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Learning from the historical failure of farm management models to aid management practice. Part 1. The rise and demise of theoretical models of farm economics

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Abstract. A potential source of lessons for agricultural modellers aspiring to influence farm decision making is the historical experience of agricultural economists in the field, variously termed 'Farm Management Research' or 'Farm Management'. Although the histories of Farm Management in the USA and in Australia differ significantly, in both cases the field was originally characterised by pragmatic on-farm research by agricultural scientists and later taken over by agricultural economists committed to theory-based economic analysis to enable rational planning and decision making. But in both countries, it became painfully evident to reflective participants that model-based Farm Management was not proving relevant to practical managers of farms. An insightful few went further to conclude not just that theoretical models of practice *had* not been relevant but that they *could* not be relevant, and since the late 1970s, the field has been in crisis.

In this series of 2 papers, we seek insights that might explain this extraordinary 'market' failure of models that generate theoretical best practice as a basis for intervention. As an 'experiment', the history of Farm Management is enriched by the discontinuity between 2 'eras' characterised by 2 contrasting intervention approaches, an 'early' interactive and pragmatic era and a 'late' academic and theoretical era. In this first paper, after a brief history of the early pragmatic era and the 'take-over' by economic theorists, we analyse the 'crisis of relevance' that led to demise, relying heavily on the remarkable intellectual journey of John Dillon, the first Professor of Farm Management in Australia who turned from being elder economic theoretician to pioneer philosopher of pragmatic Farming Systems Research.

The significant turn to Farming Systems Research by disillusioned Farm Management economists in the 1980s was preceded by a turn to another systems approach 2 decades earlier, that of agricultural systems modelling. Learning from the autecology of these significant systems efforts to influence the management of farms is the aim of the second paper in this series.

Introduction

It is ironic that as the apparent need for decision support systems (DSS) for farmers and the scientific and computing resources for their provision have grown, so have reasons to question whether our profession's expectations for theory-based intervention in farming practice are well founded. McCown (2002*a*) concluded on the basis of a close look at the histories of 14 cases that the opportunities for a DSS successfully finding a niche in farming practice were limited to 4 functional types. In 2 of these, instead of farmers using DSS software, professional intermediaries use computer models to generate customised analyses or simulations for, or with, farmers (e.g. Carberry *et al*. 2002). Although this has been widely viewed as a novel mode for decision support, ironically, it is the mode for using models in management that preceded the personalised DSS. In reviewing this practical use of models, McCown (2002*b*) looked for lessons from the field of Operations Research/Management Science, but a source even closer to home is the field variously called 'Farm Management Research' (e.g. Taylor and Taylor 1952), 'Farm Management' (e.g. Dillon 1965), and 'academic farm management' (e.g. Malcolm 1990).

Although Farm Management in recent decades became a branch of applied agricultural economics, its some 100 years of history is a particularly rich source of learning for those concerned with scientific research directed towards making a difference in farm management practices. For the first 40 years, Farm Management can be seen as an early form of

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on-farm research and intervention by agricultural *scientists* in North America. After a bitter struggle, the field was then taken over by agricultural *economists* on the grounds that there was a lack of methodological coherence and direction that could be provided only by economic theory. 'Under new management' Farm Management became, for a time, the primary subfield of agricultural economics (Schultz 1939). In contrast, in Australia, leading agricultural scientists were instrumental in generating the institutional support for establishing the economics-oriented version of academic/professional Farm Management. It had become well established in Australia by mid-century, 'boomed and peaked in the 1960s and 1970s, and declined in the late 1970s and 1980s' (Malcolm 1990). The aim of this 2-part series is to understand reasons for the decline in this enterprise concerned with the 'testing and application of various theoretical models and methodologies which emerged from the discipline of economics or agricultural economics. . .' (Malcolm 1990, p. 24). This is followed by an exploration of whether Farm Management (FM) might, in some new adaptive form, less narrowly concerned with *economics*, have a future as effective applied research and intervention in the management of Australian farms that are experiencing new challenges, possibly combined with the notion of professionally mediated, model-based decision support.

Central to our strategy is to use the remarkable career experience of the late Prof. John Dillon, the foundation Professor of Farm Management at the University of New England and the patriarch of this branch of the profession in Australia for 3 decades, to capture both the substance and the drama of the rise and fall of FM in Australia. In his inauguration address, Dillon (1965) shared his vision of an FM enterprise rooted firmly in economic theory. He expected that 'research . . . will continue to become more and more analytical, though not . . . so disciplinary as to lose touch with farmers' felt problems'. He concluded that 'there seems little risk in predicting the continued expansion of farm management as an academic and professional discipline. Farm Management . . . has an assured future'. About 15 years later, this same John Dillon declared that 'FM based on production economics has lost, or must inevitably lose, touch with farmers' needs and the practicality of farming because [its] emphasis on logically attractive but largely inapplicable theory' (Dillon 1979). Dillon's contribution to our story culminates in his insightful analysis of failure (Dillon 1979) as he turned his attention from FM to the fledgling Farming Systems Research enterprise.

In our treatment of FM, we tap historical accounts to better understand the failure of theoretical models to provide a basis for effective intervention in the management of farms. It is an attempt made feasible by a number of reviews written by participants with long experience in this enterprise, who were critically reflective about their own experience and professional culture to a degree that is uncommon. This search for understanding of the collective experience of FM is spurred by recent developments in the environment of farming and current needs for research and intervention. The economic performance of a farm is no longer a sufficient criterion for either researchers or farmers; there is an ecological requirement as well. The inclusion of this additional 'bottom line' has revitalised interest in formal tools that can expedite the search for new adaptations, changes in practice that are both profitable and ecologically sustainable. However, if farmers have not been enthusiastic about past attempts at intervention aimed at improving financial returns, enthusiasm for inclusion of new goals and constraints to management that compete with economic returns cannot be expected without other significant changes. In these 2 papers we seek a better understanding of what changes might make intervention based on science and economics theory more effective than it has been in the past.

We begin with an overview of social changes related to the emergence of 'scientific' management and governance and implications for organised intervention in private practice of production. Against this backdrop we then sketch the course of salient events in, and views about, the 'early' and 'late' eras in FM. The early era of FM featured research and intervention in farm management *without* economic theory. The late era, beginning in the 1940s, was energised by the theoretician Heady (1952). To most agricultural economists, this era is *the* Farm Management phenomenon: the branch of agricultural economics that used theoretical models to provide normative guides for planning the allocation of farmers' scarce resources. We then provide evidence for Dillon's experience to be taken as an instance of a much broader phenomenon that can be seen as a paradigm shift regarding intervention of management *science* in management *practice*. Finally, we discuss new possibilities for intervention to aid the management of farms in the future.

