

Farmers design farm systems –not researchers: Conceptual ideas for linking farms, advisers, research projects and regions to improve technology choice in Australian dairy production

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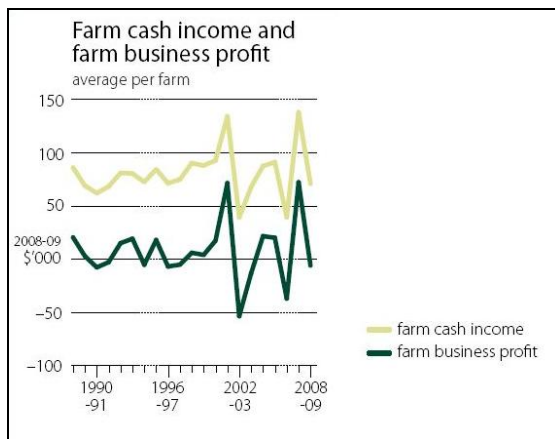
Abstract: *If farmers are the farm system designers and managers, the task for research, development and extension (RDE) then is not to develop systems that can be adopted, but to understand the systems management challenges in order to organise and engage in appropriate practices that support designers. Key challenges for an RDE project in the Australian dairy industry aiming to support farmers in managing home-grown forages more profitably are identified. These concern issues of knowledge integration across scales (i.e. farmers, advisers, projects, regions) requiring different forms of coordinated practice. In this paper, interdisciplinary deliberations, advisory tools and interaction platforms are discussed with respect to their potential for enhancing coordinated practice in farming systems design. Although holding promise, research investor demands for ‘system adoption’ rather than integration remains a challenge.*

Keywords: *Farming systems research, Community of Practice, interdisciplinary competence, knowledge integration*

Introduction

Australian dairy production systems have undergone considerable change in the last decade with dairy farmers facing a more complex production environment than at any time in the past 30 years with marked increases in the volatility of movements in markets, input costs and farm profitability (Figure 1). With national dairy production declining from 11.3 billion litres in 2001/02 to 9.3 billion litres in 2008/09, this has presented a significant challenge for dairy farmers with regard to farming for profitability and sustainability from year to year. The emergent risks of climate change, national government policy regarding emissions trading and world dairy trade, increased energy costs, water and human resource availability all represent further on-farm challenges for the medium to longer-term (Dairy Australia, 2009). Furthermore, the sector must demonstrate a responsible, transparent and efficient use of limited shared resources (e.g. water for irrigation) and be clearly active in managing its environmental impacts. As in many countries, performance in this area will impact upon the cost and availability of key production resources and the sectors social contract to operate.

Government and service organisations, particularly in natural resource management and agricultural contexts increasingly refer to enhancing the *adaptive management* capacity of farmers as a way of responding to these types of challenges (Love et al, 2008). This has been supported by developments in resilience thinking that argue for a shift in focus from seeking ‘optimum’ states to managing adaptively (Walker, et al, 2004). Overall though, there has been limited focus on the implications of these challenges on the innovation system’s response in supporting such adaptation. Clearly a ‘business as usual’ approach would appear inadequate given the scale of challenge for farm systems.



Source ABARE, 2009

Figure 1. Average annual farm cash income and profit on Australian dairy farms (1989-2009) in Aus\$(2008-09) indicating the increase in volatility in annual returns in the last ten years.

Australian agriculture's innovation system, otherwise referred to as research, development and extension (or RDE) and including public and private service delivery, is acknowledged in the Australian dairy sector as being a critical plank in the long term success of the sector (Dairy Australia, 2009). However, there are changing expectations for this system (comprised of national, state and regional organisations and stakeholder groups) including: a requirement to address a broader range of environmental and social issues whilst increasing productivity to address rising costs; increasing innovativeness to keep ahead of existing and emerging competition, and an ability to apply systems approaches and thinking around complex farm systems. The challenge now is to design an RDE system which can effectively support the adaptive management capacity of farm businesses and demonstrate increased relevance to farm, policy and society.

