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## Farm management research in New Zealand and its contribution to animal production

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### ABSTRACT

Farm management is concerned with procedures that assist farm managers allocate limited physical, financial and human resources to achieve their personal (and family) objectives. The process of resource allocation usually occurs with imperfect knowledge, and in the context of a biological and socio-economic system over which the farm manager has incomplete control. Management functions of planning, implementation and control are used to assist decision-making and the realisation of objectives in this uncertain environment. These occur at strategic, tactical and operational levels.

Early development of the farm management discipline was strongly shaped by microeconomic theory (especially production economics) and quantitative methods of analysis (mainly from operations research). More recent development of the discipline has seen the addition of the farming systems research (FSR) philosophy and the application of qualitative techniques used in the social sciences. These additions have improved the capacity of farm management research to account for the needs and aspirations of the farmer and farm family, and to consider the dynamics of the community in which they live. This holistic view recognises that farmers frequently do not exhibit economic optimising behaviour and that their decision-making processes often ignore the classical steps outlined in management textbooks.

In contrast, animal scientists use a reductionist approach to investigate the animal component of the farming system, independent of the financial, social, and sometimes physical, constraints of a commercial farming situation. It is logical then that farm management specialists should work with animal scientists to interpret animal-related research within the context of farming systems. Today's increasingly sophisticated market for land-based products demands effective partnerships among all participants in the science - technology - production - processing - marketing chain. Issues such as sustainability, product quality, animal welfare and the development of effective information systems are not the preserve of any single discipline. The challenge to farm management researchers and animal scientists is to continue to develop effective working relationships in the future.

**Keywords:** farm management; agri-food system; farming systems; resource use; animal production; research.

### INTRODUCTION

This Conference was last specifically addressed on the discipline of farm management and its relationship with animal production in 1962 by Professor Candler. He argued the case for farm management personnel to be involved in an inter-disciplinary role in the design of experiments (particularly in the applied sphere) to ensure maximum utility was obtained by farmers from the data generated. Interestingly, there is a considerable degree of unanimity between Candler's comments and those of Blaxter (1961), who a year earlier, had presented an animal scientist's perspective to the British Society of Agricultural Economists.

More than 30 years later, the setting of New Zealand agriculture in relation to the environment, Government policy and the international market, is radically different to that of the 1960's. The purpose of this paper is to provide an update on the discipline of farm management and expand on the reasons why farm management researchers must be incorporated in inter-disciplinary teams investigating applied animal science problems. A brief discussion of the attributes and history of farm management is provided to give perspective to this discus-

sion. The relationship between the "people" aspect of farm management and animal production research is emphasised.

### The new setting for agricultural research

Agriculture in New Zealand is confronted with a more market orientated economy that involves greater inter-dependence of farm production systems, processing, distribution and consumption. This has been associated with the adding of value to products; improved quality assurance, a legislated requirement for sustainable farming practices, the abolition of Government subsidies; minimal public funding of agricultural extension; increased reliance on computer-based information and decision-support systems; and changes in farm structure that include a trend towards larger farms, a shift towards non-family ownership, more part-time farmers and greater specialisation of labour (although as discussed later sustainable farming practices may reverse the later trend). These changes have brought into focus issues of property rights, animal welfare, quality assurance, landcare and risk management, and the historical need to continue to improve the efficiency of food production. At the farm (micro-) level

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these issues have a common linkage through the farmer and the management system adopted. Beyond the farm, there are links with the processors, marketers and consumers of agricultural products, and importantly also with society, its legal infrastructure and the physical resources of the environment in which the agri-food system functions.

Two other points should also be noted in relation to the setting for agricultural research. The first is that most of the "easy" gains associated with animal production increases (e.g. fertiliser inputs, subdivision, water, grazing management) have been achieved; "second generation" gains will be largely dependent on improving the efficiency of management of pasture and livestock (Dillon and Anderson 1990). In a similar vein, Leaver (1987) suggested to this Conference that the basic resources of animal-pasture systems of land<sup>1</sup>, labour and capital<sup>2</sup> are relatively fixed and as a consequence increases in production efficiency "have to be brought about mainly by changes in management". The second point is that agricultural science in New Zealand has been radically restructured in terms of its organisation, funding and delivery through the Crown Research Institutes. The Government has clearly signalled that it expects a return on public good science funding (PGSF) for research. The key strategic directive for New Zealand's science and technology is "to foster a sustainable, technologically advanced society which innovates and adds value, especially to our strong base of biological production" (Government Statement of Science Priorities, October 1992). In allocating PGS funds, the Government (MoRST/ForST) has indicated that it requires the development of effective "chain-linked" research and the establishment of mechanisms that encourage innovation. This model features feedback links between all stages of the innovation chain, and recognises that innovations occur at various stages within socio-technical systems (involving people, organisation, finance, legal, ecological and other constraints). A collaborative interdisciplinary research orientation, rather than the disciplinary focus which has dominated agricultural research in New Zealand, will be necessary to establish across sector linkages.