John Dillon was one of a number of disillusioned FM economists who turned their attention to the new Farming Systems Research enterprise in the 1980s. This 'systems' turn had been preceded by a FM turn to another systems approach 2 decades earlier, that of agricultural systems modelling. Learning from the autecology of these significant systems efforts to influence the management of farms is the aim of the second paper in this series.

Changes in management and governance in Western society and the emergence of Farm Management research and intervention

The setting for a publicly funded support system for farm management was, for nearly a century, a taken-for-granted aspect of modern agriculture. But this can now more clearly be seen as part of a broad social trend that featured (*a*) a shift

in the nature of *practice* in production and management activities, (*b*) the proliferation of the professions, and (*c*) the appearance of 'progressive' government with the intent that policy be underpinned by science. From this perspective, FM research might be seen as an instance of a radical new approach to work processes that emerged in the latter half of the 19th Century as a continuation of the industrial revolution. At the time FM research began, the principles championed by Frederick Taylor on how labour activity can be analysed and redesigned by experts for increased efficiency were being 'applied wholesale in U.S. industry' (Anon. 2000). Although originally centred on more efficient returns to industrial labour, 'Taylorism' spread to management. A new view of management emerged, which competed with the traditional view. In the traditional view, the 'manager is a *craftsman*, a practitioner of an art of managing that cannot be reduced to explicit rules and theories' (Schon 1983, p. 236), but rather constitutes a unified *practical* rationality. In the modern view, 'the manager is a *technician* whose practice consists of applying to everyday problems. . .the principles and methods derived from management science', a *technical*/*economic* rationality rooted in theoretical normativism (Schon 1983, p. 236) and providing a basis for rational planning.

These changes constituted something of a revolution in the relationship between knowledge and action, i.e. 'knowing how' in *practice*. The revolution was a displacement in workplace cultures of *customary* management practice, based on cumulative, or sedimented, experience, by theoretical principles of management. In this revolution, management action facilitated by professionals came to be valued over the subjective knowledge of the experienced expert because it was 'rational' and standardised.

Contrasts between these idealised types of knowledge leading to action are highlighted by the knowledge typology of King and McAulay (1991) as adapted in Fig. 1. The first dichotomy is between 'adaptable' and 'actionable' knowledge. Important attributes of 'adaptable' knowledge

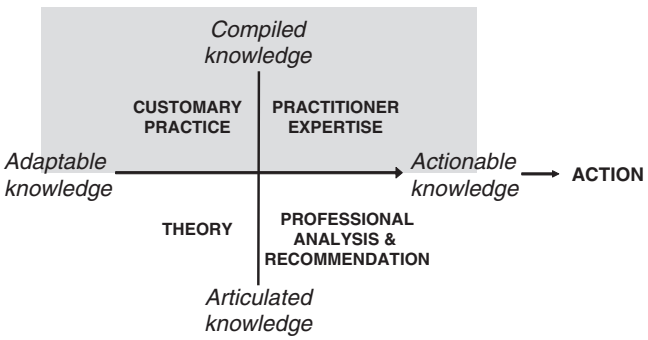

Fig. 1. Knowledge application in two contrasting epistemologies of action: practical (shaded) and technical/theoretic (after King and McAulay 1991).

are its soundness and relevance to action, *in principle*. 'Actionable' knowledge, in contrast, answers the question 'what should I do in this situation?'

Although they appear as a dichotomy in Fig. 1, 'compiled' and 'articulated' knowledge are more realistically considered as anchoring their respective ends of a continuum. Compiled knowledge is specific to its purpose and influences action *as if* it existed as procedural rules. This tacit knowledge is taken for granted by members of a community as 'our way' of doing things, and its nature may make explanation or delegation to 'outsiders' difficult.

Articulated knowledge, on the other hand, is transparent and makes knowledge links explicit. It features 'deep' knowledge that constitutes theory. Articulated knowledge based on theoretical principles produced the standardised *technical* practice that lay behind the proliferation of professions in the first half of the 19th Century (dentists, veterinarians, engineers, and architects), an expansion that reached full pace by the turn of the 20th Century (Vollmer and Mills 1966).

> 'To use the term *professional role* is to imply certain regularities encompassed finally by institutions, and hence standardization. [ ] . . . there are sufficient uniformities in problems and in devices for solving them to qualify the solvers of problems as professional. [ ] . . . professionals apply very general principles, *standardized* knowledge, to concrete problems requiring solution or palliative measures. [ ] The antithesis to a profession is an avocation based upon customary activities and modified by the trial and error of individual practice [Compiled knowledge, Fig. 1]. The profession on the other hand involves the application of general principles to specific problems, and it is a feature of modern societies that general principles are abundant and growing' (Moore 1970, pp. 55, 56; original emphasis).

Early in the 20th Century, the American government set up an instrumentality for undertaking organised programs of research and professional intervention in the management of farms. North American governments also set about modernising rural public education in ways that Taylor (1994) saw as profound social engineering with the aim of 'fashioning' a new type of farmer. This was all part of the 'progressive model' of governance of the early 20th Century.

> 'The progressive movement of the turn of the century sought to introduce scientific methods and techniques into government. It reflected an age when public confidence in science and human progress was at its peak. Progressive political theories sought

> to define a mutual working arrangement between the sources and providers of expert knowledge and the democratic political process. Since the progressive faith in science and human progress seemed boundless, it is not surprising that the progressives were concerned to, first, expand the role of experts in government, and second, ensure that these experts functioned according to the then-prevailing notions of positivistic science' (Maxwell and Randall 1989, p. 234).

Within the 'progressive' philosophy of governance, professional analysis grounded in theory (Fig. 1) became the explicit approach of FM. The following sections highlight the changes in importance of theory, successive episodes of recognition of failure of articulated knowledge to influence farm managers, and successive attempts to rectify this by changing the method and/or scope of analysis or the mode of intervention.

Although the origin of an academic/professional field of FM can be related to the above broad social changes in and around management generally, it can also be related to pressing problems of agriculture at the turn of the 20th Century. Economic and social problems due to radical change in agricultural production and marketing were being felt not only in North America, but in Australia as well.