In addressing this challenge, we identify a trend away from *technology-adoption* designs in which proving a relative advantage of a particular technology is the focus of research along with expectations from research investors for the uptake of that technology through awareness and promotion, toward *system-adoption* designs whereby research undertakes a process of testing and defining different farming systems with investor expectations for the uptake of those systems through awareness and promotion. However, this trend runs counter to the demand for adaptive RDE for a number of reasons. Firstly, farm system designs produced through research are but one source of knowledge for farm decision making and cannot be applied *off-the-shelf*. Secondly, the "fit-to-farm" complexities of different systems has implications for the management practices and work organisation on-farm that are rarely addressed in system designs. Thirdly, the motivation for modifying an existing farming system – or changing farming systems varies from farm to farm but is central for the design process. In light of this, we submit that the translation process of research to practice change is best conceived as a supported decision-making process at the local and farm-scale level. The challenge in this is finding ways of working between system designers (farmers or land managers) and system design supporters (the RDE system). This moves the problem from one of *system adoption* to *system design support*, and toward questions of how to arrange and organise an RDE system as a more effective *supporting system*. The paper aims to better define the challenge of farming system design in the context of innovation, offer appropriate theories for this challenge and analyse activities within a case study project in the Australian dairy industry with respect to their contribution toward better farming system design support.

Theorising the challenge of adaptive farm management and the use of research

It is important to understand the challenge of farm system design in order to organise an RDE system to support it. Langeveld, Roling and Jiggins (2006) identified participative, systems oriented research, that integrates multidisciplinary knowledge at different scales as playing an important role in the design and implementation of new alternative land use systems in a European context. This

emphasis on learning processes and interaction amongst stakeholders appears ideal for the adaptation challenge because RDE would be continually engaged in reflexive learning with farmers or communities and responding to emerging challenges in `real-time`. There has been less focus however on the constraints to such processes like funding, resources, time, institutional arrangements and the capacity constraints for an RDE system to be adaptive. Furthermore, the challenges of learning and adapting across scales (e.g. a project to other regions) have also been largely ignored. Consequently, we ask, can reflexive learning between farmers and an RDE system be institutionalised? We discuss below two areas of theory that we believe can support the institutionalisation of reflexive learning within RDE, in order to make the RDE system more appropriate to supporting system design. These concern theories of knowledge integration from interdisciplinary studies (Klein, 1990; Aboelela et al, 2007; Hinrichs, 2008), and theories of social learning, particularly communities of practice (Wenger, 1998; Leeuwis and Pyburn, 2002; Blackmore, 2006).

An appropriate theory of knowledge integration across scales

A common response to questions regarding the use of research is to think about processes of knowledge transfer. However, in following the social theories of learning, there can be no transfer of knowledge but rather translation, integration and synthesis of knowledge through learning opportunities grounded in specific situations and contexts (Lave & Wenger 1990; Wenger, 1998; Wenger *et al.*, 2002; O’Kane *et al.*, 2008). As integration, or synthesis, is a defining feature of interdisciplinary work, what is to be integrated, by whom, for what purpose and effect are common concerns. In the context of the challenge of supporting the design of farm systems the definition of integration or synthesis changes according to scale. For instance:

- At the farm-business level, knowledge integration concerns how farmers manage their farm resources to achieve their goals and how they incorporate knowledge in their practice.
- At the advisor-level, knowledge integration concerns how advisers work with farmers to improve their management and how they draw on RDE knowledge to improve advisory capacity.
- At the RDE project level, integration concerns how multidisciplinary teams construct key messages and principles from their work to aid on-farm application and enable partnerships to support farm system design (often described by investors as the route to market for RD&E). At this level, connection between disciplines is essential for the identification of principles, messages and practices that have project-wide acceptance and validity and are, therefore, able to be presented to industry as outputs.
- At a regional level, integration concerns how regions best capture and make use of RDE resources (knowledge, people, practices) for their region. Here it is the issue of how knowledge generated in one region may be translated or synthesised to be of benefit in another.

