Learning and research for sustainable agro-ecosystems by both farmers and scientists.

End of Award report

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Background

This project is based on the premise that knowledge production on rural environmental issues requires a collaborative systems approach that involves a range of stakeholders (especially farmers) and crosses disciplinary boundaries. We use the term agro-ecosystems to refer to the relationships of humans and natural resources in the production of agricultural goods and environmental services. However, the complexity and diversity of such agro-ecosystems presents challenges to researchers who are conducting research. This requires greater understanding amongst scientists and between scientists and farmers, recognising each other's strengths and weaknesses, and finding ways of working together.

This report explores how researchers can examine whole systems, how farmers learn about their systems, how researchers can carry out interdisciplinary research, and how farmers and researchers can collaborate. This interdisciplinary subject is examined by a team of social, environmental and biological researchers, examining ten cases of farmer researcher collaboration with the aim of identifying good practice in interdisciplinary research on agro ecosystems in UK agriculture.

Research into agro-ecosystems can combine research from traditional agricultural disciplines (animal science, soil science, plant pathology, agronomy, agricultural economics) with wider ecological issues, long-term environmental implications, and social and economic issues (Checkland, 1999). Furthermore, sharing the results of scientific research with farmers requires a greater understanding of how farmers learn and develop farming systems that are best suited for their land and the context of their farming enterprise.

A systems perspective to research offers many advantages (Nissani, 1997), and there have been many papers arguing in favour of integrating social and biological research (eg Berkes and Folkes, 1998). These include an improved relevance of results to beneficiaries and greater uptake of results by end users. However, such approaches also present challenges, such as finding a common language and methodological approaches; integrating the results of social and biological research; and effectively integrating the results of research carried out at different scales, so that scientific advances at the level of the genome, plant, field and ecosystem are integrated together and with greatest relevance to the farming system and wider food production system. Furthermore, a systems perspective requires research to consider the needs of all actors, including farmers, agriculture-related businesses, scientists and social scientists, and also the relationships between all actors.

There are limitations to systems approaches when compared to more ‘reductionist’ research that examines specific parts of systems independently of other variables. The strength of a ‘reductionist’ scientific method is that it relates to concepts, practices and technology that are based on tried and tested theories leading to universally applicable results, or results related to a specific set of conditions. Knowledge is generated through rigorous procedures that attempt to control variables in order to get quantitative results with a high degree of precision for statistical analysis. Robust results can be used to convince others, make confident recommendations and can also be extrapolated to different contexts. The results are tested to ensure potential general applicability but may not be ideally suited to particular agro-ecosystems.

At the same time, farmers and other land users are doing their own research to tailor their farming to their specific agro-ecosystem. This research may be carried out in a less rigorous manner, often through observing their experiences. They may not refer to this as research or experimentation, but it is an important way of learning and generating ‘anecdotal’ evidence.

Scientific research relies on the use of averages and a probabilistic outcome while farmers want to know what happens under different conditions. The diversity between and within farms means that research scientists cannot specify the work for specialised recommendation domains. Farmers develop ideas for a particular farm and not necessarily for extrapolation.

The challenge of agro-ecosystems research is to find ways of combining scientific and farmers’ own research and learning. Therefore agro-ecosystems research needs to be tackled from a wider perspective than mono-disciplinary approaches can achieve. This report draws on a framework that makes a distinction of multi-, inter- and trans-disciplinary research. While these terms have been debated extensively, for the purpose of this report the following definitions are used

Disciplinary research is research which focuses on a single disciplinary perspective .

Multidisciplinary research is research which tackles research issues from several disciplines. Each discipline reaches its own conclusion, and there is no attempt to integrate the research results by the multidisciplinary research team, rather, it is up to each reader of the disciplinary reports to link and integrate the results as they see fit.

Interdisciplinary research is research carried out between the academic disciplines, at the boundaries of existing disciplinary knowledge, and in the interstices between disciplines. The aim of interdisciplinary research is to develop new knowledge and new approaches to research and thinking based on the integration and further development of ideas from individual disciplines. Such cross-fertilisation between the disciplines can ultimately develop new disciplines (e.g. biochemistry), or new theories.

Transdisciplinary research goes beyond academic disciplines to include other, non-academic groups, such as farmers, other businesses, government and policy makers, and the public. In this way, it is participatory, although the participation can be with producers of research, consumers of research, or both. It can also focus on the links between research, decision makers, and the development of policy from research outcomes.