> 'The [North American] prairie agricultural economy developed in a global context. Between 1870 and 1930 the world market in wheat emerged and was consolidated, the geographic frontiers of global production expanded, and farm households displaced both capitalist and peasant enterprises as the primary form of wheat production in all regions of the world market. This new world market facilitated the emergence of farm households, but their expansion was dependent upon individual and varied state initiatives. [ ]
> . . . fifty million people left Europe between the 1870s and the 1930s . . . [ ] European emigration was organized through states and corporations seeking to colonize new lands with farmers. The territorial expansions in the United States, Australia, Canada and, to a lesser extent, Argentina utilized farm settlement to effectively incorporate new areas into existing states. Wheat farming required the least financing and organization of any alternatives for incorporating new territory and governing it adequately' (Taylor 1994, pp. 7, 8).

Drawing on the archives of the Victorian Crown Lands Commission, Powell (1973) described this phenomenon in Australia:

> '. . . the pioneer was not simply confronted with the consuming challenge of a strange land: he was obliged to work within a type of artificial environment, the product of the various efforts of individual governments to control the spread of settlement. [ ] As in so many of these subhumid areas of the New World, wheat swiftly became the chief product – in addition to its obvious qualification as a frontier cash crop, its expansion was assisted by protective duties from 1868. Victoria became self-supporting in wheat in 1877 and started to export the surplus. Concurrently, the proportion of the employed population engaged in agriculture increased – from one-seventh to one-quarter between 1861 and 1881; but already there were signs that these impressive statistics hid a great deal of doubt and uncertainty and more than a little downright despair amongst the new agriculturalists' (Powell 1973, pp. xiii, xiv).

A great deal of the despair traced to an external source:

> 'As farmers began to produce wheat for the market, the price fell. Any producers who were paying rent or wages, were tending too small a plot, or were unable to improve production techniques were put under pressure' (Taylor 1994, p. 8).

As these conditions worsened during the closing years of the 19th Century, in the United States there developed the idea of directing the, still young, agricultural *science* enterprise and the still infant enterprise of agricultural *economics* onto the task of improving farm profitability through professional facilitation of more efficient farm management planning and decision making.

> 'It was the cost-price squeeze farmers experienced in the latter part of the century that created the climate for a growing interest in farm management. The need for correlating farm management precepts into a unified set of scientific principles became apparent. [ ]
> . . . pioneer economists and agriculturalists with economic interests began to make their contribution by drawing upon the *logic of the situation* to urge a more business-like development of agriculture' (Case and Williams 1957, pp. 8, 9; emphasis added).

In 1902 the Office of Farm Management within the Bureau of Plant Industry was established in Washington DC. Although many agricultural producers were experiencing

acute financial stress, in many respects this was a heady time for agriculture from the standpoint of national policy: large areas of vacant land had been settled; a revolution in mechanical technology for the farm was well advanced; and agricultural research systems had been established. The new Office of Farm Management was established with the objectives of

> '. . . bringing together in concrete form of all the facts developed in the Bureau as a whole, sifting the results, and applying them in a practical way where they will do the most good. To enhance the value of his work general studies have been inaugurated in the matter of securing facts regarding the way in which the best paying farms in the country are being managed, and what are the relationships of surrounding conditions such as proximity to markets, ways of leasing or controlling the lands, soils, and climate, and the methods of farming followed' (Report of the Secretary of Agriculture 1902, quoted by Wilcox *et al*. 1943, p. 3).

In 'Fifty Years of Farm Management', Case and Williams (1957) provide a comprehensive history of the origins of FM. Although this deals only with the American experience, Williams was an Australian who had returned from study in the US and, by the time of publication, was working in the Bureau of Agricultural Economics in Canberra. As viewed by these agricultural economists, the ideological and institutional rationale for 50 years of government-funded intervention in farm management practice was unambiguous:

> 'The changes of the last fifty years have created problems which are too widespread and too complex for the individual farmer to solve most satisfactorily without help. Since an efficient agriculture is in the interest of all consumers, state and federal government agencies have been created to deal with these problems, and specialists trained to cope with the particular problems of farm management have found a practical role in influencing techniques of agricultural production' (Case and Williams 1957, p. 10).

The 'early era': research and intervention in farm management without economic theory

In even a cursory reading of the American history of FM, the discontinuity between what we are calling the 'early' and 'late' eras reveals the existence of 2 cultures, one succeeding the other following a period of vigorous contention. Since the vantage point of hindsight has been accessible only to those of the late era, historical accounts of the early era have been written from the perspective of economists. To Case and Williams, the problem in the early era was that

> 'The early leaders in the studies of farm management were not trained in economics . . . [and] had not been trained to appreciate the need of co-operation with economists and other social scientists. The workers attempting to solve problems in agriculture were trained as physical scientists' (Case and Williams 1957, p. 14).

If this interpretation by economists has a condescending tone, it is no greater than that in earlier writings by agronomists about economics, such as the following by G. F. Warren, who 'trained as an agronomist and horticulturalist' (Case and Williams 1957).

> 'Of all the men working in agriculture, the *agronomists* came nearest to seeing the farm as a whole. It was not a long step from crop rotations to cropping systems and from that to the farm as a whole. [ ] One distinct advantage for this procedure was that it resulted in the immediate adoption of the scientific rather than the philosophical method of procedure. In the earlier days, *economics was primarily philosophy rather than science*. The agronomists who went into farm management carried over their scientific method at once into all their work' (Warren 1932 quoted by Case and Williams 1957; our emphasis).

The man chosen to develop the American program in the new Office of Farm Management was W. J. Spillman. In 1902 he set out his philosophy about the nature of the enterprise his organisation was to support.

> 'The most successful system of farming is that which gives the largest profit, leaves the soil in condition to yield maximum crops, and brings to the farmer and those dependent on him the largest measure of happiness. In conducting a farm upon such a system, the farmer must continually answer for *himself* the questions. What crops shall I grow and what area of each? What care shall I give these crops and the soil upon which they grow? What disposition shall be made of the product of the fields? If the crops are to be sold, then when and where? If they are to be fed, then to what classes of stock and to what number? What manures and fertilizers shall be applied to the soil, to what crops, in what season, in what quantities? [ ]. The repeated answering of these and other similar questions constitutes farm management – a business in which is found the application of many sciences, but

> *a business so broad and complex that it must rest mainly on the accumulated experience of generations of those who have followed it*' (Spillman 1902 Yearbook of Agriculture; emphasis added).

To Case and Williams (1957) the positive side of this stance was its attempt to treat the farm holistically, as opposed to the treatment by the agricultural science disciplines. The deficiency was its dependency for this unity on customary practice based on cumulative experience rather than on economic theory of the farm as a firm.