Clearly, the key to meeting the multi-faceted challenge of integration lies in the ability of RDE systems to generate adaptive capacity. Klein (1990) highlighted three challenges for integration. Firstly, creating or mobilising a practice for integration that is dialectic in nature (i.e. where differences in disciplinary discourses are stated, clarified and resolved in order to produce a synthesis). Klein (*ibid*, p194) refers to this as an integrative core. Secondly, it is important for people to recognise the magnitude of achieving synthesis, and thirdly, to consider the task of the interdisciplinarian in constructing and projecting a synthesis to those outside the core. Fundamentally, this hints at the type of social processes involved in integrative work. Integration theories offer a framework for focussing on the work of integration at multiple scales that needs to occur within RDE projects.

An appropriate theory of social learning for practice change across scales

Learning as it normally occurs is a function of the activity, context and culture in which it is situated (Lave and Wenger, 1990). Social interaction is a critical component of situated learning, where learners become involved in a community of practice (CoP) which embodies certain beliefs and behaviours to be acquired. A CoP is defined as a group of people bound together by shared expertise and passion for a joint enterprise who develop a shared repertoire of resources thereby enabling the evolution of a specific desirable practice (Wenger *et al.*, 2002: 139). Knowing, becomes a matter of competence requiring active engagement. So, although localised practitioners develop localised practices that may differ in levels of compatibility with the practices of other groups (Sole & Huysman 2002) the CoP concept helps address this issue by identifying the practice of integration as a specific task which may be evolved through a continuing discourse between a group of people seeking ever more effective ways to support farming system designers.

Case study Project 3030: Supporting farmers in the design of their farm systems at local, regional and national scales

The following case study and analysis of a farming systems project in the Australian dairy industry outlines the main integrative activities conducted to increase the effectiveness of a project as a resource to farm system designers. The case study has been compiled by social researchers in the project (King *et al.*, 2009; O’Kane *et al.*, 2008a; O’Kane *et al.*, 2009; O’Kane and Nettle, 2009) and draws on insights and lessons from other industry studies of cross-disciplinary endeavour in farming systems in an Australian context (see Kenny and Nettle, 2006; Crawford *et al.* 2007). Project 3030 commenced in 2005 in the State of Victoria, Australia funded by the dairy industry peak RDE body (Dairy Australia); State Government (Victoria) and other industry and research institutions (See O’Kane, *et al.*, 2008a; Chapman, *et al.*, 2008). It was predicated on modelling that suggested a 30 percent increase in the consumption of home grown forage on dairy farms could result in a 30 percent increase in return on capital assets over a period of a financial year. The project aimed to develop knowledge that could be used by Australian dairy farms to improve profitability. The project activities include:

- a. Bio-physical research (trial farmlets at a demonstration farm in a regional area of south-west Victoria consisting of two herds of 36 milking cows run respectively under two different feed-base production systems (Perennial ryegrass pasture with bought in supplements – the ‘Ryegrass Max’ system, and Perennial ryegrass supplemented by other home grown pastures and forage crops (otherwise known as ‘Complementary Forage’);
- b. Agronomic research involving comparison of forages in trials at the demonstration farm (above)
- c. Four Partner Farms in Victoria (South-Western, North-Eastern and Gippsland) and South Australia (Fleurieu Peninsula). Partner farms are commercial farms operating as research partners where knowledge is generated about the management challenges of farm system designs (Crawford *et al.*, 2008; O’Kane and Nettle 2009) ;
- d. Social research (adoption challenges to farm businesses; effective strategies that partner farmers use to capture opportunities and manage risks; the advisory support network; social network analysis; integrating multidisciplinary knowledge);
- e. A small extension team (Victorian Department of Primary Industry’s Dairy Extension Centre) to facilitate knowledge co-development about forage production at a regional level.

