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Achieving 4% productivity: Implications from a longitudinal study of farmer learning in dairy farming

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ABSTRACT

The New Zealand dairy industry needs to achieve 3 to 4% pa gains in productivity. Accomplishing this on-farm will require continuous innovation by farmers. Innovation may result from the refinement of existing practices, or the introduction of new practices or technologies. Farmer learning will be pivotal to the rate of innovation. However, despite its importance, relatively little is known about farmer learning. We investigated the tactical feed management processes used by two high-performing dairy farmers over summer-autumn for three years, using a multiple-case study design. Learning undertaken by the farmers could be classified within three broad domains (the production and management systems, and the environment), but normally involved the interactions between at least two of these. Two stimuli initiated learning: the occurrence of extreme conditions or the introduction of a new management practice. Different learning processes were identified with respect to these. This study provides a framework for extension agents to identify the “*knowledge gaps*” farmers need to close in order to improve productivity. It also assists developers of a new technology, since farmers want to know how the new technology impacts on their production systems, responds under a range of conditions, and is best incorporated into their management.

Keywords: farmer learning; innovation; tactical management; knowledge, systems.

INTRODUCTION

Over time, and through research and extension, New Zealand dairy farmers have developed a competitive advantage (Porter, 1990) in the management of pastoral systems (Mitchell, 1993). However, this leadership is under threat as farmers in countries such as Australia and Ireland, which can also produce pasture year-round, have entered dairy export markets (Parker, 1998). Threats are also posed from biotechnology that has the potential to dramatically improve the cost efficiencies of our competitors (Parker, 1998). To minimise such threats, Dexcel has set an industry goal of increasing dairy farm productivity by 4% per annum (Boedeker, 2000). Farmers’ ability to innovate will be pivotal to the achievement of this goal and such innovation is driven by farmer learning (Hubert *et al.*, 2000). However, despite its importance little is known about how farmers learn. Even in the extension literature, Ison *et al.* (2000, p. 37) considered this area to be “*under-theorised*” and “*...poorly understood by those who write about it*”. The results in this paper, from a broader longitudinal case study of dairy farmer decision making, provide some insights into how farmers learn. These insights provide cues for technologists and consultants to enhance technology design and transfer.

MATERIALS AND METHODS

A multiple-case study (Yin, 1993) was undertaken over three years to investigate the tactical feed management processes used by two “*expert*” seasonal-supply dairy farmers over the summer-autumn (Gray, 2001). Case farmers were selected on their high levels of performance for the district and expertise in summer-autumn feed management (Gray & Lockhart, 1996). Monthly field observations and semi-structured interviews were undertaken and the interviews were taped and

transcribed verbatim to limit bias (Patton, 1990). Data were analysed using qualitative techniques (Dey, 1993) and the software package NVivo (Richards, 1999) to develop models of the farmers’ decision-making processes. These models were verified with the farmers and then compared to the literature (Yin, 1993).

RESULTS

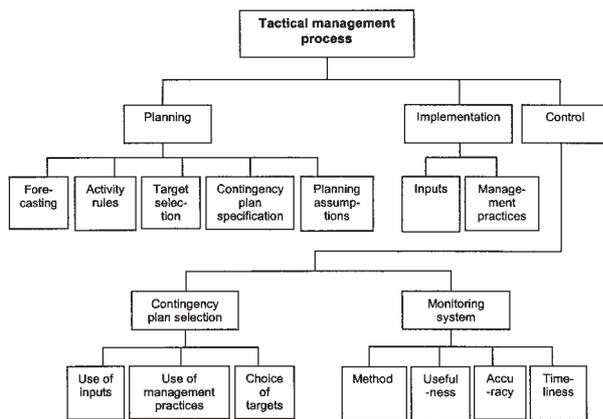
The majority of the decisions made by the farmers during the study were for routine management. The only “*apparent*” learning that was associated with these decisions was that they confirmed the veracity of their existing knowledge. In certain situations, normally stimulated by extreme climatic conditions or the postulation and introduction of a new management practice (or technology), the farmers undertook quite different and more complex decision making processes that were associated with learning experiences. The learning undertaken by the farmers over the three years of the study could be classified under three broad areas: management system, production system and the environment. Learning about the management system related to three major areas: planning, implementation and control. Figure 1 demonstrates the complexity of farmer learning in relation to the management system. For example, learning in relation to planning included their ability to forecast the future, and the efficacy of various planning decisions such as: their choice of activities in the plan (the sequencing, timing, level and types of inputs they used); their choice of targets; and their choice of contingencies to cope with climatic variation (Figure 1).