> 'The emphasis [of Spillman] on the interrelationships between different farm enterprises in operations indicates the break from the subject-matter of the specialists in various branches of agricultural science. Although economic problems were raised, there was not at this stage any attempt to use economic principles in solving the production problems of the individual farm. [ ] "Accumulated experience" was considered the best guide. [ ] Farm management, as then conceived, consistent largely of seeking out successful farms as models so the other farmers might adopt practices followed on them' (p. 19).

The most successful contributions during the early era of FM came from *farm management surveys*, which focussed on 'factors affecting profits' and *farm business analysis* featuring cost accounting. Early research on farm accounts and bookkeeping involved very intensive data collection and was carried out in cooperation with individual farmers. Although the level of detail of much of the record-keeping research proved to be more than was warranted for routine management, conducted as it was by agricultural scientists motivated to rigorously describe the farm system, it did lead to more feasible, effective methods of financial monitoring, including budgeting (Wilcox *et al*. 1943, pp. 7, 8). For a period of about 30 years from 1910 these methods were institutionalised in universities and government agencies nationwide and beyond (Taylor and Taylor 1952, p. 388).

Although pressure for more economics in agricultural economics and more agricultural economics in FM intensified during the 1920s and culminated in the 'take-over' of North American Farm Management by agricultural economists in the 1930s and 1940s, some economists who supported the change later conceded that the researchers of the early era could not be condemned for their resistance.

> 'They had strong constituent support among the farmers they serviced well and academic support in the allied technical agricultural disciplines from whence they came. Though these workers employed very little economic theory, they contributed to the solution of many problems facing farmers with relevant information from their accounting and descriptive work and a substantial quantity of commonsense. No one can deny that the earlier, non-theoretical farm management workers made real contributions to agriculture, contributions which developed much financial support for the emerging discipline of agricultural economics' (Johnson 1963, p. 13).

The nature of the intervention approach that was characteristic of early era FM does not fall neatly in either of the contrasting knowledge paradigms of Fig. 1. It lies somewhere between 'compiled knowledge' and 'articulated knowledge'. Researchers acting as professional facilitators of expert practice recognised the legitimacy and importance of compiled knowledge in customary practice. But they also saw opportunity for intervention that resulted in new actionable knowledge, not by applying the 'deep structure' of economic theory as did their successors, but by facilitating farmers to see regularities—'surface structure' (Dreyfus 1994, p. 114)—of their business to augment their expertise. The tools of cost accounting, cost-price analysis, and budgets created articulated, actionable knowledge through methodical monitoring and abstracting their own management history and the current environment.

Underlying the incursion of economics into FM was the diversification beyond the original goal of providing data for an extension service designed to aid individual farmers in increasing their profits to finding 'some reconciliation between this goal and that of the *general* welfare' (Case and Williams 1957, p. 341). But late era FM still retained the original goal, and continued to claim that increased use of theory and models would be more effective in achieving direct benefits to farmers than traditional descriptive approaches.

The effects of the Great Depression and World War II hastened the inroads of economic theory to the FM movement. 'The submersion of farm management into agricultural economics continued to occur intellectually as well as administratively' (Johnson 1963, p. 14).

> '. . .the early descriptive, non-theoretical work in farm management was relevant for the solution of practical problems. [ ] However with the passage of time, the interests of these workers and their successors became introverted instead of focused on problems. Much of the descriptive work began to be done for its own sake,

> i.e. it concentrated on repetitive estimation of certain accounting ratios and on repetitive surveys and reports. Essentially the same pattern of facts was gathered from account keepers and cooperators in surveys, while times and problems changed violently in the 1920s and 1930s. [ ] After World War II, the irrelevance of much of the positivistic farm management accounting and survey work was clearly apparent to agricultural economists and to administrators. The older or "traditional" type of farm management fell in administrative esteem. Those pre-war Departments of farm management, which had existed independently of Departments of agricultural economics, were merged with those Departments and, for the most part, lost their identity under administrators more fully committed to the use of economics in farm management' (Johnson 1963, pp. 13, 14).

In Australia, prior to the domestic growth of a discipline of agricultural economics, there was no distinctive field of FM. Research, development, and extension related to management of farms were part of several disciplines comprising agricultural science. In 1965, John Dillon became the foundation Professor of Farm Management in Australia. In his inauguration address, Dillon pieced together fragments of the Australian experience in the period of 'The Forerunners' and made some general observations:

> 'What of the orientation of [Australian] farm management work, so far as it existed in this early period from the start of the century through to 1940 odd? . . . the predominant influence was an agricultural science orientation and training complemented by an apparent lack of interest by general economists in farm management or economics relating to farms. [ ] . . . virtually all of the farm management work carried out over this earlier period fell within the compass of simple cost accounting, the description of farming methods, and the commonsense appraisal of the impact at the farm level of macro-economic conditions and policies . . . the work of the period was extremely naive and unanalytical [but] overall it certainly did not have the fault of not being addressed to real farmers' real problems' (Dillon 1965, p. 181).

In contrast to North America, where the FM was dominated by a struggle for primacy between the pragmatic agricultural scientists and the theoretical agricultural economists, in Australia, appeals for a greater agricultural economics presence were put forward in the early 1940s by agricultural *scientists* (Dillon 1965; Malcolm 1990).

The 'late era': the struggle to make the 'theory of the firm' applicable to the family farm

Dillon (1965) noted a gradual change in research concerning farm management in Australia from 'a rather descriptive to a rather normative and strongly analytical orientation' over a period of 2 decades and attributed it to the methodological developments made in the US in the 1930s. But in American FM, following the take-over by the economists, it didn't take long for some to conclude that things were not going according to expectations. As early as 1963, Glenn Johnson lamented the institutionalisation of FM as a subfield of production economics in American universities and the USDA. With no lack of irony, he reported on 'Trends since the triumph—A loss in productivity'. The good news was that the use of economic theory in FM had increased many fold, as had the use of advanced statistics, mathematics, and computers. But the bad news was that this new FM with a production economics orientation had become 'more focused on methodological and theoretical issues of *less and less relevance* to the solution of practical farm management problems. . .' *Use* of FM outputs in intervention by extension workers had *decreased* as its theoretical orientation had *increased*. Johnson concluded:

> 'Somehow or other, these trends are not in accord with the expectations accompanying the shift [away from description] to problem-solving Farm Management based on the use of more theory. *There has been no rush of farmers to obtain the results of agronomic-economic research or of similar research in animal husbandry*' (Johnson 1963, p. 17; emphasis added).