It is also clear that a much greater degree of vertical coordination will have to be developed in the agricultural sector. This will require institutional, economic and other links to be addressed (Maughan and Wright 1993), as well as supply management strategies at the farm level to reduce the seasonality of production. A systems approach is essential to achieving vertical coordination, but the "system" is bigger than the farm system; it encompasses the agri-food industry. As discussed by McCall *et al.* (1994) a key part to a systems approach is the inclusion of feed-back from all components of the systems.

Farm management researchers have an important partnership role, along with other research (disciplines), in mak-

ing the chain-linked research model effective. They are strategically positioned to integrate the on- and off-farm factors that impact on agricultural production. On one hand, they can incorporate component research, as generated for example by animal science, into sustainable and profitable farming systems. On the other hand, signals from consumers can also be accounted for in the design of farm production systems (e.g. to produce high quality, wholesome foods through systems which minimise usage of chemicals).

Farm management researchers, as discussed in the following sections, have developed the analytical tools and skills to solve problems both up- and down-stream from the farm.

## The attributes of farm management

Definitions of farm management have been provided by the authors of most standard farm management texts (e.g. Barnard and Nix 1982). However, Dillon's (1980) widely accepted definition (below), encapsulates the essential features of farm management, although it should be understood that the farmers' personal goals are expected to fit within the legal framework of society. This includes the political and social context in which the farm is placed.

*'[Farm management is] the process by which resources and situations are manipulated by the farm manager in trying, with less than full information, to achieve his [or her] goals'.*

More recent authors, such as Boehlje and Eidman (1984), have preferred to discuss farm management in terms of its functions of planning, implementation and control in a manner which is consistent with management science. The need to plan in farming arises from three basic considerations; goals are to be achieved, resources available to meet these goals are limited and the resources available have alternative uses (Barnard and Nix 1982). The farmer must forecast input prices and yields and these sources of uncertainty give rise to business risk (Martin 1994). Although there are a range of planning techniques, (e.g. simple methods such as gross margin and partial budget analyses), surveys of farmers suggest that their use in systematic planning for change is not common (e.g. Lockhart 1990). Rather, it seems that many farmers only undertake a fundamental re-planning of their business once or twice in their working lifetime (Hardaker and Anderson 1981) and this may influence their adoption of new animal science technologies.

Implementation, or putting the plan into practice, typically does not proceed exactly as planned because changes in conditions both on and beyond the farm require adjustments to be made. While the general neglect of implementation in the literature suggests that its relative importance is less than that of planning and control, deficiencies in implementation are just as likely to reduce farm performance as those in planning and control.

<sup>1</sup>It is worth noting here that the New Zealand Meat Producers' Board Strategic Plan indicates that the land available for pastoral farming and cereal crops will decline from 14.66 to 13.30 m ha by 2000.

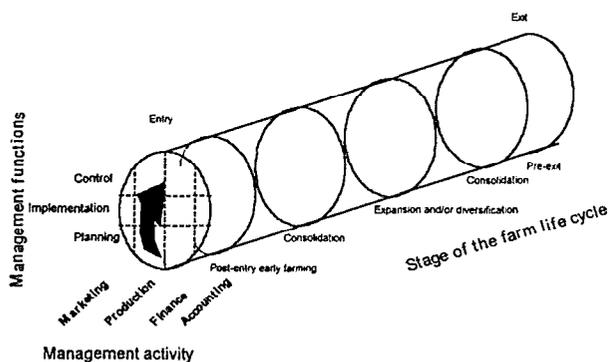
<sup>2</sup>Lyson and Welsh (1993), contend that this neo-classical view of resources in production agriculture, gives little credence to the community and environmental linkages to the farming business. Conventional agriculture, has generally placed emphasis on achieving economies and scale through specialisation, increasing capital inputs, rationalising labour and enhancing management practices. In contrast, diversification of production and strong linkages between production, society and the environment is advocated for sustainable farming systems.

