaborate this by pointing out that the greater variability is due to the tendency of the distribution to be skewed towards the upside rather than the downside risk (*i.e.* in this case greater variability does not imply greater downside risk). This all occurs before ZH provides a more complete explanation of the representation in [Line 4].

Learning / repair: To minimise possibilities for misinterpretation the research facilitator should provide explanations of representations ahead of their presentation. In subsequent presentations with other groups the figure below was used as a guide to interpreting this type of histogram:



5.3.1.4 Is there common understanding about what a representation means?

Transcript 3 provides an example of where the correct meaning has been derived from a correct interpretation. In [line 2] farmer [M2F] demonstrates correct interpretation of the role of error bars (spread of bars as an indicator of risk) within the graph (Image 4, right hand side). However, the subtleties of implication of the positioning of the error bars and downsize risk require further discussion. This demonstrates that common interpretation of scientific constructs can continue to evolve in the context of an engagement between scientists and farmers.

Learning / repair:
The risk here is that if the research facilitator moves to the next graph before establishing understanding by farmers, farmers will either remain silent about their own interpretation of meaning or attempt to establish meaning amongst themselves in hushed tones (so as the research facilitator can not hear) while the researcher progresses through the content of the presentation. The repair we have mostly trialled to date is for the researcher to initially elaborate meaning and then ask specifically for farmer comment and for some confirmation that the farmers are deriving correct meaning from the representation. Alternatively the researcher can ask farmers themselves to describe what the representation means to them and, after considering the reply, follow up with further elaboration where it is needed.

5.3.1.5 Correct technical function
Online workshops conducted with the Moonie group including and prior to that depicted in Transcript 2 often featured 'drop outs' of the Internet connection. A 'drop out' is defined as a situation where the network connection between the farmer PC and the farmer's Internet Service Provider (ISP) is lost. This often occurs due to the poor telecommunications infrastructure in rural areas, or as a result of modems designed for use in urban areas. When a 'drop out' occurs there is no way for either farmers or researchers to ascertain this, without some form of active monitoring. Transcript 2 provides a clear example of a type of activity where this occurs. Within Transcript 2 there is no way for either the research facilitator or the farmer to easily determine if the Internet connection is still active.

Learning / repair: The research technical support person needs to *actively test remote connections*. Sending a 'ping' is a simple and effective means of establishing if an Internet connection to a farmer's PC has 'dropped out' or is active. Software applications that allow 'pinging' to multiple remote sites are commonly available and inexpensive. We used 'BITcom Xnet' software, a freely available shareware application. This had the observable effect of greatly reducing the often-disruptive discussion between participants to attempt to establish if the Internet connection was still active. Research support staff can ascertain immediately when a participant 'dropped out' and bring them back into the meeting without substantial disruption.

5.3.2 How does the fidelity of video, audio and application sharing effect the interaction?
A minimum threshold for application sharing and audio fidelity must be met. Video enhances the interaction, however is not required for interactions to be regarded by participants as successful. Low quality video is if often regarded as an enhancement to a situation where there is no video.

5.3.2.1 Application sharing fidelity
The primary variable in terms of the quality of application sharing *is integrity* of display. [Image 3] displays a situation where the display integrity is low due to limited bandwidth. This situation often occurs when the research facilitator rapidly changes representations on his/her screen. This is particularly obvious if the researcher uses 'scroll' rather than 'page up, page down' for window navigation. Using 'scroll' Microsoft NetMeeting® attempts to send each change on the researcher display to the farmer's display. With low bandwidth connections the result is often a patchwork of unintelligible graphs. However, NetMeeting® software is sufficiently robust that even in less than ideal situations like these, the integrity of the original image is maintained. In these circumstances the complete image may take some time (ie <15 secs) to stabilise.