Governance of the project consists of a Project Management Group (PMG) and a Steering Committee (SC).

The integration challenge

The documents of the project state that Project 3030 will move well beyond knowledge production to: *“Review and package information in a systems context, and work with leading farmers, advisors, consultants, and agribusiness (including milk companies) to embed the knowledge in their skills base* (Chapman, 2008). Project success then, is dependent not on the uptake of Ryegrass Max or Complementary Forage systems across a population of farms, but on the way service providers and extensionist’s integrate the technical and managerial information stemming from the research into their advisory practice. In this context the Australian dairy RDE system has a unique advantage in the form of a spectrum of feeding options and management guidelines from farming and RDE in specific local contexts which are both available, and subject to, ongoing development nationally. The integration challenge for supporting farmers as farming system designers concerns how this regional resource advantage can be adapted and integrated into different situations as different challenges emerge. Rather than the challenge being that of geographic scale and bio-physical variation between scales (a research site to a farm; management of a farm system from one region to another, etc) it is the appropriate organisation and connection between different forms of expertise and practices to affect a *joint performance* that defines the nature of the shift from system *adoption* to system *design support*. (Paine 1997, Paine and Kenny 2002, O’Kane et al., 2008b, 2009a).

The integration work of Project 3030

Three main activities have been instituted in the project to address the integrative relationship at farm, project and regional levels:

1. Within-project integrative work: The Technical Co-ordinating Committee (TCC)

Different types of expertise (i.e. agronomy, animal production, social science, extension science, consulting and farming) are operating within the project contributing knowledge about new farm systems, management challenges and practice change. It is often assumed that people working together, by this very act, will synthesise and integrate their findings, discuss contested knowledge and tease out implications of knowledge work for a broader population, assuming integration *just happens*. Two years into the project, the TCC was instigated to harness the different types of expertise resting within the project structure in order to gain consensus around and drive out principles and practices that would be robust enough to be applicable across a wide range of dairy farming contexts. For this emergent process to evolve, there is a requirement that must be met on behalf of the project team and the industry concerning commitment to alignment, reflection and communication as core practices. The social research team (King et al., 2009; O’Kane et al., 2008, 2009) worked with the extension leader and the project management group to establish the TCC. The steps developed for such multi-disciplinary knowledge integration in the project include:

- a. A Project 3030 theme leader presents key findings of their work as a principle(s) with key messages.
- b. Other theme leaders and expert practitioners (farmers, advisers) add (in writing) to this principle/message from their research/practice experience (identifying points of agreement, points of fine-tuning, and points of contestation).
- c. The group discuss the extent to which the principle/message can be supported by all. The alignment/agreement reached is noted along with points of dissent.

Joint discussion follows of what is required to put this principle/message *into practice?* (i.e. what would it take to live-out this principle?) by each member of the TCC; by farmers (discussion of targets); by others (i.e. advisers, extension, re-sellers) and what does the project need to do next. At the time of writing, the TCC has reached consensus concerning the key principles, practices and rules for grazing management of ryegrass pastures and for the use of nitrogen fertiliser on pasture. Additionally, significant progress has been made towards understanding and documenting best

management practices concerning the alignment of feed supply with demand emerging from the research.

Development of collaboration within the TCC has to date has been focused on clarifying and contributing to the technical task relating to review of management principles and practices, and the structural fit of 3030 messages with industry. However there has also been significant discussion about the process of the group itself. The TCC has provided a unique space for key Project 3030 participants to integrate knowledge across each area of expertise and in doing so ensure that there is agreement on project principles.