The control function involves the regular comparison of planned targets with information obtained by monitoring the present state of the farm. Adaptive responses are not required providing the performance of the farm, or some component of the farm, is within a prescribed boundary of planned targets. However, when actual performance occurs outside these limits, due to variations in physical or economic conditions or incorrect assumptions/data used in the planning phase, a revised or new plan (sometimes complete with new goals) may need to be developed [see Parker (1993) for a discussion of the application of these management functions on a sheep farm].

The management functions are inter-dependent; there can be no control without a plan; implementation is *ad hoc* unless there are specifications to follow, and data generated by the control process can be used in planning. Movement through cycles of planning, implementation and control is iterative; the frequency being determined by the nature of the production system, the degree of divergence between actual outcomes and that forecasted, or changes in the farmer's circumstances (Gray *et al.* 1992).

Boehlje and Eidman (1984) further segregated farm management into fields of production, marketing and finance and matched this against a life cycle of entry, growth and exit for the farm(er). Osburn and Schneeberger (1983) subdivided an accounting activity from the finance field, in recognition of the difference between financial management and the requirements of statutory compliance (often the only form of "financial" management undertaken by some New Zealand farmers (Lockhart 1990)). The three functions, fields and stages of the farmers life cycle, initially represented as a cube by Boehlje and Eidman (1984), are shown in a modified form in Figure 1. Temporal progression through the farm life cycle is represented along the Z axis of the tube. Some farmers repeat the process of consolidation, expansion and/or diversification several times prior to the final stage. The management process, resulting in decision-making by the farm manager, is presented as being cyclical and is related to coordination of the inter-dependent activities of production, marketing, finance and accounting.

**FIGURE 1:** A graphic representation of the attributes of farm management. Planning, implementation and control is an iterative process across four non-exclusive activities. The farm life cycle is depicted as being largely progressive.



While Hardaker and Anderson (1981) claimed that most farmers adopt a conservative policy of minimal change' it is

still possible to characterise their decisions in order of importance and frequency as being strategic, tactical or operational (see Castle *et al.* 1987). Strategic decisions, involving the acquisition of fixed assets and the long term deployment of resources are likely to occur infrequently (once or twice in a lifetime - see Murray-Prior and Wright (1994)) and set the overall farming policy (e.g. enterprise mix, institutional and other off-farm relationships). Tactical decisions involve modifying the strategic plan for the conditions that apply to the farm for seasons within a year. Thus, the date for a full wool shearing policy may be altered by a month to capture a rise in wool prices (tactical adjustment). Finally there are operational decisions to run the farm on a day-to-day basis. Animal science research impacts at the strategic (animal breeding), tactical (marginal changes to livestock policies), and operational (monitoring of worm burdens) levels of farm management decision-making.

### A brief history of farm management

The farm management discipline evolved during the late 1800's. Up to the 1940's it was primarily concerned with the collection of data through farm surveys, cost studies and the analysis of financial accounts, and the development of farm budgeting techniques (Currie 1955). In 1948, Heady foreshadowed an important change in farm management towards the neo-classical theory of the firm, statistics and mathematical economics, that was to largely dominate farm management and production economics research and education in the post-World War II period (Jensen 1977). Heady believed farm management should (a) guide individual farmers in the best use of their resources and in a manner compatible with the welfare of society and (b) provide analyses of the efficiency of farm resource combinations to assist public administration of resources related to agriculture. It was in the 1950's that courses in farm management were inaugurated at Massey Agricultural College and Lincoln College, although 'farm management' advisors had been working for the Ministry of Agriculture from about the mid-1920's.

Two areas of farm management research were prominent through the 1950's and 1960's. The first related to the development of mathematical programming techniques to analyse the problem of the efficient allocation of resources (e.g. linear programming; Heady and Candler 1958). This work, which used many of the procedures developed in operations research, identified the need for accurate input-output relationships in a form suitable for use by decision-makers. However, it was only partially successful in stimulating inter-disciplinary cooperation between animal scientists and farm management personnel on research programmes to derive such relationships (Wragg 1970). Furthermore, the adoption of quantitative planning methods was poor, in part because many of these approaches were well-removed from reality, but also because the power, availability and cost of computers at that time was seriously limiting (Malcolm 1990, Cameron 1993).