Another dimension of integrity is the nature of the farmer display. Two types of display were used during this research: a computer monitor, as depicted in [Image 4] and projected display as depicted in [Image 3]. The display depicted in [Image 2, B1 and Image 3, B1] show that the graphs at the farmer's site are being projected on a stripped bed sheet attached to a wall. These images show some distortion to the projected image, particularly on the left hand side, due to the way the bed sheet was hung. Although this is obviously less than ideal, farmers can generally 'repair' the situation sufficiently to extract meaning.

Learning / repair: The pre-workshop distribution of printed copies of graphs was a useful strategy to mitigate risks of irrevocable failure of the Internet connection. This was initially suggested by farmer participants, and is now a frequently practiced process. Farmers saw other benefits in having printed copies of materials beforehand. It allowed them to prepare questions, takes notes during the session directly on the graphs and to begin interpretation and situation of the results for their own farm.

5.3.2.2 Audio fidelity

Good quality audio is essential for successful interaction. It is currently not feasible, even over fast modem connections (ie 56Kb/s) to use the Internet for application sharing, video and audio simultaneously. To achieve good quality on all three of these we use a conference telephone call to connect participants. This does mean that host farmers are required to have two telephone lines. This is rarely a problem as most farmers have a second line for their fax machines.

We tested a number of telephones including a Polycom SoundStation® ($1500) 'professional' conference phone and a low cost Panasonic 'home' speaker-phone ($150). When a group consisted of <10 participants, our evaluation revealed that audio quality was generally regarded as sufficient when using low cost 'home' speaker phones (like the Panasonic unit we tested). However these standard 'home' units were not always ideal. If the room configuration did not permit all participants to sit within a five (5) meter radius of the phone, the ability of participants to hear and speak effectively was reduced significantly. Moreover, quality does not seem to be uniform in all directions. The more expensive 'professional' models provided noticeable improvements. Audio quality remains a challenge to low cost communication with groups of 10 or more participants.

5.3.2.3 Video fidelity

Many participants regard the addition of video positively. Video serves two parallel functions, by supporting establishment and maintenance of relationships between participants (discussed earlier) and by improving the researchers ability to effectively facilitate.

> 'Some of the interviewees who had participated only by phone [plus data sharing] regretted the absence of visual images and had felt less closely involved.' (Van Beek 2003.)

When video was used over *low speed* modem connections, often researchers would use video for a short period at the beginning of the workshop and again at the end. This was seen as analogous to a 'hello/goodbye handshake'.

When a good Internet connection existed (ie consistently >48K) the researcher would 'start and stop' the video throughout the presentation. Typically this would involve use of video during discussion, after each major section of the workshop, and again at the end. The researcher could control the cameras at both the researcher and farmer endpoints by turning them on or off. The quality of video was typically low, although clear enough for the research facilitator to correctly determine the identity of the farmer participants. We would often have the farmer facilitator to actively point the web cam at farmers that were speaking. Researchers reported that this provided a significant enhancement to their ability to effectively facilitate.

5.3.3 What are some important dimensions of facilitating online interactions?

An important feature of the interactions with the Birchip group compared with our earlier experiences with the Moonie group was the role played by a professional facilitator at the farmer end. A second key factor is the implementation of simple but robust procedures for facilitation.

> 'The social process worked well. There were more than 10 in the room and [the local adviser]… facilitated. He understood the process and the data and helped to interpret data. That was critically important to have someone in-between farmers and scientists.' (Birchip Farmer, 2003)

> '[The researcher and local adviser] … are both qualified people who know the issues, and you need them at both ends to keep it on track, make sure that researchers or farmers do not hijack the communication.' (Birchip Farmer, 2003)

> '[The local adviser] … brings it down to a paddock level. He knows us and can understand the direction of our questions. He can read the mood of our meeting and say, "Come on, hurry up!"' (Birchip Farmer, 2003)

There is variation among researchers in terms of their natural inclination, and ability to facilitate. However, by adopting good meeting procedures and with the help of a facilitator at the farmer node, the potential for an effective interaction is maximised. The above quotes illustrate the importance farmers place on their local facilitator to mediate the interaction between themselves and researchers.

