The Importance of Trust in the Development and Delivery of a Decision Support Tool to Reduce Environmental Nutrient Losses from Pasture Systems

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EXTENDED ABSTRACT

Managing uncertainty and risk is an increasing challenge for running profitable grazing systems. There is continual pressure to increase efficiency and productivity, while at the same time there is mounting scrutiny of the impact of grazing systems on the environment. Of particular interest is the impact of nitrogen and phosphorus losses from grazed pasture systems to water and the atmosphere. A combination of industry demand for information on environmental management of nutrients on farms, and the few existing decisions support systems (DSS) to help manage these issues in Australia led to a government and industry funded project (the Better Fertiliser Decisions project, BFD) for developing a new decision support system, the Farm Nutrient Loss Index (FNLI). The objective of the FNLI was to provide a DSS that can be used to identify where and when there is a risk of nutrient loss to the environment from grazed pasture systems in Australia.

Current fertiliser applications on grazed pasture are based largely on previous practice, budget or recommendations from fertiliser industry staff and consultants. The fertiliser industry is therefore an ideal group for using the FNLI and delivering advice to farmers on how to minimise off-farm nutrient loss. Already the fertiliser industry has developed nutrient management codes of practice and guidelines (eg. Cracking the Nutrient Code) to support advice on environmental nutrient management. However, using the fertiliser industry as intermediaries between research scientists and farmers for delivery of the FNLI raises two challenges. Firstly, farm DSS have traditionally focussed on the extension of production-related outcomes and off-farm impacts have not been considered. There is often no profit-driven incentive for farmers to change management in order to improve off-farm environmental outcomes, which reduces the demand from the private sector for DSS such as the FNLI. Secondly it is well recognised that there has not been widespread use of DSS for on-farm decision making, so new and innovative models of science-farmer interaction will be required to empower farmers to manage nutrients in ways that protect the environment.

To develop the FNLI, workshops were held with government scientists, fertiliser industry agronomists and farmers. This paper describes reflections of the authors on how these development activities and the FNLI itself may help the fertiliser industry deliver environmental nutrient management advice to farmers.

Trust emerged as an important theme in our reflection on the FNLI development process because it seems to underpin the development of scientific rigour, stakeholder ownership and mutual learning. The FNLI development process offered many opportunities for developing the necessary trust between the government scientists and the fertiliser industry representatives. By collaborating with the fertiliser industry, the BFD project is providing an opportunity to exchange environmental and production-based knowledge between the commercial and public sectors. Our confidence in the fertiliser industry's ability to adequately deliver environmental information and technology is increasing due to the industry's strong commitment to environmental stewardship.

To ensure the FNLI is accepted by the fertiliser industry, it is important to maintain a transparent development process and regularly communicate with project stakeholders. This will build trust in both the tool and the development process itself. Developing trust in and relevance of the FNLI through participation of fertiliser industry and farmers in its development has greater potential to lead to adoption of environmental management practices than developing the DSS in isolation and 'selling' it to the industry.

1. INTRODUCTION

The cost-price squeeze that affects agricultural industries, and evidence that higher stocking rates can increase profit has lead to a trend for the dairy and other grazing industries in Australia to intensify over the last few decades (Gourley 2001; Trompf 2001). One consequence of farms supporting higher stocking rates has been an increase in the amount of nutrients applied and returned to pastures as fertilisers, dung and urine. However, as grazing systems have intensified, so has awareness of the potential for excess nutrients to move from farms and contribute to problems such as blue-green algal blooms in waterways and greenhouse gas buildup in the atmosphere. Community and government awareness of these problems has increased expectations and imperatives upon farmers and the fertiliser industry to operate in ways that minimise off-farm nutrient loss.

The fertiliser industry has responded to these community concerns by engaging in steps to be more environmentally responsible. In their 2002 Fertilizer Industry Environment Report, the Fertilizer Industry Federation of Australia (FIFA) recognised the need to translate information regarding the modes of transfer of nutrients from agricultural land to water into a framework for decision-making by fertiliser users (Fertilizer Industry Federation of Australia 2004). To enable this, FIFA has developed codes of practice and a training and accreditation program called Fertcare® for industry staff to set and maintain industry standards of environmental stewardship. In 2002, scientists and dairy industry research funders convened a workshop with the fertiliser industry to identify gaps in knowledge and areas of inconsistency in nutrient management advice being received by farmers. They concluded that there was a need for tools to support advice on environmental aspects of nutrient management.