It is fair to say that many projects may combine elements of these three distinctions. Research, such as this RELU project, may be both interdisciplinary and transdisciplinary, if it involves a range of stakeholders and disciplines who seek to work in an integrated manner. Multidisciplinary research may become more interdisciplinary if the research group chooses to work more closely together and exchange ideas and insights.

The question of language is also relevant to interdisciplinary research. Disciplines use terms in particular ways, and have created languages in which to discuss their findings. An initial challenge to interdisciplinary research can be to find a common language in which to discuss research issues, and how they might be approached. The challenge at the beginning of any research process is to develop a common conceptual framework that all “types of scientists” can live with and agree to.

The process of reviewing, funding, and evaluating research poses a minefield of problems for interdisciplinary and transdisciplinary research. Are more applied research aims as widely respected as pure research? It is widely believed that interdisciplinary journals are not valued as highly as specialist journals, so what about publication and dissemination of results? What about the career progression of individuals who take the intellectual challenge to engage with other disciplines, but may find they are penalised in terms of promotion within their own original discipline? The Research Assessment Exercise and current publishing systems are seen as stifling creativity and innovation in cross-boundary research and discussion because the greatest weighting is given to single authored papers in "blue chip" journals and everything else is given a lower rating

Objectives

The key research objectives identified for this study are:

How do research scientists carry out whole farm agro-ecosystems research?

- What research methods are most suitable for research on agro-ecosystems?
- How can scientific data from different scales (e.g. test-tube, plot, ecological surveys) be brought together to identify more general trends at the system level?

How do organic farmers innovate, learn and develop farming systems that are best suited for their land and the context of their farming enterprise?

- How do farmers balance the multiple functions and objectives of their farming enterprise (food production, ecological services, profit generation etc)?
- What are the forms of experiential learning, farmers' own research and adaptation to local agro-ecosystems?

How do researchers collaborate in interdisciplinary teams?

- How can social science be integrated with other scientific disciplines for the development of sustainable agro-ecological systems?
- How have projects managed to overcome separate disciplinary traditions of information gathering, research methodologies and language in order to work together to achieve results?

How can farmers and researchers collaborate ?

- How can agricultural scientists implement statistically rigorous methodologies within the diversity and complexity of on-farm farmer participatory research?
- What factors constrain collaboration between farmers and researchers, and conversely what factors are considered important in successful cases of collaboration?

Methods

Literature review

A review of the literature provided the material for a conceptual framework to be examined and tested through the project, and the development of an interview checklist. The review examined literature from agricultural research methodologies, small business strategic management and innovation, and the sociology of science.

Selection of case studies

In total 10 cases of farming enterprises working with scientists were examined. These were selected purposely from existing and completed research projects, and ensured that there are a range of different approaches to interaction and different degrees of collaboration/ participation. The interactions involved DEFRA funded research, research funded by research councils and private sector research. Within in each case study, semi-structured interviews took place with a minimum of four individuals having differing roles, including farmers, advisors and researchers. The case studies are:

1. Home Farm Organic Farming Study – comparing organic and non organic systems
2. WildCRU-Chichester Coastal Plain Sustainable Farming Partnership – examining agri-environmental measures using water voles as indicator species
3. Sustainable Arable Farming For an Improved Environment – SAFFIE – developing approaches to enhance biodiversity on farms
4. Evaluation of the pilot Entry Level Agri-environment Scheme– commissioned by DEFRA to understand farmers' experiences of using the scheme
5. Nickersons plant breeders, Brown and Co (farm consultants) and The Buster Club – using a group of farmers to give feedback and ideas for the development of new crops, especially those requiring less inputs
6. Integrated control of orange wheat blossom midge: examining how variety choice, use of pheromone traps and treatment thresholds can reduce this pest and reduce pesticide use
7. Birdseye Unilever Sustainable Farming Partnership – developing new agri-environmental approaches
8. Nitrates - Improving N use and performance of arable crops on organic arable farms - using an expert group approach to create models that were tested on farmers systems
9. Animal Welfare **–** developing qualitative assessment of behaviour as a method for the integration of welfare measurements.
10. Biosecurity – examining the constraints to uptake of adequate biosecurity on UK cattle and sheep farms

Data collection

Data was gathered using semi structured interviews and observations. The topic guide for the interviews was used to collect background information on the individual being interviewed and their organisation. Detailed probing was used to explore how they are going about their research and learning, their interaction with other stakeholders, and external factors that have shaped this. Particular attention was given to exploring what happened at 'critical incidents' such as meetings to discuss the research objectives or results. Observations of people's reactions to questions are also important in terms of documenting information that might be tacit knowledge or gut reactions to particular issues (Ambrosini and Bowman, 2001). Interviews were carried out by natural, biological and social scientists, with training provided to those who have not had experience of interviewing before.