Another finding was that generally, a greater proportion of the total workshop time is used for discussion about 'process', at the expense of discussion about 'content', when the interaction is undertaken via the Internet. The proportion of discussion about 'process' issues was observed to decrease over time as: participants became increasingly technically competent; as technical problems were progressively resolved, and; as participants learnt how to deal with situations where the technology failed.

5.3.3.1 Consequences of technology limitations

A researcher described their experience of attempting to facilitate a workshop without video as 'Like trying to facilitate a group with your eyes closed.' A workshop without video reduces the researcher's ability to: effectively judge participant reaction to content; to judge participation temporally at different points during an interaction, and observe participant farmers' body language responses and intra-group dynamics during interactions. Even low quality video enhances researchers' ability to judge a group's reaction.

Similarly some farmers found meetings frustrating:

> 'It came through all right, but it is an intermediate set-up, we could not see who was asking, or when. You don't get the feel when there is no visual human interaction.' (Birchip Farmer, 2003)

The nature of facilitation was essentially constrained by the available technology. However, even though the technology is primarily seen as a constraint, both interested observers and researchers noted the potential positive influence on farmer participation of having researchers located off-site. This was characterised as reducing the potential 'power and influence' by researchers on farmer group process. This is corroborated by video data that farmers appear more inclined to 'talk amongst themselves' about content when researchers were not present on-site.

During a particular point-to-point online interaction, farmers at Moonie are seen discussing costs associated with planting dryland cotton for input into a spreadsheet by a researcher in Toowoomba. The farmers can be seen actively discussing and calculating costs in lowered voices as to not be heard readily by the researcher over the phone. The following extract from video data illustrates the way the participants struggle with facilitation online.

Transcript 4

Line 1 ZH: "… cost without fertilizer at $750… is that…??"

Line 2 Farmers can be seen discussing alternative costs among themselves in lowered voices so as not to be easily heard by the researcher over the telephone link to Toowoomba. There is some 'back and forth' discussion between farmers in attempting to negotiate and agree on costs.

Line 3 ZH: "It's gone quiet on that one..."

Line 4 M4F: "Yes… we're doing some calculations…"

In [line 1] the researcher states the value that he has entered in the spreadsheet as costs for cotton which takes the form of an implied question for farmers to comment. During [line 2] farmers are seen discussing a range of potential figures amongst themselves. They deliberately speak in hushed tones so as not to be heard by the research facilitator. In [line 3] the research facilitator indicates that the farmers are not responding and he attempts to stimulate a response. This query by the researcher may serve to: check that the phone call hasn't dropped out or to establish if the farmers correctly heard and/or comprehended his last statement. In [line 4] the farmer M4F realises this and makes explicit what is happening at their end.

5.3.3.2 A protocol for facilitation of online workshops:

From the accumulated experience of conducting more than 15 online workshops a facilitation protocol can be distilled. Following the guidelines outlined below should reduce the risk of 'fatal' facilitation breakdown and help reduce the disruption associated with discussions about 'process', as opposed to 'content'.

i) *Research facilitator should liaise with farmer facilitator* prior to workshop. It is essential for both facilitators to have opportunities to develop common understandings of the purpose, intent and content of the workshop. This involves the joint discussion of a possible agenda and who is likely to attend; while providing an opportunity for the research facilitator to 'get a feel' for farmers' current issues.

ii) *Introduce participants*. This provides an opportunity for participants at each site to introduce themselves. Facilitators take note of participant's names; which then provides an opportunity for the researcher and/or farmer facilitator to address individuals specifically during the meeting. This is particularly helpful in relation to content that the researcher knows, from previous engagements and from step (i), might be specifically relevant to a particular farmer. This is a strategy used effectively by researchers to engage farmers in active dialogue.