A common response to perceived agricultural problems, such as environmental nutrient loss, is for science organisations to develop decision support systems (DSS) in an attempt to make researched farm management solutions accessible and useful for guiding on-farm management (McCown 2002). The potential value of simulation models and DSS for assisting decision making in agriculture has been recognised since the late 1960s because of their capacity to predict the consequences of the many interacting factors affecting productivity. DSS are used for a range of purposes, including as a 'proxy' for a decision process and as a 'tool' that simulates part or all of a complex system (McCown 2002).

Industry groups such as Meat and Livestock Australia and Dairy Australia (Black 2005), as well as relevant State and Federal government agencies across Australia, have invested significant funds into a wide range of simulation models and DSS for Australian grazing systems over many years. Most of the DSS that have been developed specifically for aspects of farm nutrient management have focussed solely on production-related decisions such as choosing optimum fertiliser rates. In terms of environmental management, there has been a comprehensive pool of research into nutrient loss processes and pathways, from which a number of complex biophysical models were developed separately from production related DSS. An exception to this is a software format DSS called Overseer® which predicts nutrient requirements for optimum productivity and estimates the quantity of nutrients lost to the environment from New Zealand farms (McDowell *et al.* 2005). However, no readily available DSS for advice regarding environmental risks of nutrient loss exists for the grazing industry in Australia. A combination of community concern, industry demand for information on environmental management of nutrients on farms, and the lack of existing decisions support systems (DSS) to help manage these issues in Australia led to a government and industry funded project (the Better Fertiliser Decisions project, BFD) for developing a new DSS, the Farm Nutrient Loss Index (FNLI). The FNLI can be used to identify the relative risk of nutrient loss to the wider environment from different management zones in grazed pasture systems.

It is well recognised that there has not been widespread use of DSS for on-farm decision making (McCown *et al.* 2002; Black 2005). Despite advances in knowledge about the relationships between soil nutrients and pasture growth, new soil analytical tests, and the development of numerous DSS to support production-related decisions, even the most basic tools such as soil testing are poorly understood and infrequently used by most farmers (Gourley 2001). Key reasons for the failure of many of DSS to gain support from farmers and advisers appears to be the large amount of time required for sampling, pasture assessment, questioning the farmer and entering data and for farmers to understand and operate the systems in contrast to the perceived poor financial return from the time invested. Other reasons include; the feeling that the final options provided by the models are similar to those which extension personnel would have recommended without the use of the DSS; a lack of reliable input information, a general lack of confidence in the models' recommendations and a concomitant decline in extension services in most states. Some of these issues relate to a lack of effective interaction between the scientists building models and the model users, which can lead to the majority of DSS being used only by those people who have been involved in their development (McCown *et al.* 2002). Scientists and industry personnel have therefore attempted to increase the usefulness and use of DSS by developing simpler and more task-specific tools for farmers (Eckard and Box 1998), by engaging with the advisory sector as intermediaries for using more complex software DSS with farmers, and by involving the intended users of the DSS in their development (McCown 2002). Black (2005) also suggests demonstrating the cost effectiveness of using a DSS, training in the use of DSS and continued support for interpretation of DSS outputs are essential for their widespread adoption.

Further challenges arise, however, for transferring models and information about environmental issues because traditionally, DSS development and delivery has focussed on the extension of production-related management issues. In contrast to production-related information and skills, there is often no profit-driven incentive to change management in order to improve off-farm environmental outcomes and so these traditional extension models are even less likely to be effective (Ridley 2004). New and innovative models of science-farmer interaction are required to empower farmers to manage nutrients in ways that protect the environment.