Learning about the production system focused on important cause-and-effect relationships both within and between the three sub-systems: soils, pastures, and animals. Learning about the environment in this study

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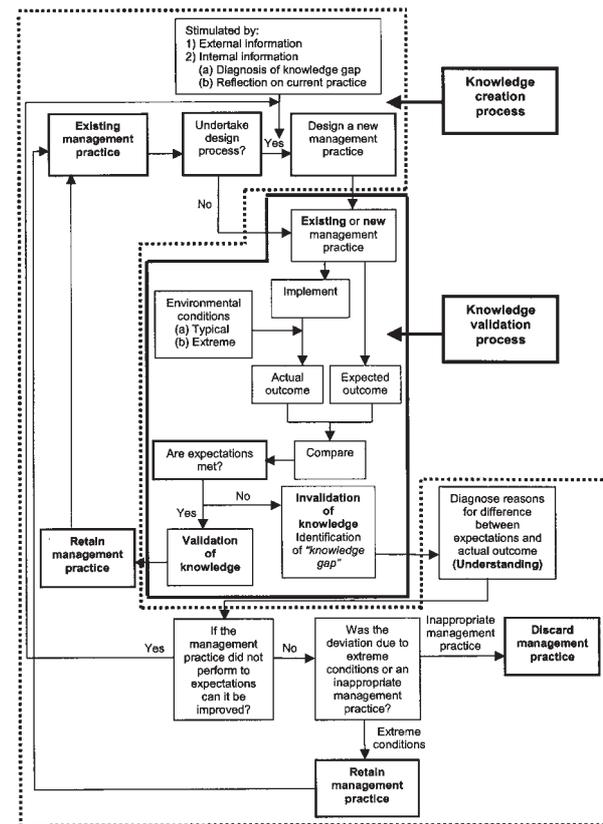
FIGURE 1: A typology of the areas of learning in relation to tactical management undertaken by the farmers.



was primarily about the biophysical environment and in particular, the variation in climatic conditions that occurred over the summer-autumn. Although the three learning categories are intended to represent discrete areas of learning, in fact, most of the learning by the farmers involved the interactions between two or more of these categories. For example, the farmers might learn about the impact of extreme (outside the farmer’s previous experience) climatic conditions on the production system, or the impact on the production system of introducing a new contingency plan to cope with such conditions.

Several types of learning were identified during the study. First and most commonly, the farmers confirmed the veracity of their existing knowledge, a process of “validation”. Knowledge was “validated” when the actual outcome from the implementation of an existing management practice matched their “expectations” for the particular situation (Figure 2). Second, the farmers identified conditions under which their existing knowledge was invalid, using the same process. This occurred when they encountered extreme climatic conditions that were outside their previous experience (Figure 2). As such, a “knowledge gap” was identified because their “expectations” differed significantly from the actual outcome. Once a “knowledge gap” was identified, the farmers undertook a diagnostic process to determine the cause of the deviation. The outcome from the learning was new knowledge (or understanding) about the variation in the environment and how their production system responded to such variation under current management practices. On the basis of their diagnosis, the farmers then determined whether the management practice could be improved. If they believed that it could not, they accepted that, under those extreme conditions this was the level of farm performance they could expect for that management practice. The existing management practice was retained and the main learning in this instance was about the performance of their farming system under current management practices when it experienced extreme conditions. In contrast, if they believed that the existing management practice could be improved, they undertook a design process which resulted in the creation of a “new” management practice (Figure 2).

FIGURE 2: The learning processes used by the case farmers.



The third form of learning happened where the farmers postulated or designed a change in management practice, an innovation (Figure 2). This occurred as a result of new information obtained through either internal or external sources. Internal sources included information obtained as a result of the diagnosis of a knowledge gap as previously explained or as a result of the farmers reflecting on their existing practice. External sources included farm consultants, discussion group days and farming publications and these provided information about new farming practices or technologies. This new information triggered the farmers to postulate or design a management change. Such a change could range from simple (replacement of an old forage crop cultivar with a new one) to complex (introduction of maize silage). Once incorporated into the plan, the management change was implemented at the appropriate time and then the outcome of the change monitored and compared to the farmers’ expectations. Learning accrued from each of the three outcomes: (1) if the expectations were met (validation of new knowledge); (2) if they were not met and the reasons for the deviation were diagnosed (invalidation of new knowledge); and (3) given (2), the farmers then determined if the new management practice could be refined to enhance performance (further innovation). If it could, it was implemented when conditions were appropriate and the cycle repeated. However, if the new practice could not be refined, it was discarded if the deviation between expected and actual performance was thought to be due to the new management practice being inappropriate rather than because it had been implemented under extreme climatic conditions.

DISCUSSION

As predicted by Scoullar (1975), for the majority of the time the farmers used a “structured” (Gorry & Morton, 1971) decision-making process based on previous experience. Occasionally, when faced with a “knowledge gap” (Scoullar, 1975), they changed to a less-structured form of decision making that resulted in learning. These less-structured decisions had more steps and involved diagnosis and design sub-processes as reported in an earlier study by Mintzberg *et al.* (1976). Three broad areas of learning were identified during the study: the production system, the management system, and the environment. Previous authors have identified the production system (Papy, 1994) and the management system (e.g., Dalton, 1982; Kay & Edwards, 1994; Papy, 1994) as areas of farmer learning. However, the “environment” has not been specifically identified. Given that climate is an important source of risk to dairy farmers (Martin, 1994), knowledge of the variation within their environment is a critical area of learning. Detailed typologies (Gray, 2001), not previously found in the literature, were developed for each learning area.