iii) *Develop and negotiate an agenda.* Based on the setup discussions the research facilitator presents a draft agenda via 'application sharing' at the beginning of the meeting. This provides a basis for the joint negotiation of the actual agenda among participants.

iv) *Researcher to specifically and frequently request feedback.* In response to graphs displayed the researcher addresses individual farmers directly, with specific questions based on researchers' background knowledge of participant circumstance and experience.

v) *Research facilitator to refer to the agenda at regular intervals*. This provides an opportunity for renegotiation of the agenda in light of progress within the discussions and given remaining time.

vi) *Farmer facilitator actively monitors progress and mood of the audience and communicates this to the research facilitator*. A farmer facilitator who is actively soliciting questions from farmers and providing feedback to researchers can improve the effectiveness of a workshop. A proactive and highly skilled farmer facilitator reduces the demand on the researcher's facilitation capability. A good farmer facilitator that can effectively manage researcher input in relation to the group's broader agenda is highly desirable in terms of good group function.

vii) *Have strategies in place to effectively deal with technology breakdown.* Pre-prepared strategies to deal with technology breakdown reduce discussions about 'procedure' and reduce the interruption to effective process. Typically such a procedure involves the research facilitator briefly making the group aware of the technical issue, before proceeding using printed materials. Technical support staff at each site can communicate by using mobile phones to reduce the need for other participants to be involved in these technical and procedural discussions.

5.4 Implications for an interactive online method for consultants

One of the expressed objectives of the project was to develop a method for consultants to provide farmers with customised soil monitoring and simulation support for timely planning and decision making. In this section we consider the lessons relevant to that objective.

> 'I believe that in discussions about future delivery, there is a need to distinguish between educating people (such as changing concepts about soils and sub-soil moisture), one-off services (such as characterising a paddock), and consulting services (such as running what-if sessions for individual farms or paddocks). Optimal delivery of these 'products' involves different combinations of methodology, e.g. education involves groups.' (Van Beek 2002)

An essential condition for online sessions to be successful is the situation of simulation in terms of the farmer's own paddocks, experience, and practice. Simulation is situated in the physical reality of the farm by using soil and weather data collected from those farmers' paddocks. It is also situated in the managerial reality of a farm through configuring of the simulation to reflect actual management alternatives available to individual farmers making important decisions about their farming operation.

> 'Interviewees in all groups were aware of the need for APSIM to be fine-tuned or calibrated for the region or even sub-regions (e.g. the poorer soils with higher rainfall in the Southern part). Many stated the need for accurate soil data. Some saw variability of soil types within paddocks as a major obstacle hence "The difficulty now is mapping the soil types." The adjustments for rooting depth and the resulting increased accuracy of APSIM were often mentioned.' (Van Beek 2003)

There was also considerable evidence that farmers' willingness to pay for such a service required them to be convinced of the validity and accuracy of the simulations:

> 'Many interviewees remarked on APSIM's accuracy during the last season (unwelcome as that had been) but most qualified this by saying that it had been an abnormal year. Achieving accuracy in normal years will be important to nearly all interviewees for developing trust in APSIM – accuracy meaning APSIM's predictions matching up with realised yields. Wanting to test APSIM before trusting it is something interviewees have in common with all interviewees since 1995. I expect a rapid uptake of APSIM once people trust it and other conditions are met.' (Van Beek 2003)

Given that APSIM can be locally contextualised and validated, the data gathered appears to support the prospects for online consultancy on a fee for service basis.

> ‘Many interviewees expected that eventually any delivery of FARMSCAPE and APSIM would have to become a fee for service. The preferred ways varied from having “instant access, a format you can read plus access to talk to a competent person” to being satisfied with delivery through “Yield Prophet; it is the most economic (way) and gives access from a distance to Zvi and Peter”. Some mentioned delivery over the Internet; others said that demonstrations had also been good, and on-going group discussions were important to others. A valid comment to this question was that “It is hard to know until you know how easy it is to deliver”.’ (Van Beek 2002)

The strongest evidence for the feasibility of employing online meting technology in commercial consulting practice is in the action of two consultants who are already adopting the technology.