However, in Australia, establishment of the Chair of Farm Management at the University of New England in 1965 was indicative of continued momentum in establishing a more rigorous FM research and professional practice. In Prof. Dillon's inaugural address (Dillon 1965), after looking back on past FM in Australia, he set out his vision of how farm management, as a *science*, could make greater impact on practical management of farms. Deficiencies of production theory to represent farming realistically were acknowledged. Of pressing importance were the overly heroic assumptions in production economics theory:

> 'Obviously, this is a tremendous simplification of reality. Questions of risk and uncertainty and non-profit motivations, whether they be fixed or changing over time, are completely ignored. The assumptions totally ignore the fact that each farmer is an

> individual. He has a unique set of preferences that shift over time between profit and other goals that both involve uncertainty of attainment' (Dillon 1965, p. 187).

Dillon advocated a stance of 'conditional normativism' to provide greater relevance to real management systems by allowing conditions to be specified with regard to a farmer's (*a*) preferences for different types of benefits additional to profit and (*b*) uncertain knowledge that affects actions. This stance set the agenda for research for the next decade. The objective became to inject reality by means of risk analysis while still attempting to retain the ability to generalise from the analysis:

> 'Research, I expect will continue to become more and more analytical, though not, I trust, so disciplinary as to lose touch with farmers' felt problems. The major area of research, probably, will be farmer decision making, both in terms of the search for. . .behaviour patterns in the face of risk and uncertainty, and in terms of applying modern techniques of business analysis to farm problems conceived as a conditional normative framework' (Dillon 1965, p. 189).

However, he judged that there were limitations to how far customisation of analysis could go:

> 'Obviously this conditional normative approach *could involve highly individualistic analysis if carried to extremes. In such terms it is clearly unmanageable*. The best procedure would seem to be the compromise one of relaxing the profit maximisation and perfect knowledge assumptions slightly, evaluating broad classes of problems under the assumptions and *presenting the results to farmers on a* '*take it or leave it basis*'. Such an approach implies saying to farmers, for example, "if you want to keep a fodder reserve for drought that has the least expected cost, then your best bet is so and so"' (Dillon 1965, p. 187; emphasis added).

As regards practice of farm management *intervention* in which the theory was applied, Dillon took heart at the 'seeds of adequate Farm Management and advisory units' in the public sector. He also placed significance on the development of a private management consultant industry in Australia that had grown to 120 from a single practitioner 10 years earlier in 1955. As to the flows across the 'gap' between theory-oriented analysts and practitioners, he expected 'feedback pressures from the fast developing profession of farm management consultancy, in turn reflecting the increasing and never-ending managerial pressures faced by farmers. . .'. Thus, Dillon seemed to hold a picture of FM researchers using a conditionally normative method and in close contact with public and private extension workers who ensured that the research questions being analysed were relevant.

Judged by the academic eminence achieved by his department, Dillon's vision in 1965 of a bright future for a discipline of FM in Australia seemed to be realised over the succeeding decade. But problems grew. By 1976, the then President of the Australian Association of Agricultural Economists and colleague in Dillon's department (having been renamed 'The Department of Agricultural Economics and Business Management'), judged that 'Farm Management barely existed as a branch of agricultural economics *providing advice which influences the decisions of farmers*' (Musgrave 1976, p. 138; emphasis added). This was not due to a paucity of powerful analytic techniques. Such techniques continued to develop, but evidence of a decline in confidence of their value for aiding practical decisions accumulated, e.g.:

> 'We do not believe that all the theoretical niceties discussed are relevant to all real-world agricultural decisions. How much effort should be put into any particular decision depends on the time available, the cost of the analysis, and the importance of the decision' (Anderson *et al*. 1977, p. x).

And it was not long before Dillon was questioning if it was *possible* for economic theory to lead to actionable knowledge on farms:

> 'In general the criticism can be summarised as saying that . . . FM based on production economics has lost or must inevitably lose touch with farmers' needs and the practicality of farming because of this emphasis on *logically attractive but largely inapplicable theory*' (Dillon 1979, p. 11; emphasis added).

The *fact* of this critique by this renowned champion of economic theory in FM was in itself significant, although it received very little attention. But the critique of Dillon (1979) so systematically and comprehensively encompasses the crisis of the enterprise of FM that we believe it justifies the length of the following quote.

> 'There is no conceptual difficulty in formulating static production economics in terms of a utility-maximizing criterion, nor in conceptualizing its logic for non-physical processes. The difficulty lies in *application*.
>
> First, data are not available to be able to specify the relevant production processes (both physical and non-physical) to any significantly relevant degree – particularly if we recognize the *uniqueness of individual farms* (*1*).
>
> Second, the farm system is *dynamic*, not static (*2*), both in the broad as a purposive organization in a *changing* environment and also through the pervasive role of

> biological time-dependent growth processes in its technical subsystem. [ ]
> Third, even if data were available to specify the required production processes adequately, the task of analysis even under perfect information would be both *too complex* (*3*) and too costly for either farmers or computer-aided professionals. "Non-optimizing" modes of behaviour have to be used.
> Fourth, the problem of *uncertainty* (*4*) has to be handled. Again this is pervasive in agriculture due to the stochastic vagaries of climate and markets especially, but also because of uncertainty about technology, policy and people. While techniques have been suggested to handle such uncertainty, their cost on anything approaching an individual farm basis makes them impractical.
> Fifth, even if all farmers faced the same production functions and the same judgements about the probabilities they faced, they would still have *different preferences* (*5*) and so need different prescriptions for utility maximisation across their *individual multiple goals* (*5*)' (Dillon 1979, p. 11).

In the broad terms of Fig. 1, professional facilitation of articulated knowledge ran into difficulty because the richness of real farm systems, with their human dimensions, could not be adequately approximated by analytical models based on microeconomic theory.

In the introduction to the present paper, part of our 'scene setting' for FM was provided by Schon's distinction between *practical* and *technical* epistemologies of practice and the trend in displacement of the former by the latter. Schon (1983) went on to describe a general crisis that developed in the professions in the 1960s:

> 'When leading professionals write or speak about their own crisis of confidence, they tend to focus on the mismatch of [their] traditional patterns of [facilitator] practice and knowledge to features of the practice situation – *complexity* (*3*), *uncertainty* (*4*), *instability* (*2*), *uniqueness* (*1*), *and value conflict* (*5*) of whose importance they are becoming increasingly aware. Why . . . should leading professionals and educators find these phenomena so disturbing? Surely they are not unaware of the artful ways in which some practitioners deal competently with the indeterminacies and value conflicts of practice' (Schon 1983, p. 19).