The results suggest that learning involves two main sub-processes: a knowledge validation process, and a knowledge creation process (Figure 3). Other authors (Petit, 1977; Boisot, 1998) have made a similar distinction. At its simplest level, learning involves the validation of existing or previously validated knowledge under known conditions. In this case, no new knowledge is generated. The same process is used to validate new knowledge, that is knowledge that has not been previously validated and this new knowledge is associated with an innovation or new management practice. In this case, validation is critical for confirming that the new practice performs as expected. Petit (1977) also discussed the role of knowledge validation, but only in relation to existing, not new knowledge.

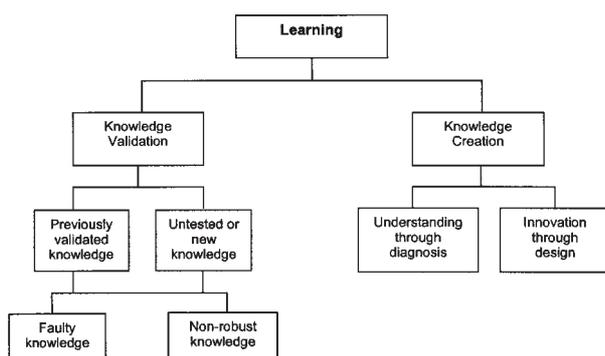
Learning also occurs when the validation process identifies knowledge that is invalid; that is, the farmer identifies that the actual outcome is significantly different from his/her expected outcome. These findings support Boisot’s (1998, p. 20) view that knowledge is a “set of expectations that an observer holds with respect to a given event”. Validation is used to assess the efficacy of both existing or previously validated knowledge and newly postulated or untested knowledge. Knowledge may be

invalidated for one of two reasons. First, the knowledge (existing or new) is faulty, or second, the knowledge (existing or new) is not robust enough to cope with extreme environmental conditions. Invalidation of existing knowledge for either of these two reasons creates in itself new knowledge. Petite (1977) recognised that innovation and improvements in management practice were an outcome when existing farmer knowledge was invalidated. However, he did not discuss the role of the validation process in relation to new management practices or extreme environmental conditions. Interestingly, no instance of the invalidation of existing knowledge was found in this study. Given that the farmers were experts, they may be less likely *ceteris paribus* to identify problems with the validity of their knowledge than counterparts with poorer performance.

The second sub-process (Figure 3) of learning involves a creative element (Petit, 1977; Boisot, 1998). Knowledge is either created through a diagnostic process, or a design process. A diagnostic process is initiated if the validation process identifies a knowledge gap. The role of diagnosis in learning was recognised by Scoullar (1975) as a process designed to close a knowledge gap. In contrast, other decision-making models view diagnosis as a necessary step in closing a performance gap as opposed to a knowledge gap (e.g. Lee & Chastain, 1960; Johnson, 1976). Diagnosis of the reasons for the knowledge gap creates new knowledge in the form of understanding. This may stimulate the design of a new innovation or alternatively, this may be stimulated by understanding that comes through reflection on existing practices (Kolb, 1984) or the investigation of new practices through external information sources (Figure 3). This understanding of a situation, event or technology is translated through a design process (Mintzberg *et al.*, 1976) into management decisions (planning, implementation and control). It is not until the design process is undertaken that a farmer can turn knowledge into action. In a similar vein, Boisot (1998, p.34) distinguished between *creating* knowledge and *applying* knowledge. Knowledge about a new practice is viewed as provisional until after it is implemented and validated (Petit, 1977) over several years. Interestingly, despite the importance of this “creative” process to innovation, little has been documented on it in the literature.

Productivity gains of 3 to 4% per annum, about twice historical levels, will require rapid and effective learning and innovation in the farming community. Innovation is a knowledge-based process and as such extension agents need to focus on the most limiting knowledge gaps in dairy farming and the learning processes best suited to closing them. The framework from this study provides direction on how to achieve this. Both extension agents and the developers of new technologies need to consider technology adoption by farmers from a learning perspective. Farmers will want to know how a new technology impacts on their production systems, responds under a range of environmental conditions, and is best incorporated into their decision-making and management system. Learning was shown in this study to occur through different processes that achieve different

FIGURE 3: A typology of learning.



outcomes. These results suggest that new or novice farmers may focus on validation and refinement of existing knowledge and determining the robustness of their knowledge across a range of climatic conditions. In contrast, experienced farmers may be more interested in incorporating new technologies into their existing system. An awareness of these different learning processes will help extension agents and consultants to promote faster farmer learning and, hence, the innovation necessary to achieve the dairy industry's productivity goal. This paper also highlights the paucity of research into the learning processes of farmers and this should be a concern to an industry that has set itself productivity goals that require high rates of innovation.

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