2. Project work to integrate with farmers and service providers: Advisory tools

Project 3030 complementary forage work comes with a complex set of management practices (O’Kane et al., 2008c; O’Kane and Nettle, 2009). More often than not, these are more demanding than most ryegrass based dairy farmers in dryland Victoria are used to. Consequently one of the first challenges for any farmer thinking about utilising 3030 CF principles is to identify the type of benefits from CF; the capacity of the farm system to run a CF system, the ability of the farmer to step up to a more demanding regime of management; and the availability of the necessary time and labour resources to do so.

These challenges are not addressed through providing written information about project results, but require a learning relationship between farmer and adviser. To assist advisory services in the public or private sector in their efforts to provide their clients with the option of using Project 3030 principles on their farms, advisory tools were developed by social researchers working with farmers and advisers. The tools are designed to assist advisors engaging with farmers around Project 3030 principles. As each person learns differently, the overall approach is one which provides options for both individual and group situations. Together they represent elements of an advisory strategy designed to cope with the different contexts in which advisors need to work. This includes ways to effectively engage with farmers around 3030 principles for both farmers ready for the complexity of Project 3030 principles and for those not.

Establishing Forage Practice Groups (FPGs): The establishment of local groups, enables people to come together to pursue the development of the practice of using complementary forages on dryland dairy farms. In Project 3030 these groups are designed on the ‘Communities of Practice’ (CoP) concept which has been further developed by expanding the principles of engagement to include not only a core and a periphery, but a *participatory band of engagement* where local practitioners participate in discussions concerning decision making, but do not necessarily embark on practice change themselves (see O’Kane et al., 2008). In forage practice groups (FPG’s), the participants bring their various experiences and areas of expertise as researchers, advisers, seed company agronomists and farmers to bear on the various issues and problems raised by the complementary forages. Forage Practice Groups are suggested as a way that the different expertise required to inform complementary forage practice on farm can be coordinated in a local group setting to enhance decision making on-farm. The groups are designed to be operational in time for the major decision making times (regarding forage practices) of the year (O’Kane et al., 2008b; O’Kane et al., 2009, O’Kane and Nettle 2009);

Using a one-on-one advisory conversation - The Germinator and Risk Perception method: A method to support advisers in conversations with farmers so that they make informed decision as to who might benefit most from Project 3030 management principles was developed (see Paine and Kenny, 2002; Nettle and Paine, 2003). The process uses questioning techniques to understand the farmer as a person; the farm system (what they do) and the farming practice (the interrelationship of who they are, what they do and why they do it) and make a judgement as to whether or not a challenge like Project 3030 complementary forage practices are appropriate for the farmer’s needs, farm system and level of competence. Further, the method can be adapted to explore the context in which Project 3030 principles can be applied, being for greater production or to navigate perceived risks (see O’Kane et al., 2009).

Helping advisers analyse the knowledge network: In the context of rural production, a social network is comprised of farmers, service providers, consultants, government extension services, education providers, and researchers. The people who participate in these networks are linked by commercial, professional and social relationships. These relationships, or ties, are the conduits through which information about farming practice flows. Social network analysis (SNA) (Wasserman and Faust, 1994; Cross and Parker, 2004) is a tool for understanding how relationships enable ideas, knowledge and other resources to be shared in social groups. A social network analysis map provides a visual representation of these relationships and is useful for finding ways to help communication processes become more effective. Social research about the networks involved in Project 3030 provided project teams and advisers with a way of thinking about identifying influential people within networks. Using concepts about information flow from the field of social network analysis (Granovetter, 2002), the concept of ‘sticky’ knowledge resonated with the project team. Sticky knowledge refers to the types of knowledge flows that require significant effort, which may be due to the complexity of the knowledge and/or the social processes involved. Key roles of people in the advisory network were identified that made a positive contribution to sticky knowledge issues. Knowledge brokers (Cross and Parker, 2004) and knowledge entrepreneurs (Coulson-Thomas, 2003; King et al., 2009); represent a resource to project integration and as an advisory tool, can help locate key people for enhancing the traction 3030 principles have in a farming population. Further, it encourages critical reflection on who and what might be thwarting this traction.