The inserted italicised numbers following each of Schon's 5 features of situations of real-world practice point to Dillon's 5 difficulties in applying formal models, above. The correspondence with this analysis by Schon, a renowned MIT academic and planning consultant, reinforces the insightfulness of Dillon's critique of several years earlier.

In the context of the theme of this series, learning to make theoretical models relevant to the management of farms, this obscure paper of Dillon (1979) is one of the most remarkable and significant in the entire diverse enterprise in which agricultural economists and scientists have sought to conduct research to facilitate improved management practice. In 1965, Dillon had advocated theory-based analysis for farmers, with farmer involvement only in the decision to 'take it or leave it' (Dillon 1965, p. 187). By 1979, Dillon was impressed with farm management as a *human process*: 'a process by which resources and situations are manipulated by the farm manager to achieve his goals'. Here is one of the most eminent figures of FM economics in the world, and the leader of the enterprise in Australia, declaring that from his *experience* he had learned that analytical models based on production theory had not simply been *ineffectively applied*, but that they *were* '*inapplicable*'. Dillon (1979) declared that a new paradigm was needed and that the most promising was that of 'systems', 'at least until the next revolution occurs!'

Economists in Australia had constructed, and in North America had *re*-constructed, FM in the belief that the production theory implicit in neo-classical economics was the key to more effective aiding of farm management planning and decision making. But after 40 years of application efforts, the gap between the theory of FM and farm management practice may have *increased*. Malcolm (1990) concluded that:

> 'By the late 1970s academic work in farm management had largely run its course. Most of the trails blazed in the long boom of activity in academic farm management since 1940 had been followed at some length. . .'. '. . .over time emerged an increasingly commonly-held unease, and occasionally conviction, that these were trails which if followed, soon led from the complex and difficult whole-farm pastures of plenty to simpler and easier analyses characterised by incomplete and inappropriate disciplinary balances and resulting in work which was not really about farm management' (Malcolm 1990, p. 49).

Attempts to patch deficiencies in the theory of the farm firm

Malcolm (1990) reviewed 3 areas of innovations in theory and methods in FM: activity analysis/mathematical programming, decision analysis, and systems analysis and simulation. These 3 approaches received attention in FM as a result of (*a*) recognition of deficiencies in production theory

and (*b*) their availability from outside of agriculture, mainly from the large field of operations research/management science (OR/MS) (Agrawal and Heady 1972). OR/MS had experienced its own similar crisis of relevance of management theory to practice, whose diagnosis by Schon (1983) so closely aligned with that of Dillon (1979). We will conclude this paper with a critical look at the relevance of *activity analysis* and *decision analysis* to farm management. Systems analysis and simulation are reviewed in the second paper of this series.

Activity analysis/mathematical programming

Figure 2 uses a representation of a farm organisation as a Management System and a Production System with feedback connections (Sorensen and Kristensen 1992) to help depict the nature of the difference between 2 contending FM perspectives, or orientations. Addition of a market environment to Fig. 1 provides conceptual space for neo-classical microeconomics, i.e. the theory of the firm. In this 'theoretical orientation', models of the market enable marginal analysis of resource use for production. The Management System is represented simply as a rational profit maximiser with specified resources of land, labour, and capital. The Production System appears only in production functions: simple mathematical transformations of inputs to outputs using technical coefficients abstracted from empirical production research.

The 'theoretical orientation' of FM corresponds to the neo-classical theory of the business firm, in which behaviour of a firm is analysed with respect to actual and possible transactions in factor and product markets as well as the technical efficiencies of productions. Another orientation is provided by the *behavioural* theory of the firm of Cyert and March (1963). From this perspective, *goals*, *expectations*, *choices*, and *control* in the Management System are primary (Cyert and March 1963; Day 1964, p. 461). The *behavioural* emphasis is on interactions between the Management system and the Production system. We have labelled this a 'process orientation' to contrast it with the 'theoretical orientation' of the upper part of Fig. 2. Day (1964, 1971) attributed the emergence of a 'behavioural' school of economics and a process orientation to both the inadequacies of neo-classical economic theory in relating to the way organisations actually work and the development of mathematical programming that enabled process-level treatment without losing mathematical optimisation.

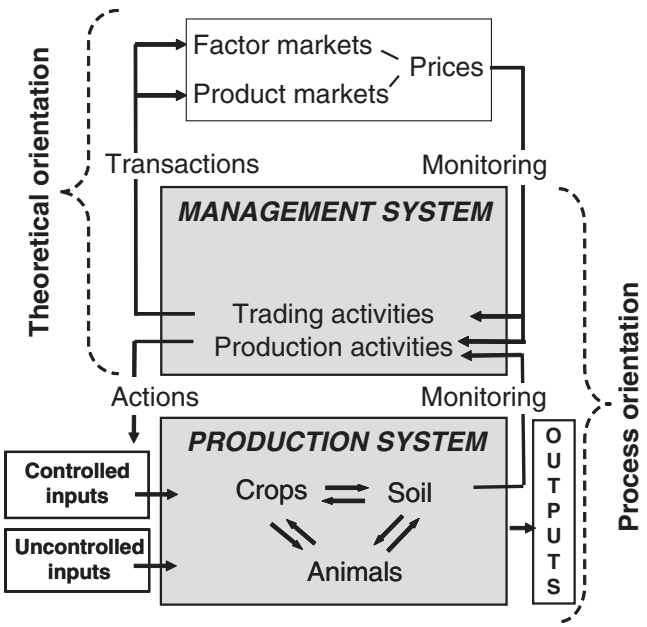

Fig. 2. The differing domains of two orientations of Farm Management.

Although it never gained wide currency, the term 'activity analysis' was sometimes used to refer to mathematical programming in the analysis of process (Dorfman 1953). Longworth and Menz (1980) proposed that activity analysis could bridge the gap between economic theory and the management of farms. These authors begin their paper with a succinct quote from Dorfman (1953), but the more complete quote serves our purpose here.

> 'The central formal problem of economics is the problem of allocating scarce resources so as to maximize the attainment of some predetermined objective. The standard formulation of this problem – the so-called marginal analysis – has led to conclusions of great importance for the understanding of many questions of social and economic policy. But it is a fact of common knowledge that this mode of analysis has not recommended itself to men of affairs for the practical solution of their economic and business problems. Mathematical programming is based on a restatement of this same formal problem in a form which is designed to be useful in making practical decisions in business and economic affairs. [ ] The motivating idea of mathematical programming is the idea of "process" or "activity". A process is a specific method for performing an economic task. [ ] Economists are accustomed to thinking in terms of decisions as to the quantities of various productive factors to be employed. But an industry or farm cannot substitute Factor A for Factor B unless it does some of its work in a different way, that is, unless it substitutes a process which uses A in relatively high proportions for one which uses B. *Inputs*, *therefore*, *cannot be changed without a change in the way of*

> *doing things*, and often a fundamental change. Mathematical programming focuses on this aspect of economic choice' (Dorfman 1953, p. 707; emphasis added).