Data analysis

The comparison of differences between cases studies of the same type and between different types of groups allowed conclusions to be drawn (Yin 2003). While there is potential bias from the small sample and the role of the interviewers/data analysers, validity and accuracy was based on ensuring a range of techniques were used (interviewing, observations, informal discussions), combined with a sampling of cases allowing cross case comparison and the cross checking of issues from multiple sources the ('triangulation').

Results

Agro-ecosystems research approaches

This project specifically chose case studies demonstrating a range of the elements for agro-ecological research, with a particular emphasis on involving a range of stakeholders and being interdisciplinary.

The scale of the research projects varied, from research at a laboratory or plot level to that at regional or national level. In some cases, detailed research at laboratory or plot level was scaled up to field testing (e.g. testing wheat varieties and pheromone traps). On the other hand, one project started with its focus at the field level, and expected to scale down to focus in more detail if problems identified at the field level needed further consideration. Research involving biodiversity required a wider, landscape scale based on the size and range of the species being identified.

How farmers innovate, learn and develop farming systems

Farmer learning and research was found to be carried out through reflection of their own activities, networking with other farmers and through discussions with advisors who can make comparisons to other farms. Farmers were found to be involved predominantly in incremental changes such as trying new varieties or equipment and often ‘experiments’ occurred unintentionally, such as following mistakes.

Our findings suggest that farmers manage their farms by adopting complex ‘system level’ or holistic thinking to link important agronomic, economic and social decisions (yield, labour requirements, input requirements, market opportunities, visual appearance, taste, relationship to other livelihood options and ecological services). Measuring, observing and evaluating the results may not be done as rigorously as conventional scientific research. Farmers may have a different concept of 'check' to the researchers with validation coming from inter as well as intra-farm replication. In this farmer networking is an important part of their learning processes, as are the roles of advisors who can compare treatments on different farms.

Farmer research was also found to be carried out subconsciously and form part of the farmers' tacit knowledge. Tacit knowledge is hard to define as it is based on the premise that “we can know more than we can tell” (Polanyi,1966: 4) and it is difficult to write down or formalise. Ambrosini and Bowman, (2001) refer to it as mental models that individuals can follow in certain situations. Nonaka (1991:98) compares it to the skills referred to as a ‘know how’, “deeply rooted in a action and in an individual’s commitment to a specific context – a craft or a profession, a particular technology or product market, or the activities of a work group or team”. Collecting data was particularly hard but it is observable from pauses in interviewee responses and from the time taken to reflect on questions by the interviewee, as well as some specific responses.

Collaboration and interdisciplinary teams

Interdisciplinary and participatory research, by their very nature, bring together people from varying backgrounds, disciplines, skills and perspectives. Most case studies involved researchers from at least two institutions. The study showed that the goals of researchers often differed. Commercial technology company scientists will want to have ideas that can be converted into profitable businesses for customers. Pressure group scientists want to disseminate research rapidly via membership newsletters or popular press. More academic researchers may want results to be more rigorously statistically tested so that they can be disseminated through publication in peer-refereed journals – a process which takes many years. There are also contract researchers who have specific funding pressures and tight deadlines in which to complete particular projects.

Balancing the needs from different disciplines was also an issue and in particular the use of qualitative social data was felt to be more of a concern by natural scientists than the use of quantitative social data.