The second area of study related to the development of a model of farmer decision making (Johnson *et al.* 1961). These studies clearly showed the limitations of the static economic theory of the firm and its underlying assumptions

of perfect knowledge and single attribute profit maximization in an agricultural setting. Instead, Johnson *et al.* (1961) confirmed that farmers operated in a dynamic environment with imperfect knowledge of future events and multiple objectives. Methods to incorporate risk and multiple objectives in planning developed from this work.

A systems approach to agricultural research was advocated in the late 1960's by Wright and Dent (1969) and quickly gained sufficient momentum for the *Agricultural Systems Journal* to be launched in 1976. Proponents of systems methodology, many of whom came from a farm management background, believed that it was inefficient to simply fragment research into component disciplines without also considering integration of the data generated and the interactions that occur between various parts of the system. The 'systems' movement of the 1970's spawned two areas of research. The first resulted in the development of simulation modelling (Anderson 1974), and subsequent derivatives such as decision support systems (Stuth *et al.* 1991; McCall *et al.* 1991) and expert systems (Jones 1989). The second, which became generally known as farming systems research, focused more heavily on the farmer, farm family and rural community (Chambers 1983, Doorman 1990). Merrill-Sands (1986) listed the major characteristics of farming systems research as being (a) farmer-orientated; (b) systems-orientated; (c) orientated towards problem solving, (d) inter-disciplinary; (e) complementary to mainstream commodity and disciplinary research; (f) involved with tests of new technology on farms and (g) concerned with obtaining feedback from farmers. Different branches of farming system research quickly evolved (e.g. Farmer First) and new methods to diagnose and resolve the problems faced by rural communities (e.g. "rapid rural appraisal" (RRA)) were developed, especially in less developed countries. In the Western world more emphasis, although substantially less than that given to production economics and farm modelling, was placed on understanding farmers' including their goals (Cary and Holmes 1982), factors influencing motivation, attitudes and beliefs (Pryde 1977), method of learning (Paine 1993) and the processes used in decision making (Attonaty and Soler 1991).

In more recent times (ca. 1980's) farm management has become more aligned with other fields of management science, including agribusiness (Cameron 1993), and less heavily focused on agricultural economics. This shift, evidenced by the writings of Boehlje and Eidman (1984) for example, has been assisted by the greater applicability of the general management model to farming than that of neo-classical economic theory (Johnson 1987).

### Impact on Animal Production

Against this background, and in the light of the new setting for agricultural research, farm management research can contribute to the efficiency and efficacy of animal production in New Zealand in a number of ways including: (a) integrating knowledge from both the micro- (e.g. component experiments) and macro- (e.g. agricultural policy) levels into whole farm systems to assess the physical and financial implications of a change in the method of production through systems research; (b) identification of current practices, pref-

erences, production opportunities and research needs through some form of survey; (c) assessing the economic implications of input:output relationships for animal production systems; (d) incorporating knowledge of the aspirations and circumstances of farmers and the community in which they live with animal production data to design practical farming systems; (e) providing understanding of the decision-making process used by farmers so that information can be presented to farmers in an appropriate format; (f) accounting for uncertainty of production and price in the farm environment to improve farmer confidence in adopting new animal science technologies, and (g) quantifying the impact of various management systems on resource use and sustainability. To date, most collaborative work between farm management and animal science researchers (as evidenced by papers in the Society's Proceedings) has been in the area of integration of component knowledge through farmlet studies (Clark and Lambert 1983), on-farm trials under commercial conditions (Lowe *et al.* 1988) or modelling (McCall 1984), the collection of industry performance data (Taylor 1978) and economic evaluation of alternative production systems (Wright and Pringle 1983). Until recently, relatively little research had been published on the management behaviour of livestock farmers (Paine 1993), the factors that influence the adoption of new animal technologies (Parminter *et al.* 1993) or to the needs and circumstances of farmers and the social context in which they work (McRae 1993). Even less has been published on the sustainability of New Zealand's pasture-based animal production systems; modelling alternative farm systems over a 100 year or more time frame is likely to provide the only practical method of obtaining a long term view of the environmental impact of alternative livestock systems.