> ‘The BCG (Birchip Cropping Group) intends to invest more money in the Internet technology for their office and in mobile equipment to take to other locations. The main advantage mentioned was that this technology gives access to “world-class scientists who otherwise would not be available to groups such as BCG”. There is of course the corollary; it gives distant scientists access to leading groups of farmers such as BCG.’ (Van Beek 2003)

6. Conclusions

During the course of this research we have had more than 35 interactions with 8 farmer groups, directly involving 160 farmers from 4 states: Western Australia, New South Wales, Victoria and Queensland. An additional 20 stakeholders participated in an interested observers program. Some 500 farmers received information derived from the project via the Birchip Cropping Groups regular 'Yield Prophet' fax. A further 6000 stakeholders received information derived from activities within these workshops as part of the quarterly Birchip Cropping Group's (BCG) annual production manual, the 'FARMSCAPE Insights' newsletter and the FARMSCAPE website.

Replacing face to face FARMSCAPE workshops with Internet enabled Online FARMSCAPE workshops proved to be cost effective and time efficient while delivering the same measurable impact on farmers' learning and management practice.

The reasons for success of online workshops were investigated and found to be dependent on certain conditions being met. There must be opportunities provided to build sufficient *mutual understanding* between farmers, advisers and researchers. Some important components of *mutual understanding* are mutual respect (both for farmers' expert farming knowledge, and for scientific expertise), and sufficient appreciation by researchers for farmers felt problems.

There must also be *effective interaction* between participants. Some dimensions of *effective interaction* are: good local and remote facilitation; common understandings about interpretation and meaning of representations and reliable technical function.

6.1 Impact of FARMSCAPE Online on Farmers' learning and management

External evaluation provided a great deal of evidence that FARMSCAPE Online had significant impacts on farmer practice. Most frequently farmer participants themselves attribute changes in their knowledge of their farming system, their yield expectations, their rules for management action, and actual management to participation in simulation aided online workshops.

i) Understanding system function – soils, root depth, and crop physiology
There was ample evidence that farmers changed the way they think about their soils. Many farmers have adopted the scientists' concept of 'plant available water capacity', which they expressed by using terms such as 'bucket', 'lower limit' and 'upper limit' and by talking about subsoil moisture and where the water is in the profile. Farmers also learned about the rooting depths of their crops and that different crops have different capacity to extract moisture from a soil.

ii) Learning about crop selection.
Evidence for changed farmer intentions in relation to tactical crop choice was expressed in terms of thinking about growing crops they have not tried previously, matching crops to soils, or being more responsive to seasonal indicators when making a decision about which crop to grow.

iii) Learning about crop rotations
Farmers learned from simulations about the relative performance of different crop rotations. Others saw value in using the simulator to look at the value of fallows and to re-consider the balance between cropping and grazing.

iv) Learning about fertiliser application
Exposure to "what if" simulations about crop yield responses to rates of N with different starting conditions over a range of seasonal conditions has had a strong impact on farmers' thinking about application of nitrogenous fertilisers.

v) Changed production expectations

Farmers' response to benchmarking crops against the potential calculated by APSIM was often rejected initially, but as the simulator gained credibility farmers upgraded their yield expectations.

vi) Putting it all together
There was ample evidence that farmers were combining the individual insights listed above to derive a more systematic understanding of the functioning of their biophysical system and that this impacted on their thinking about their management system.

vii) New rules of thumb
For new knowledge to impact on management it must first be translated into rules for action. Such rules are commonly described as 'rules of thumb'. Data presented showed that farmers were learning rules for moving away from basing yield expectations, crop choice and fertiliser application on average conditions to being responsive to soil and weather conditions in making these decisions.