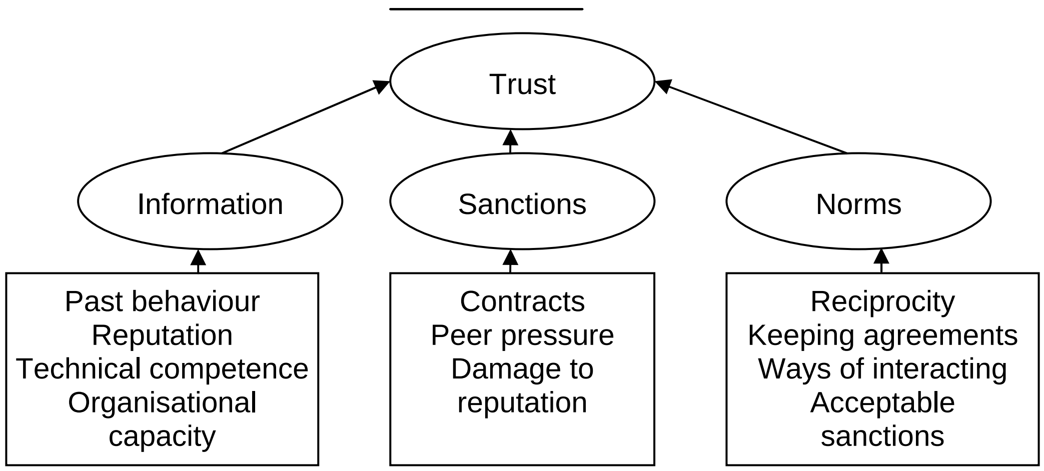
Table 1 The use of natural and social science in the case studies

Project	**Description**	**Use of natural science**	**Use of social science**
1. Home Farm Organic Study	Impact of organic farming	Biodiversity surveys	Economic analysis of organic agriculture
2. WildCRU on Chichester plain	Restoring water voles & other species	Biodiversity surveys	Collect qualitative information on farmers' opinions
3. Saffie	Agri-environmental measures	Biodiversity surveys	Economic assessments to be carried out by ADAS farm advisors
4. Entry level Scheme	Evaluation of the entry level scheme pilot	Environmental indicators	Questionnaire on farmer perceptions with some 'open questions'
5. Nickersons/ Brown & Co and the Buster Club	Wheat breeding	Agronomic data	Informal collection of qualitative data on what farmers want from varieties through talking to farmers
6. Orange Blossom Midge	Identifying resistance & developing traps	Agronomic data Pheramone performance Genetic data	Information on the perceptions of farmers collected through a questionnaire sent with traps and informally
7. Unilever	Crop and agri-environmental trials for sustainability	Biodiversity surveys Agronomic data	Limited information on the perceptions of farmers collected informally and through farmer forum groups
8. Nitrates	N Management in Organic farming	Nutrition status of farms	Perceptions of farmers on their farming systems collected through questionnaires and open group discussions
9. Pig welfare	Developing pig welfare assessment	Descriptors of pig welfare	Questionnaires and less formal consultation with farmers
10. Biosecurity	Constraints & incentives to biosecurity uptake	Research questions shaped by epidemiology	Predominantly focus groups, structured and analysed using qualitative data software by a veterinary science and anthropologist together. Questionnaire survey as well.

In each of the cases, issues of co-operation were based on interpersonal trust. Trust was found to be shaped by issues of information on others, sanctions and common norms as shown in the diagram below. The information on others comes from existing relationships, from intermediaries, or is built up through working together.

Trust based relationships appeared to be instinctive at times with people habitually trusting others as they have sanctions over them (and information on their reputation) that might not be drawn on consciously. This was evident from the hesitation in replies to questions and the difficulty in explaining the nature of trust relations. From this we can conclude that trust does not necessarily have to be a pure calculation but also includes elements of habits and routines.

Figure 1. Trust production



Scientist involvement with farmers in interdisciplinary agro-ecosystems research
The types of farmer involvement in different projects is shown in table 2.

Table 2 Types of farmer and other land user involvement in each case study project

Project	**Description**	**Types of land user involvement**
1. Home Farm Organic Study	Impact of organic farming	Farm owner initiated study, farm manger allowed researchers to examine his practices
2. WildCRU on Chichester plain	Restoring water voles & other species	Farmers allowed monitoring and tried new treatments. Managers of nature reserves and farm advisor involved in design and data collection
3. Saffie	Agri-environmental measures	Farmers on steering board advise on practicalities of treatments. Farmers on monitoring sites give feedback on problems of specific treatments.
4. Entry level Scheme	Evaluation of the ELS pilot	Farmers selected options and researchers collected views on the process of applying
5. Nickersons/ Brown & Co and Buster Club	Wheat breeding	Farmers consulted through the 'Buster club' and are given samples of developing varieties to try out
6. Orange Blossom Midge	Identifying res-istance & traps	Farmers try out pheromone traps on land
7. Unilever	Crop and agri-env. trials	Farmer forum identifies research, research undertaken on a farm under commercial conditions
8. Nitrates	N Management in Organic farming	Farmers practices are recorded and farmers involved in interpreting the results at a workshop
9. Pig welfare	Pig welfare assessment	Farmers give their opinions on issues of welfare and 'what makes for a happy pig'
10. Biosecurity	Constraints & incentives to biosecurity	Farmers involved in focus groups

The relationships between researchers and farmers were also seen to be crucial. Farmers operate at the whole farm system level, not focussed on one particular research topic. Therefore researchers needed to show respect for farmers' commitments, take into consideration the demands the project is making on normal farming practices, and the timing of research work in relation to farmers' work calendar. The issue of trust was again raised as an important issue allowing co-operation.