3. Project work to integrate with regional needs across Australia: Organising a “speed-date” between projects and regions

Project 3030 is one project in a suite of projects across Australia funded to support the feedbase decisions of Australia’s dairy farmers. Because projects are regionally-based but nationally significant; a way of integrating the knowledge of different projects to regional needs was required. A national dairy RDE workshop was held with representatives of regional RDE groups and feed-base projects from across Australia (including Project 3030). The process developed for this event included:

- a. A presentation by each RDE project to all of the regional groups represented with the aim of providing an overview of achievements and future directions.
- b. A *speed-date* between each region and each project: Each of the 8 Regions met in turn with each of the 7 RDE project groups (including Project 3030). The Region asked questions of the project team as to how that project might meet some of their local feedbase needs. A facilitator was present for all the ‘dates’ to assist the conversation flow and take notes. The facilitators prepared a summary report of themes and any specific ideas, strategies, or actions to tackle the themes, for reporting back to the workshop as a whole. For example, if a key regional need related to ‘understanding how farmers might best structure their feedbase to deal with climate change’, and the region is meeting with the Project 3030, the question was something like: ‘what role can your project play in helping us understand the place of complementary forages in a) exacerbating the risks of climate change, and b) mitigating the risks of climate change?’
- c. Each region then formalised a “Regional feedbase development group” responsible for keeping pace with regional needs for feedbase information and resources (including advisers, farmers) and identifying ways to access Project resources (like Project 3030) at a regional level.

Have these activities progressed integration and supported farm system design?

The integration activities across scales (TCC; advisory tools; speed-dating) shared some key attributes:

- A focus on learning and communication cycles as a dialectic: to synthesise disciplinary perspectives for the needs of different scales (farms, projects, regions)
- A focus on scale-appropriate joint activity;

- A focus on less visible elements of farm system design support such as networks, advisory relationships and needs analysis.

The activities shift the focus for practice change on farms toward the quality of the relationship between projects and service providers, rather than just the quality of the technical messages. We suggest this subtle shift represents an indicator for RDE as a supportive system. In addition, the activities represent a commitment by an RDE team to rigorous internal processes to generate clear consistent messages from all disciplines and actively develop the pathway for this knowledge to become practice. This is a form of interdisciplinary rigour and an indicator for an increasingly adaptive RDE project. However these attributes would need to extend further, through resourcing a shift in advisory practice or through providing more support to regions in translating RDE knowledge for their farms practices outside the project. Overall then, the activities appear to represent a middle-ground between systems adoption and system design support. That is, on one hand the project is trying to develop systems that can be adopted; and in doing so, offering design support to participating farmers, advisers and regions.

Therefore challenges remain for RDE to operate as an adaptive system to support farming system design. If one common assumption is that integration just happens, another is that there is an assumed value proposition for the people involved from integrating. This is particularly an issue at the project-to-region scale. People resources for regional projects to gain traction or integrate with other regions are often stretched and the resources available to projects (including advisers and service providers) are diverse and often pre-determined and not flexible. This establishes a conundrum whereby the value proposition from integrating has to be incredibly strong for *both* projects and regions. A key question for integration then is how to create or foster a strong value proposition for integration? Does resourcing alone create these conditions? Current evidence would suggest that there is variation in engagement of regions with projects that cannot be explained by resourcing conditions. It would appear that the capacity of regions themselves to understand and articulate gaps in practice for their region and identify the potential in projects outside their region creates an impetus to integrate and synthesise. Finally, building advisory capacity to support development is contingent on an engaged advisory sector and on trust-relationships regarding what constitutes legitimate knowledge for farmer clients. Unless these assumptions are explored, limited progress will be made beyond the middle ground. It would appear that a shift toward farm system design support requires a degree of institutionalisation of RDE as an adaptive resource.