A 1998 survey of Gippsland dairy farmers found that most sought advice on nutrient management from fertiliser industry staff, rather than directly from public service research or extension networks (Gourley 2001). This interaction between farmers and the private sector was consistent with a general trend towards privatisation of extension services in Australia and New Zealand (Marsh and Pannell 1998). For farm production-related extension, which is perceived to have partial or complete private good, privatisation has usually adequately captured the free-market and a fee for service approach has had a reasonable level of success. However, issues relating to environmental outcomes, which have more public good, are less likely to be adequately 'extended' through private industry due to less farmer demand for this knowledge (Ridley 2004). Extension of natural resource management issues has therefore continued to get good government support such as through the National Landcare Program (Marsh and Pannell 1998).

The BFD project is developing information and technology to help support both production and environmental-related issues about farm nutrient management. Therefore, the BFD project team identified farm advisers, particularly those from the fertiliser industry, as key clients for extension of information and technology outcomes from the project. Subsequently, collaboration agreements were signed by the major fertiliser companies in Australia and the project research team. These agreements gave consent for the fertiliser companies to share any of their pasture trial data with the project team, and for the companies to be represented at both technical and strategic planing levels of the BFD project at no net cost to the project.

This paper describes and discusses some of the challenges and opportunities in developing a nutrient management decision support tool, the FNLI, with the anticipated involvement of fertiliser industry advisory staff as intermediaries with farmers. Our reflections highlight the importance of trust relationships between those involved in using such a DSS to exchange information and technology. We conclude that in order to ultimately influence farm practice, developing trustworthy relationships is an important aspect of DSS development that should not be neglected.

2. MATERIALS AND METHODS

2.1. The FNLI

The FNLI identifies a range of land characteristics and management practices that affect the risk of nutrient loss to the environment from beef, sheep and dairy grazing systems in Australia. For each farm management zone, FNLI users select from a range of levels for each factor and this level is allocated a score. The scores are then aggregated to calculate a final risk rating for nitrogen or phosphorus loss via each pathway. The risk ratings for each farm zone that is assessed can be used to guide the management of nutrients. Further details regarding the format and content of the Index are described in Melland *et al.* (2004).

2.2. Stakeholder Interaction

A range of activities were undertaken over a 2.5 year period for the development of the FNLI that involved scientists, extension experts, fertiliser industry staff, private consultants and farmers. Four meetings of a technical advisory group (the 'National Network') were held to guide and provide feedback on the general format and conceptual development of the FNLI. The advisory group generally consisted of 73% university or government researchers, 10% state government extension staff and 16% fertiliser industry representatives. Details of the process and content of these meetings are provided in project Milestone reports available on the website (Peverill *et al.* 2005).

In addition to the National Network meetings, nine participatory workshops involving nutrient management experts were held across key grazing regions in Australia in 2004. The 90 participants of the workshops included government (55%) and university (20%) research and extension staff, fertiliser industry agronomists (20%) and private consultants (5%). A modified Delphi process (Adler and Ziglio 1996) was used in these workshops to elicit expert opinion on the content of the FNLI (Melland *et al.* 2004). The Index was also trialled on 27 farms across the regions to review the relevance of the content to a range of grazing regions and systems in Australia. The format and content of the FNLI therefore represents a synthesis of the best available data and expert opinion regarding nutrient loss from grazed systems.

Two separate groups of grazing extension (DPI Victoria BestWool/BestLamb Program co-ordinators) and fertiliser industry personnel have also had the opportunity to provide feedback on the concept, format and utility of the FNLI for their extension and business services. The fertiliser industry agronomists were participating in a 1-day environmental stewardship accreditation course (Fertcare®), during which they trialled the FNLI (V3.4_July2005) in small groups.

Farmers were involved in the development of the FNLI through group field days and individual consultations. The field days involved small groups in south-west Victoria, the Sydney basin and New England. At these field days, each factor in the FNLI was discussed and the FNLI was trialled by assessing contrasting paddocks. As part of a National Landcare Program project, the FNLI was then trialled individually with sixteen farmers in Gippsland (described by Love *et al.* (in press)). The FNLI was used along with a production-focussed DSS in separate consultations to help develop farm nutrient management plans and trial the effectiveness of the FNLI as a decision support tool.