Earlier in this paper it was indicated that further advances in agricultural productivity would be largely dependent on improving the efficiency of management. However, the measurement and modification of management behaviour (as opposed to output changes resulting from changes in management) is not straightforward and, to date, has not been very successful (Cameron 1993). There is some empirical evidence to support the case that enhancing management decision-making ability (such as through the provision of management aids such as weighing) can enhance production efficiency and in this respect expert systems could provide positive benefits to pastoral farmers (Gray *et al.* 1992). Basic research into how pastoral farmers learn and make decisions (e.g. Paine 1993) is required for these models to be constructed.

### Improving experimental design for farm management use

Data from animal experiments is often rendered unsuitable for economic analysis and application to farming problems because the range of inputs selected cover only part of the production range (Wragg 1970). This is exacerbated if the research environment is atypical to that in which the farmer operates. However, resolving the data needs of animal scientists and farm management researchers is not always straightforward. The former mainly wishes to obtain statistically significant and reproducible results in order to develop theory

on animal biology (Baxter 1961). The latter requires empirical data to solve farming problems and optimise resource use in a manner which is economically (or managerially) significant (Candler 1962, Wragg 1970). To paraphrase Dillon and Anderson (1990): "*The farmer's problem is not whether or not there is 5% or less chance that an animal-feed allowance function exists, but how much feed to use. Even if the estimated function is only statistically significant at the 50% level of probability, it may still be exceedingly profitable for the farmer to base his/her decision on the estimated function*".

The focus of experimental designs will be sharpened by prior definition of the needs and circumstances of farmers (Chambers 1983) and other participants in the agri-food system. This work should also clearly identify the client group to which the research findings are to be applied. The soft systems research methodology described by Saunders and Townsley (1991) can be applied here to identify differences in beliefs about technical relationships held by 'players' (farmers, researchers, consultants) in the production-technology development business. The methodology shows which aspects of a production technology should be the focus of further learning, provides a means of monitoring the effectiveness of alternative learning strategies, and points to attitude constraints associated with a production technology. Paine (1993) showed that soft systems methodology had the potential to enhance the effectiveness of communication between the players and hence can assist in the process of developing the feedback between system components that is necessary for effective animal production research.

The concerns expressed by Wragg (1970) mean that where possible experimental protocols for animal research should; include measurement details of "state" variables (e.g. soil fertility, pastures, animal breed and status) as well as "management" variables, and be repeated under a range of climatic conditions and physical environments. In presenting the results of animal science to farmers and their advisors, the points listed by Dillon and Anderson (1990) should be borne in mind: "(a) it should be recognised that most farmers operate under opportunity cost constraints imposed by other opportunities and the need to borrow funds; (b) because farmers differ in their risk preferences, probability judgement, and in their managerial style, no particular recommendation is likely to be best for all farmers in a region (c) so far as possible, not just one, but a few alternative recommendations and information on their possible range of outcomes due to [production] and price risk should be given; (d) in basing recommendations on experimental data, allowance should be made for the difference expected between farm and experimental response and it should not be forgotten that traditional tests of significance have little relevance to the farmer's decision problem".

## CONCLUSIONS

The environment for agricultural research in New Zealand in the 1990's is significantly different to that which confronted scientists in the 1960's. The new setting includes a shift in emphasis towards sustainability and more 'risk' in business. Resolving problems and opportunities in this setting will require interdisciplinary cooperation (see Stuth *et al.*

(1991) for a useful discussion on this issue) and mechanisms to be put in place (through the allocation of funds) to ensure that the earlier calls for interdisciplinary cooperation by Blaxter (1961), Candler (1962), and others, are heeded rather than simply given lip-service.

Farm management specialists have an important role in building linkages in the agri-food system both upstream and downstream of the farm. Animal welfare, product supply and quality, and the sustainability of production systems are emerging areas where cooperation between farm management and animal science research is essential. While recent changes in science funding in New Zealand emphasise more efficient resource use, greater accountability to science-users and a higher degree of cooperation, the attainment of the national goal may be hampered by competition for limited funds and the relatively poor ability of the science output classes to handle research that spans across several output classes (i.e. systems). Nevertheless, it is to be hoped that the information presented in this contract session on Farm Management will not be followed by a Presidential address to this Conference that echoes the comments of Campbell (1968): "*One subject we seem never to have considered at this point in the Annual Conference is the place of the New Zealand farm in the general scene of animal production and animal science. We have neglected the human environment in which our science has to function and the impact which our scientific findings and proposed technological changes may have on that environment.....to be effective the scientific solution must be readily applicable within the economic and social framework of individual farms.*"

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