Conclusion

This paper outlines the key challenges for RDE in moving from approaches based on *farm systems adoption* to approaches based on *farm system design support*. Key processes of knowledge integration across scales for supporting farm system design were identified through examples of tools and processes operating in an RDE project in the Australian dairy industry. The Project 3030 case study has revealed three scales of challenge for RDE to operate as a support system to farm system designers a) within-project processes between different disciplines; b) project engagement with farmers through advisors and advisory tools; and c) project partnerships with different regions. The processes in Project 3030 were suggested as offering some progress toward enhancing integration through coordinated practice and therefore some progress toward RDE as an adaptive system. However, remaining challenges were noted in moving beyond a middle-ground between system adoption and system design support. We suggest further research is required in ensuring RDE systems adapt to the needs of farm system designers to include: (1) development of processes for advisers and farmers outside of projects to be part of more effective feedback loops to adapt practices; (2) development of ways for regions to share methods for improving service provision to farmers; and (3) enhanced definition of the capacity required in project teams to broker up and down integration scales. The extent to which such research can support adaptive RDE systems is largely dependent on how integrative activities are positioned by investors and participants. That is, as a side-line activity or the “main game”.

References

- ABARE (2009) Australian dairy 09.1. Australian Bureau of Agriculture and resource economics.
http://www.abareconomics.com/publications_html/livestock/livestock_09/9_1_dairy.pdf (Sourced February 1, 2010)
- Aboelela, S. W., E. Larson, S. Bakken, O. Carrasquillo, A. Formicola, S. A. Glied, J. Haas and K. M. Gebbie. (2007) Defining Interdisciplinary Research: Conclusions from a Critical Review of the Literature. *Health Services Research* 42(1P1):329-346.
- Blackmore, C. (2006) Where do participatory approaches meet social learning systems in the context of environmental decision making? In: *New Visions for rural areas – Changing European farming systems for a better future*. Ed: Roling, N and Langeveld, H. pp. 29-34. Wageningen University Press.
- Chapman, D., G. O'Brien and J. Jacobs. (2008) Project 3030: A 30% improvement in return of assets through a 30% increase in the consumption of home grown forage. in *Milestone 8: Final Report*. Dairy Australia.
- Coulson-Thomas, C. (2003) *The knowledge entrepreneur: How your business can enable, manage and profit from intellectual capital*. Kogan Page, London.
- Crawford, A., Nettle, R., Paine, M. and C. Kabore (2007) Farms and learning partnerships in Farming Systems Projects: A response to the Challenges of Complexity in Agricultural Innovation. *Journal of Agricultural Education and Extension*. 13 (3) pp. 191-207.
- Cross, R. and A. Parker (2004) *The Hidden Power of Social Networks: Understanding how work really gets done in organisations*. Harvard Business School Press, Boston.
- Dairy Australia (2009) "Dairy 2009: Situation and Outlook." Melbourne. Australia
- Granovetter MS (2002) 'The strength of weak ties', In J Scott (ed.), *Social Networks Critical Concepts in Sociology*. London: Routledge.
- Hinrichs, C. (2008) Interdisciplinarity and boundary work: challenges and opportunities for agrifood studies. *Agricultural Human Values* (25):209-213.
- Kenny, S. and R.A. Nettle (2006) *Extension as a knowledge partner in farming systems research – Early lessons from "FutureDairy" Australia*. In *New Visions for rural areas – Changing European farming systems for a better future*. Ed: Roling, N and Langeveld, H. pp. 325-329. Wageningen University Press.
- King BJ, Paine MS, Beilin R and O'Kane M. (2009) Encounters with Knowledge Entrepreneurs and 'Sticky' Knowledge: Case study Project 3030 *Extension Farming Systems Journal*, vol. 5, no. 2, pp 19-28.
- Klein, J. (1990) *Interdisciplinarity: History, theory and practice*. Wayne State University Press, Michigan.
- Langeveld, H., Roling, N. and J. Jiggins (2006) General Introduction and new arrangements for land use and communication. In *New Visions for rural areas – Changing European farming systems for a better future*. Ed: Roling, N and Langeveld, H. pp. 19-23. Wageningen University Press.
- Lave, J. and E. Wenger (1990) *Situated Learning: Legitimate peripheral participation*. Cambridge: University of Cambridge Press.
- Love, S Sharma, M., Boxelaar, L. and M. Paine (2008) *Enhancing the resilience of dairy farm businesses*. Final Report. Melbourne, University of Melbourne.
- Leeuwis, C and R. Pyburn (eds.) (2002) *Wheelbarrows full of frogs – social learning in rural resource management*. The Netherlands.
- Nettle, R.A. and M.S. Paine (2003) "Building Effective adviser-client relationships- Findings from the Learning Plans project": A workbook. University of Melbourne, Australia
- O'Kane, M.P., Paine, M.S. and B.J. King (2008a) Thoughts on Reflexive Learning Strategies: Structural decision-making in forage management innovation. Dedieu, B and Zasser-Bedoya, S (Eds), *Empowerment of the Rural Actors: A Renewal of Farming Systems Perspectives: 8th European IFSA Symposium*, INRA Metafort.
- O'Kane, M.P., Paine, M.S. and B.J. King (2008b) 'Organising Research: Using Action Research Methodologies to Re-Organise Research Structures'. EGOS Organising Committee (Eds), *Upsetting Organisations*,