The distinction between these 2 domains of Fig. 2 is described nicely by Longworth and Menz (1980):

> 'Historically, the neo-classical theory of the firm was developed to explain the behaviour of markets, rather than to prescribe optimum management strategies for individual firms. The neo-classical theory of the firm is essentially outward looking towards the market, in that it emphasizes the response of the firm to market forces. On the other hand the activity [process] approach to representing the production choices faced by the individual firm is inward looking. The emphasis is on representing the situation as managers tend to see it' (Longworth and Menz 1980, p. 17).

These authors refer to a family of process-oriented techniques, including physical input–output ratios, gross margins analysis, and budgeting as 'traditional' practical procedures that stemmed from the early era of FM. They argued that the so-called 'activity', or 'process', analysis using mathematical programming demonstrates and uses the *substantive congruity* of the process and the theoretical orientations. Dorfman (1953), Longworth and Menz (1980), and Rae (1994) all emphasise the benefits of the gain in relevance to the Management System (Fig. 1) by using analytical representations that align with managers' ways of 'seeing' and ways of doing, and without forcing analysts to forego optimisation. But, in spite of these conceptual advances, there has been a notable lack of use of activity analysis in farm management and intervention aimed at helping farmers' planning. Pannell (1996) argues that farmers manage quite well without such formal models 'because of their intimate knowledge of their farms. . . .they are usually near enough to the theoretical ideal for their particular circumstances to obtain most of the potential benefits'. In Western Australia, the main benefits to farmers of the programming model, MIDAS, have been indirect, through providing 'outsiders attempting to serve or influence farmers [a] way of analyzing and understanding whole-farm issues' (Pannell 1996, p. 374).

Decision analysis

No shortcoming of the neo-classical theory received more attention than the assumption of an environment of perfect information for choice among alternatives, with the implication that analysis need not deal with the complications of uncertainty or risk (Dillon's 4th point of criticism, p. 9 above). Decision theory offered a means of rational economic analysis and design of plans that didn't assume away the psychologically rational preferences and expectations of managers. It did this by incorporating managers' *utility functions* that weighted preferences for possible consequences as well as their *subjective probabilities* for uncertain events.

Substantial attention was given to decision analysis in FM in Australia, led by the University of New England group with their widely acclaimed book, 'Agricultural Decision Analysis' (Anderson *et al*. 1977), and at the time of this innovation, many, like Musgrave (1976), felt that 'the door has been opened on a vast and complex field well beyond the neoclassical starting point of the profession in Australia' (Musgrave 1976, p. 140). But these enhancements to the theoretical orientation failed to extricate academic FM from its crisis. Two decades later, Pannell *et al*. (2000) pointed out that this school, surprisingly, failed to even ask, let alone answer, the question: 'For a risk-averse farmer, what is the extra value of a recommendation derived from a model that represents risk aversion in a theoretical orientation (Fig. 2), compared to a model based on risk neutrality'.

> 'Most studies of risk in economics and agricultural economics have adopted the static framework [of the theoretical orientation] and included risk aversion in the decision maker's objective function. In these studies, risk or uncertainty matters because decision makers endeavour to move away from strategies with relatively high variance of income towards strategies with relatively low variance, if necessary at the cost of some reduction in expected income.
>
> Most farmers would be puzzled that as a discipline we focus so much on this aspect of risk management. For them, the main issue raised by variability of price and production is how to respond tactically and dynamically to unfolding opportunities or threats to generate additional income or to avoid losses. [ ] . . .*the information farmers desire for risk management is largely concerned with defining the expected outcome*, not with avoiding risk per se. Such information allows farmers to respond profitably to variations in prices or climate and so is attractive even to 'risk-neutral' farmers . . .
>
> Several discrete stochastic programming studies have represented both tactical farm management responses and risk aversion, allowing the possibility of examining the relative importance of including tactics and risk aversion in the models. [ ] The increase in expected profit from tactical adjustments is 10–12%, whereas the reduction in expected profit given risk aversion is less than 3%' (Pannell *et al*. 2000, p. 71).

Although helpful as hindsight, a surprisingly similar point was made with foresight 60 years earlier. In 1939 the FM economist, and later, winner of the Nobel Prize for economics, Theodore Schultz explained that:

> 'It is through price and technical expectations, that changes in taste, techniques, and resources are transmitted to the firm. These expectations, accordingly, act as a barometer of all the economic changes which impinge upon the actions of the firm from without. The farmer as entrepreneur must do two things. He must formulate the price and technical rates that he expects. He must then develop a production plan based on his expectations which will give him optimum use of his resources. Expectations cover the first and the plan covers the second.
>
> The more difficult and also the more important of these two categories of decisions, both to farmers and to other entrepreneurs, is the formulation of expectations. ... there is in reality a considerable element of risk and uncertainty in whatever expectations are formulated . . .' (Schultz 1939, p. 577).

Schultz concluded this passage by rhetorically asking if this didn't suggest that FM should give major attention to aiding managers' formulation of expectations:

> 'We know that the prices and outputs which farmers expect are at best probable, very often nothing more than guesses, and sometimes even only hunches. Economic theory, however, is not able to give us much help. [ ] A farmer's most costly mistakes can usually be traced back to faulty expectations. [ ] It is in the imperfections of expectations that we come into contact with the more important real production problems and also the more difficult analytical problems of economics'.

We suspect that the reason why this 'tip' on how to be more relevant to the management of farms has been so ignored in the frequent references to and quotations from this classic paper is that subsequent developments in economic theory never made it any easier for FM interventionists to help farmers formulate more realistic expectations. Pannell *et al*. (2000), after acknowledging the failure of 'elaborate decision analytical methods', saw the 'straight-forward farm management budgets' of the process orientation as 'extremely useful':

> 'Use of sensitivity analysis to examine discrete key scenarios and identified break-even circumstances are simple but viable methods of *incorporating risk in this decision process*, both from the point of view of risk aversion and tactical adjustments. The techniques are unsophisticated and old, yet they provide the farmer with an opportunity to discern the nature and potential impact of uncertainties in a way that *promotes sensible management of risk*. They can capture sufficient detail, *sometimes implicitly*, so that the value of the information generated for the farmer is higher than could be generated by a less timely, more partial and more obscure sophisticated risk model' (Pannell *et al*. 2000, p. 76; emphasis added).