viii) Innovative changes to farming practice
Given the relative brief period of engagement with the farmers there was significant evidence of changed management that farmers attributed to these interactions. Reported changes in farm practices were in response to researchers' predictions of a poor season in northern Victoria for 2002, to predicted responses to fertiliser, and to comparative crop performances given pre-season conditions and price variables.

ix) New management tool
A new product, the 'Yield Prophet' was developed by the BCG through its interaction with this project. Farmers' subscription (on a fee for service basis) to the individual 'Yield Prophet' clearly demonstrates that even after a single season's exposure to this predictive tool they place real value on its potential to improve their production risk management.

6.2 Mutual understanding

Given the success of our Internet enabled interactions with farmer groups it was important to capture the lessons learned from our experience and to attempt to generalise this experience where appropriate. In this section we summarise our findings about the need for opportunities to be provided for building sufficient *mutual understanding* between farmers, advisers and researchers. Some important components of *mutual understanding* are mutual respect, and sufficient appreciation by researchers for farmers' felt problems:

i) A minimum trust threshold must be met. Farmers need to trust that the researchers will use the personal data (ie soil, economics) they provide in appropriate ways. Researchers need to demonstrate commitment to farmers' 'felt problem' and demonstrate a *problem* focus, rather than a *process* focus. Researchers also must trust that farmers will be open to new ideas, respond frankly to researchers' contributions, and contribute their local and systemic knowledge to the exchange.

While meeting online may not be as personally satisfying for participants as face-to-face meetings, the evidence from evaluation indicates when the primary mode of interaction is via the Internet, sufficient trust can be established to achieve changed farmer practice. Farmers, their advisers and researchers need to be actively provided with opportunities to establish this 'trust threshold'.

ii) Mutual understanding can be achieved when the primary mode of interaction is via the Internet. Sufficient mutual understanding can be achieved to impact farmer practice when the primary mode of interaction is via the Internet, so long as there are occasional social get togethers. In general farmer response could be characterised as: 'Online meetings are good, as long as we see them [researchers] once or twice a year for a drink… to keep the relationship going…' (Moonie Farmer, 2000). When the primary mode of interaction is online it is important for participant researchers to plan for occasional face-to-face meetings with farmer participants.

iii) The local intermediary / facilitator's role in establishing mutual understanding
In the absence of direct face-to-face interaction with researchers, the local facilitator becomes important in terms of: i) building and maintaining relationships between researchers and farmers, and; ii) coordination of the farmer group in relation to their activities with researchers. A well-respected local facilitator with an appreciation of the potential of the tools of simulation and soil monitoring can also contribute to the process of farmers being more open to accepting these tools as legitimate and useful aids for learning about crop management.

iv) Video is regarded as positive for establishing and maintaining mutual understanding between remote participants.
Video also plays an important role in enhancing the researchers' ability to facilitate. Data collected through analysis of video material indicates that researchers were impaired in their ability to effectively facilitate online meetings without vision. One researcher expressed the experience this way: 'It was like trying to chair a meeting with your eyes closed …'.

6.3 Effective interaction

In addition to mutual understanding there must also be *effective interaction* between participants. Some dimensions of *effective interaction* are: good local and remote facilitation; common understandings about interpretation and meaning of representations and reliable technical function.

i) *Both farmers and scientists need to be confident that they are seeing the same representation for an interaction to be successful.*
The nature of 'application sharing' over slow Internet connections (*i.e.* <28 kb/s) means that there is often a measurable delay between when a researcher displays a new representation and when that representation is visible at the farmer end. Research facilitators must be conscious of this and take steps to ensure that all participants are viewing the same representation.

ii) All participants need to be confident that there is common understanding about the interpretation of the representations.
This includes correctly interpreting the graph in terms of the title, 'x' and 'y' axes and the 'graph type' (eg histogram, cumulative distribution function etc.). The research facilitator should read each in the same order for each new representation. The local facilitator should actively engage farmer participants in an ongoing way to establish that there is clarity about this, particularly when there are changes between representations.