2.3. Evaluation and Reflection

Feedback on the accuracy and usefulness of the FNLI format, content, development and delivery process was elicited during all of the development activities using written survey or evaluation sheets and through informal discussion and emails. The feedback was reflected upon during formal and informal project team meetings and during discussions amongst the authors of this paper. These reflections are used for developing iterative versions of the FNLI and for planning how the tool should most effectively be delivered to industry during and beyond the life of the project.

3. RESULTS AND DISCUSSION

Initially it was intended that the FNLI would be developed as a stand-alone manual scoresheet or automated software with its main purpose being for calculating the relative risk of nutrient loss from different parts of the farm. The primary aim of the activities used to develop the FNLI was therefore to ensure the scientific rigour of the Index. Secondary objectives were to engage potential users and create in them a sense of ownership of the FNLI and to educate participants about environmental management of nutrients.

Trust emerged as an important theme in our reflection on the FNLI development process because it seems to underpin the development of scientific rigour, ownership and education outcomes. Trust between all parties involved in exchange of information is necessary for information or technology to be successfully adopted. In the case of the transfer of environmental management solutions to nutrient losses from farms using the FNLI, this requires the development of trusting relationships between the government and university scientists, the fertiliser industry and farmers. The FNLI development process has offered many opportunities for developing these relationships between these stakeholders. Whilst trust on a personal level is often built through iterative and frequent interactions (Kramer *et al.* 1996), 'professional' trust is often based purely on someone having a certain set of qualifications that is perceived to carry with it trustworthy credentials (Wenger 1998). The significance of building trust between farmers and the providers of information, and between research scientists in order to effectively exchange and deliver scientific information and promote practice change has been documented by others (Eshuis and Van Woerkum 2003; Jones 2004; Ridley 2004; Vanclay 2004). In this paper we reflect on the importance of building trust between the government and fertiliser industry stakeholders to promote the effective delivery of environmental management of nutrients.

Due to a paucity of interactions in the past, it is the relationship between the government scientists and the fertiliser industry that probably needs the most nurturing to improve our confidence that the FNLI will get used, and used effectively. Demand for knowledge from the private sector regarding how to manage environmental nutrient losses is unlikely to gain the same market 'pull' from farmers as production related advice, because it is commonly perceived that there is greater public than private benefit from most environmental management outcomes (Marsh and Pannell 1998). An assumption that the fertiliser industry will adequately share knowledge and advice regarding environmental management of nutrients on farms with their clients is therefore a risky one. Ridley (2004) suggests developing strategic alliances between public and private organisations is a practical way forward for enhancing the delivery of environmental management advice in the current climate of privatisation of agricultural extension services in Australia. Through its engagement and formal collaboration agreements with the fertiliser industry, the BFD project is providing an opportunity to partly bridge the gap between the commercial sector's production knowledge base and the public sector's environmental knowledge base (Marsh and Pannell 1998). Individual fertiliser companies made significant in-kind contributions through their representation at steering group meetings, national network workshops, invitations to provide staff training opportunities, and FNLI development activities. The FNLI project team's confidence in the fertiliser industry adequately delivering environmental information and technology is increased due to both farmers and the fertiliser industry in Australia placing an increasingly higher priority on environmental management (Gourley 2001; Ridley 2004; Fertilizer Industry Federation of Australia 2005) and therefore seeking both environmental and production-related knowledge and advice (Vanclay 2004).

Due to the non-traditional nature of exchanging environmental knowledge between public sector scientists and the fertiliser industry, it is important for the scientists to employ empathy for the business drivers of the fertiliser industry and the farming reality, in order to make the FNLI marketable and acceptable. This is not dissimilar to the need for DSS designed for farmers to be able to demonstrate relevance as a basis for uptake (McCown 2002). Building empathy for the economic, social and environmental drivers for managing nutrients can be achieved by developing mutual trust between the participants involved in knowledge exchange. McCown (2002) describes the imperative for scientists and stakeholders to exchange knowledge in order to empathise with each others' situations. The National Network meetings, regional technical workshops and the Fertcare® course all provided forums for discourse between the science and fertiliser industry stakeholders in the project.