This use of 'process oriented' budgeting models to explore scenarios facilitates the farmer to formulate expectations through virtual experience of simulated risks. These expectations then influence the farmer's decision process in a way that promotes 'sensible' (*vis a vis* 'optimal') management of risk, and *generally*, we suggest, through learning that is 'implicit': personal construction of situated knowledge rather than receipt of objective knowledge.

Hence we have identified 2 separate deficiencies of the theoretical orientation of FM: 'avoidance of process' and 'ignoring of risk'. From the standpoint of a farmer as a deliberative agent, they are not separate. Intervention that treats risk in a way that is meaningful to managers will have a *process orientation* rather than a *theoretical orientation* as per Fig. 2, and will be dealing with the formation of expectations. This type of intervention may better fit in the systems paradigm that is a feature of the second paper in this series, a paradigm in which 'the more direct effect [of intervention] is on the outlooks, perceptions, and appreciative judgments of the participants. These are the invisible products of the application of the methodology' (Rosenhead 1989).

Late era FM severely abstracted the farm and its management to make it amenable to analysis using economic theory that was really market focussed. Malcolm (1990) lamented that this abstracting away of complex reality succeeded in achieving simpler and easier analyses but the result was 'work which was not really about farm management'. One universal abstraction of farm management process was the qualitative distinction between 'decision' and the 'execution' domains of management: between *planning* and physically *intervening* in the production system. In the classic paper cited above, Schultz (1939) highlights this dichotomy, depicted in Fig. 3:

> 'In the real world the production processes of the firm are being altered continuously. Routine procedure will not suffice. Change born out of dynamic circumstances, is ever present. Adjustments are called for. It is the

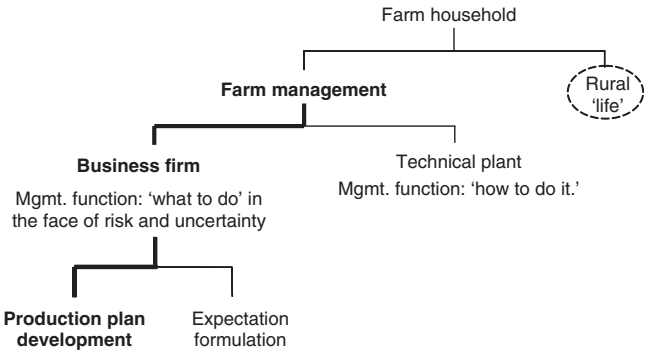

Fig. 3. The abstracted structure of a farm showing the domain of the theoretical orientation of 'late era' Farm Management in bold.

> entrepreneur who decides what must be done. The decisions of the entrepreneur are carried out within the framework of the firm. Two inter-related decisions must be made, (a) the amount of adjustment that is necessary, (b) the method for making the adjustment; that is, what to do and how to do it' (Schultz 1939, p. 574).

Campbell (1959, quoted by Malcolm 1990, p. 10) saw Schultz (1939) as 'the starting point for modern farm management', and after over 60 years of application of theory that was 'inapplicable', the process concepts of Schultz's seem refreshingly novel. The problem seems to have been that late era FM consisted only of the subset of elements connected by bold lines and text in Fig. 3. Although Schultz distinguished between planning and action, the rigidity with which late era FM defined itself as *business* management seemed to increase later, e.g. when Dillon (1965) declared 'tradesman-like' processes of management ('how to do it' in Fig. 2) of little interest to FM research. Avoidance of the 'technical plant' and 'expectation formulation' (Fig. 3) abstracted out the most practical aspects of management, i.e. husbandry process in the Production System (Fig. 2) and decision process in the Management System (Fig. 2). Later, activity analysis restored these, at least notionally. As pointed out above, a rare acknowledgement of the importance of 'expectation formulation' was the case made by Pannell *et al*. (2000) that description of farmers' risk aversion has been substituted for intervention in expectation formulation, with considerable penalty in terms of value to the management of farms.

Conclusions

Malcolm (1990) saw activity analysis/mathematical programming, decision analysis, and systems approaches as theoretical approaches that had been embraced by FM workers for their potential to compensate for deficiencies in production economics. But analyses 'had been of virtually no direct use as far as actual decision-making on farms went'. Reflecting on this conclusion a decade later, Malcolm elaborated that:

> 'The main reasoning . . . was that all models can only ever be partial representations of reality, and farm businesses are complex operations, then techniques that enabled information about more of the important elements of the decision problem, both measureable and unmeasureable, to be incorporated into the analysis, should prevail over techniques that dealt with some parts of the decision problem in great depth but insufficiently encompassed all the important parts of the whole of the problem' (Malcolm 2000, p. 14).

Although we concur with Malcolm's critique that model-based analysis can never comprehensively represent a farm, we tend to focus on the distinction between this failure of a model as a *proxy* and the potential use of a partial model as a *tool* for a difficult aspect of management. Such thinking radically departs from the notion of whole-farm analysis, so central to FM economics, but it is rooted in the observation by Schultz (1939) that the management of farms is made difficult not as much by the challenges of allocating resources rationally as by uncertainties about the environment in which allocation plans are being made. Re-enforcing this is the conclusion of Pannell *et al*. (2000) that the most valuable contribution of an intervention in planning may be the facilitation (e.g. using a simple budget) of a farmer's 'sensible management of risk' by contributing to a subjective ('implicit') decision process. We argue that it is uncertainty, rather than complexity, that makes management of a farm difficult, and interventions that prove to be 'applicable' will be ones that effectively facilitate farmers' construction of more realistic expectations. This is a central theme of the second paper in this series.

Although 'systems approaches' fared no better in FM than other approaches (Malcolm 1990), experiences and developments in other domains justify a closer look at systems approaches for research and intervention in farm management. In the second paper we look at the substantial history of systems analysis and simulation in FM, the evolution of the systems field that captured John Dillon's attention and energies late in his career (Farming Systems Research), and analyse Jack Makeham's singular success in intervention in light of his claim that he was 'a professional goal adjuster'. The paper concludes by discussing the implications for future FM of a recent program that combines simulation, on-farm participative research, and engagement with farmer groups in analyses and discussions with the aim of facilitating farmers' formulation of realistic expectations in conditions of uncertainty.

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