iii) Common understanding should be established about what a representation means. Given that participants are looking at the same graph, and that there is a common framework for interpretation, there needs to be a process for establishing participants derived meaning. There are two possible approaches and both involve the research facilitator explicitly addressing interpretation, either through: i) an initial explanation, or ii) asking for a farmer participant to make an interpretation, followed by group discussion.

iv) Correct technical function.
It is important to minimise participant discussion about 'technical aspects' caused by technical failure. Most common technical failure relates to the Internet connection dropping out; NetMeeting failing to operate correctly (eg crashing); (particularly related to the Internet connection); phone dropout; and other problems relating to individual farmers PC set up. It is our experience that most of these issues can be effectively managed by implementing robust procedures that include contingency plans.

v*) Learning from 'breakdown' about possibilities for repair.*
If any of the previous four criteria are not sufficiently met, then 'breakdown' is said to occur. 'Breakdown' is useful in terms of learning, as it effectively reveals the otherwise hidden structure. If there is breakdown (eg a graph is not interpreted correctly, or the Internet connection is lost) there is

opportunity to start ‘repair’ procedures, and to analyse the structure of the situation to extract learning.

vi) Some important dimensions of facilitating online interactions.
Lack of high audio and video fidelity reduces the researchers’ ability to facilitate the interaction. Additional challenges posed by online interactions include difficulty in effectively judging farmer response to content and difficulty in establishing if farmers understand content. We found that researchers need to frequently request responses and elicit contributions from the farmer participants.

vii) The affects of fidelity of video, audio and application sharing on an online interaction. A minimum threshold for application sharing and audio fidelity must be met. Participant farmer sites must receive the shared screens accurately and without extended delay. Audio must be clear enough that the farmer group participants do not need to move position to either hear or be heard effectively. Low quality video if often regarded as an enhancement to a situation where there is no video.

6.4 Implications for further research

This project has demonstrated a commercially feasible methodology for using internet enabled virtual workshops to support researchers and consultants in using the FARMSCAPE approach to facilitate learning programs for farmers within their own farming situations.

The potential for commercial delivery of benefits from these technologies is demonstrated by the fact that this year a monthly ‘Yield Prophet’ is delivered on a fee for service basis to more than 30 farming families. Further work is required to ensure the sustainable delivery of the ‘Yield Prophet’ which has a potential market of thousands of dryland farmers. This requires automation of simulations and development of an appropriate user interface and an on-demand internet delivery system.

New work is also needed to discover the possibilities and opportunities that could flow to rural industries from the ever improving ICT technologies. The many possibilities opened by Internet enabled meetings between farmers, advisers and scientists should be explored further to discover their full potential. Multilateral discussions concerning multiple stakeholders in contentious natural resource management issues offer a highly relevant test bed for exploring the boundaries of new ways of appropriating this emerging technology in the service if sustainable agriculture.

7. Glossary

APSIM - Agricultural Production Systems sIMulator
APSRU - Agricultural Production Systems Research Unit
CSIRO - Commonwealth Scientific and Industrial Research Organisation
FARMSCAPE - Farmers', Advisers', Researchers', Monitoring, Simulation, Communication And, Performance Evaluation.
ISP - Internet Service Provider

8. References

1. Adler, P. & Adler, P. 1994. **Observational Techniques**. *In* The Handbook of Qualitative Research. Editied by Norman, D. & Lincoln, Y. Sage Publications, London, UK,

2. Carberry, P.S., Hochman, Z., McCown, R.L., Dalgliesh, N.P., Foale, M.A, Poulton, P.L., Hargreaves, J.G.N., Hargreaves, D.M.G., Cawthray, S., Hillcoat, N., Robertson, M.J. 2002. **The FARMSCAPE approach to decision support: Farmers', advisers', researchers' monitoring, simulation, communication, and performance evaluation.** Agricultural Systems ***74***, 141-178

3. Checkland, P. 1981. **Systems thinking, systems practice**. Wiley, Chichester, UK.

4. Checkland, P. 2000. **Soft Systems Methodology: A Thirty Year Retrospective**. Systems Research and Behavioral Science. Syst. Res. 17, S11–S58. john Wiley and Sons, UK.