24th European Group for Organisational Studies Colloquium.

- O’Kane, M.P., O’Brien, G., Crawford, A., Paine, M.S., Chapman, D.F. and J.L. Jacobs (2008c) ‘Integrating knowledge from research and farmer practice in the development of more productive forage systems for dairy farms in south-eastern Australia’. Organising Committee of 2008 IGC / IRC Conference, (Eds), *Multifunctional Grasslands in a Changing World, Volume 2: XXI International Grassland Congress, VIII International Rangeland Congress*, Guangdong Peoples Publishing House, Guangzhou, p. 1108.
- O’Kane, M.P. and R. Nettle (2009a) Partner Farms in multidisciplinary research: The continuing evolution of a research and development methodology. *Extension Farming Systems Journal*, vol. 5, no. 2, pp 19-28.
- O’Kane, M.P., King, B. and G. O’Brien (2009b) Farmer risk perceptions and practice: Utilising notions of risk for extension in Project 3030. *Extension Farming Systems Journal*, vol. 5, no. 2, pp 59-70.
- Paine, M.S. (1997) *Doing It Together: Technology as Practice in the Dairy Sector*. PhD Thesis, Wageningen University, The Netherlands.
- Paine M.S. and S.N. Kenny (2002) *Intentional Learning: interplays between farmers and service providers*. Proc. 5th Intl. Farming Systems Assoc. Euro. Symposium: Farming and Rural Systems Research and Extension: local identities and globalisation. Pp. 509-516.
- Sole, D. and M. Huysman (2002) ‘Knowledge, Practice and the Role of Location: A Community of Practice Perspective’, in *Trends in Communication: Communities of Practice*. Netherlands: Boom Publishers
- Walker, B., Holling, C. S., Carpenter, S. and A.P. Kinzig (2004) Resilience, Adaptability and Transformability in Social–ecological Systems. *Ecology and Society*, 9, 5.
- Wasserman, S. and K. Faust. (1994) *Social Network Analysis: Methods and Applications*. Cambridge University Press, New York.
- Wenger, E. (1998) *Communities of Practice: Learning, Meaning and Identity*. Cambridge: Cambridge University Press.
- Wenger, E., McDermott, R. and W. Snyder (2002) *Cultivating Communities of Practice: A Guide to Managing Knowledge*. Boston, Mass.: Harvard Business School.