Where there were difficulties in recruiting farmers specific researchers with farmer links or advisors were used to facilitate the development of relationships, ensure clear communication, and help stimulate the development of trust between all parties. We refer to these as boundary spanners.

Table 3 Ways of bridging the farmer scientist gap in each case study project

Project	Description	Bridging the scientist –farmer gap
1. Home Farm Organic Study	Impact of organic farming	Farm manager advised scientists on practicalities
2. WildCRU on Chichester plain	Restoring water voles & other species	FWAG farm advisor involved all through the project
3. Saffie	Agri-environmental measures	ADAS advisory staff asked to make links to farmers.
4. Entry level Scheme	Evaluation of the entry level scheme pilot	Used DEFRA staff to advise on agri-environmental options and used a researcher with experience of working with farmers
5. Nickersons/ Brown & Co and the Buster Club	Wheat breeding	Work with a land agent who organises the farmers. Key scientist has excellent rapport with farmers and recognizes the commercial need to get farmer feedback.
6. Orange Blossom Midge	Identifying resistance & developing traps	Scientists involved who like lots of interaction with farmers, use advisors to work with farmers
7. Unilever	Crop and agri-environmental trials for sustainability	Farm manager on research farm and field staff who work with pea growers
8. Nitrates	N Management in Organic farming	Researcher with farmer links brought into the project
9. Pig welfare	Developing pig welfare assessment	Researcher had good experience of working with farmers
10. Biosecurity	Constraints & incentives to biosecurity uptake	Use of consultant and main researcher comes from a dairy farming family

Farmer participatory research was not found to be cheaper or quicker. Rather than investing in equipment and experiments, it required a lot of staff time to develop relationships with farmers and other researchers. Several of the projects stated that they were under-costed. The difficulties of ensuring statistical rigour when working with farmers was mentioned by four of the cases

Specific statistical advice was found to be used to identify the number of farms required to provide statistically robust results, as well as guidance on experimental layout. However, some projects only called on a statistician towards the end of the project, when it was difficult to make any changes. Alongside their involvement in a research project, farmers are still running a business and may not prioritise research related treatments, or inadvertently change treatments. Researchers with experience of these constraints made allowances for the loss of experimental sites in the original statistical design of their work.

Conclusions
The findings present insights into the process of inter-disciplinarity and trans-disciplinarity. The study of farmers own research found that while formal science has to ignore local complexity in order to generate a technology for a wide recommendation domain, farmers' research is based on local complexity, with farmers having to cope with many conflicting demands. Their knowledge production may be conscious or more habitual and based on building up tacit knowledge. It also identified the key role for networking amongst other farmers and discussions with advisers in fuelling this learning.

The process of carrying out interdisciplinary research is shown to be dependent on a range of relationships that are shaped by both power and trust. There are challenges of bringing disciplines together, although funders were found to be important factors in encouraging people to work across the disciplinary boundaries. There are other boundaries observed in terms of the different types of researchers and their institutions.

The issue of trust was also central to these relationships with people drawing on existing relationships, building trust up through working relationships or using intermediaries who are known to all parties and act as guarantors. These relations are also underpinned by a set of norms concerning reciprocity, what is considered honest behaviour, and use of each other's knowledge. Trust is based on having information on the parties concerning their reliability and the expectation that they will act as expected. It is also based on having potential sanction over them, either through contractual controls, but, most importantly for the teams examined, in terms of peer pressure.

The interaction with farmers results in a range of other relationships. There is a need for farmers to trust that the researchers will work as expected and for researches to trust that farmers will co-operate. The project found that there are degrees of farmer participation with differences in the extent to which researchers hand over power to the farmer in terms of the design and evaluation of the experiment or research. Relinquishing power was found to be in conflict with the need to have statistically rigorous research as farmers may not ensure that treatments remain unchanged through the research. Where there is more farmer involvement, the interaction with researchers is found to be more informal with feedback on technology or processes that may not be published but feeds into the 'tacit knowledge' being acquired by researchers. This form of research was found to be more common amongst private sector researchers.