Another challenge in developing a useful DSS is developing trust in the science that underpins the tool. Professor Gary Jones, Chief Executive E-Water CRC, stressed in an address to the National Farmers Federation (2004) that trust and credibility are essential core values to nurture in order for science to be accepted by all stakeholders. He suggests that conducting science in ways that are transparent and open to scrutiny is fundamental to building this trust. One of the best outcomes of the National Network workshops was enabling open conversations between fertiliser industry agronomists and scientists rather than the one-way transfer of information that normally occurs.

The fertiliser industry representatives and the farmers that have been involved in developing the FNLI are more likely to feel empowered with greater confidence and certainty about nutrient management decisions regarding environmental risk than if they had simply been delivered a finished product that they knew little about (Ridley *et al.* 2003). Similarly, McCown *et al.* (2002) report that by scientists developing a crop growth simulator in conjunction with farmers and their advisors such that they had the skills to use the DSS as a 'what if' simulator, was a powerful outcome and that subsequently, DSS became the basis of a training and accreditation program for agribusiness consultants. A complementary study by Love *et al.* (in press) describes the evolution of the FNLI as both an 'advisory' DSS and 'educational' DSS and how a key strength in using the FNLI as a conversation starter and involving potential users in its development, was that the FNLI development activities provided an opportunity for mutual learning. Ridley *et al.* (2003) also found that to achieve practice change, improving farmers' understanding of environmental principles was more important than a process of documenting or calculating the actual or potential outcomes. It is likely that the risk scores that are the final outcomes of using the FNLI are less valuable for informing a farmer's decision than understanding the principles that underpin the Index. Armstrong *et al.* (2003) similarly describe the most important function of DSS is for promoting questioning and discussion of options rather than for just providing answers. A participatory educational approach such as that used in the development of the FNLI therefore enables the co-creation of an information system making use of both the practical knowledge of the fertiliser industry and government extension staff and farmers and the scientific knowledge of the researchers and agronomists (McCown 2002; Vanclay 2004). Ridley (2004) suggests a participatory 'action learning' approach also enables any gaps between the current farmer knowledge and 'new' knowledge to be breached slowly and iteratively, which increases the likelihood of farmers (or the fertiliser industry in this case) accepting the new knowledge.

4. IMPLICATIONS AND CONCLUSIONS

The development of the FNLI to ultimately inform farmers' decisions about the environmental management of nutrients in grazing systems is important because this aspect of nutrient management is not addressed by currently available DSS in Australia. As well as this, there is an increasing demand by farmers and the fertiliser industry for knowledge and information on the issue of environmental risk. Whilst the fertiliser industry has not traditionally been responsible for delivery of environmental management advice, demand for this advice is increasing. Forming alliances between public sector research and private industry as extension agents is a positive step towards increasing the adoption of good environmental management of nutrients on farms.

Developing trust, relevance and confidence in the FNLI through participation of fertiliser industry and farmers in its development has greater potential to lead to adoption of environmental management practices than developing the DSS in isolation and 'selling' it to the industry. To ensure the FNLI is accepted by the fertiliser industry, it is important to maintain a transparent development process and regularly communicate outcomes of the development to all stakeholders. This will build trust in both the tool and the development process itself.

In reflection of the strengths of the FNLI development process, a powerful use of the FNLI is as a conversation starter for stakeholders to share ideas about the processes of nutrient loss from farms. Therefore training fertiliser industry agronomists in the use of the FNLI as a scenario testing tool within the Fertcare® course and providing an opportunity for feedback to the project team on its relevance to their business and clients and farming systems is likely to have a much greater impact than simply sending them a DSS software package. In doing so, fertiliser industry agronomists are exposed to the tacit scientific knowledge represented by the FNLI and this can be used to enhance or challenge their prior knowledge of environmental risks of nutrient use. Once fertiliser industry staff have been exposed to the FNLI by participating in its development and by being trained in its use, their knowledge and confidence in giving environmental nutrient management advice may improve to the point that the FNLI itself becomes obsolete in their daily business practice. The strength of the FNLI may well lie in its development process more so than in the final product.

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