5. Churchman, C.W. Schainblat, A.H. 1965. **On mutual understanding.** Management science.

6. Hochman, Z., Coutts, J., Carberry P.S. and R.L. McCown. 2000. **The FARMSCAPE experience: Simulations aid participative learning in risky farming systems in Australia.** P. 175-188. *In* Cerf, M., D. Gibbon, B. Hubert, R. Ison, J. Jiggins, M.S. Paine, J. Proost and N. Roling (eds). Cow up a Tree: Knowing and Learning for Change in Agriculture: Case Studies from Industrialised Countries. INRA Editions, Versailles Cedex, France.

7. Hochman, Z., and Dalgliesh, N.P. 2002. **Using APSIM to assess subsoil constraints on wheat in the southern Mallee.** In: The 2001-2002 Mallee & Wimmera Crop and Pasture Production Manual 2001-2002. Birchip Cropping Group. pp47-48.

8. Hochman, Z., van Rees, H., Jackman, A., and Dalgliesh, N.P. 2002. **Using the cropping system simulator APSIM to investigate the impacts of subsoil constraints on wheat production.** In Proceedings VII European Society for Agronomy Congress, 15-18 July 2002, Cordoba, Spain. pp295-296.

9. Hasan, H., and Gould, E. 2001. **Support for the sense-making activity of managers.** Decision Support Systems. 31. 71-86.

10. Hasan, H.E., Gould, E., and Hylands, P. 1998. **Information Systems and Activity Theory: Tools in Context**. Univ. Press: Woolongong.

11. Jordan, B. and Henderson, A. (1995). **Interaction Analysis: Foundations and Practice**. The Journal of the Learning Sciences. Vol 4 (http://lrs.ed.uiuc.edu/students/c-merkel/document4.HTM)

12. McCown, R.L. 2001. **Learning to bridge the gap between science based decision support and the practice of farming: Evolution in paradigms of model-based research and intervention from design to dialogue**. Australian Journal of Agricultural Research. CSIRO Publishing, Australia.

13. Stone, R.C., G.L. Hammer, and T. Marcussen. 1996. **Prediction of global rainfall probabilities using phases of the Southern Oscillation Index.** Nature 384: 252-255.

14. Van Beek, P. 2001. **An evaluation of delivering APSIM and FARMSCAPE via the Internet: the Birchip component.** SyTrec Pty Ltd, Gin Gin, Australia.

15. Van Beek, P. 2000. **An evaluation of delivering APSIM and FARMSCAPE via the Internet: the Moonie component.** SyTrec Pty Ltd, Gin Gin, Australia.

16. Van Beek, P. 2003. **An evaluation of delivering APSIM and FARMSCAPE via the Internet: the Birchip component phase 2**. SyTrec Pty Ltd, Gin Gin, Australia.

17. Van Rees, H. 2003. **More Profit less Risk.** In: BCG_WFS The southern Mallee and northern Wimmera Crop and Pasture Production Manual 2002-2003. Birchip Cropping Group. Pp77-83.

18. Veenman, M.V.J., Prins , F.J., Elshout, JJ. 2002. **Initial inductive learning in a complex computer simulated environment: the role of metacognitive skills and intellectual ability.** Computers in Human Behavior. Pergamon, UK.

19. Winograd, T. and F. Flores. 1986. **Understanding Computers and Cognition: A New Foundation for Design.** Addison-Wesley, Reading, Mass., USA.