The specific lessons coming out of this research include:

- The need to ensure good communication and team building between researchers and with farmers. This takes time and is often not costed into research proposal. Short term funding also limits these relationships.

- Farmers' own research and holistic assessments of technologies and practices can make a vital contribution to knowledge production although its approach can be very different to scientific method
- Farmers and different types of scientists have differing agendas that have to be negotiated.
- The ability of some researchers to participate in interdisciplinary participatory research can be limited by institutional pressures (such as the need to publish in academic journals) unless there are alternative incentives.
- Boundary spanners who have an understanding of the needs of scientists and farmers may be required to facilitate the development of relationships.
- For statistical research, the selection of sites should take into consideration the likely loss of some sites from the research due to the uncertainties of farming. Statistical advice should be sought from the start.

User engagement and impact

- Several peer-reviewed papers are planned addressing different aspects of the project, such as how research is best conducted on agro-ecosystems and how researchers and farmers can collaborate.
- An article to be included in Elm Farm Research Centre's Bulletin will be prepared that will be sent to a large number of organic farmers and advisors.
- A briefing note on good practice when involving farmers in research has been prepared and will be disseminated.
- A website is being created to include the full report, summaries of the work, briefing notes and details of each of the projects examined (www.mdx.ac.uk/www/ceedr/esrc)
- The results will be fed into a detailed 'handbook' on farmer participatory research to be prepared for DEFRA by June 2006

Workshops and events

- The project has been presented at two Rural Economy and Land Use Programme conferences in Birmingham and York, and the results will be presented at the RELU workshop in Manchester in January 2006.
- A workshop was conducted for project members and others on "social science qualitative research for natural scientists"

Inter-disciplinarity

While the subject matter of this project is inter-disciplinarity, this research project itself has been an experiment in inter-disciplinary research. The design of the research has been carried out by people from different disciplines and interviews and analysis were done by a social and a natural scientist. Like other research projects, the collaboration was able to draw on previous working relationships and continued despite a change of team member at the start. The inter-disciplinary experience has resulted in social scientists learning about the process of natural science research and natural scientists understanding how research is carried out in other natural sciences. It has also provided natural scientists with first hand experience of carrying out social science research. The impact of the interaction lies in the future.

Research capacity and training

Training in qualitative research methods was carried out for natural scientists. Capacity building and learning also took place through carrying out interviews jointly by natural and social scientists. As with systems of farmer learning, the researchers gained knowledge through 'reflection in action' with the knowledge generated being both explicit recognition of new skills developed and tacit knowledge of how to carry out social research, or the nature of natural science methodologies.

Outputs

- End of project report
- Briefing notes on good practice for farmer participatory research
- Website with details of report, good practice guide and details of the case studies
- Presentation to policy makers, NGOs and academics at three RELU conferences

Impacts

Too early to state.

Future research priorities

- The roles of a wide range of stakeholders (farmers, rural businesses, other land-users, recreational users, lobby groups, different types of researchers, funders, the media and policy makers) in shaping science and knowledge production.
- A more critical perspective on what “inter-disciplinarity” means in practice (both within projects and in the interpretation of knowledge from different disciplines, scales and types of knowledge producers).
- A more detailed consideration of the role of trust and power among different members of research teams / beneficiaries / research users / funders and policy makers
- A better understanding of the tensions between the need to develop “relevant science” for practical use by farmers, businesses and land users, and academically rigorous “high science” for academic publication

Bibliography

Ambrosini, V and Bowman, C (2001) ‘Tacit knowledge: Some suggestions for operationalization’ in *Journal of Management Studies* 38 (6)

Berkes, F.and Folke, C. (1998) *Linking social and ecological systems: Management practices and social mechanisms for building resilience.* Cambridge: Cambridge University Press. 459 pp.

Checkland, P. (1999), *Systems Thinking, Systems Practice* Chichester: John Wiley & Sons, Ltd.

Nissani, M. (1997) “Ten cheers for interdisciplinarity: The case for interdiscplinary knowledge and research.” *The Social Science Journal*. Vol 43 No. 2 p201-206

Nonaka, I (1991) ‘The knowledge creating company’ in *Harvard Business Review,* 69 (6)

Polanyi, K (1966) *The Tacit Dimension* New York, Doubleday.

Yin, Robert (2003) *Case study research design and methods*. London: Sage.