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## Farm Management: rethinking directions?

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**Abstract.** Farms and farming are major contributors to the world economy, directly responsible for a large part of GDP. These achievements are not trivial and imply that farms are being managed in reasonably effective ways, else agricultural industries would not be sustained. However has the study of *Farm Management* within Australia made significant contributions to agriculture or lagged in the background. Is it contributing to better Farm Management or merely cataloguing what has happened? Is it leading or following? During recent years there has been an increasing interest in managing farms more sustainably, with emphasis on issues beyond short-term profitability to encompassing rural communities, ecosystems, biodiversity, ethics of technology and politics. The complexity of management has increased, but *Farm Management* may not be keeping pace with these changes. This paper reviews aspects of *Farm Management* and how the discipline / field is viewed by different participants. This will be contrasted with related areas of research that have expanded over recent times. It is argued that *Farm Management* is more a field than an identifiable discipline and questions are raised about where *Farm Management* is going. Suggestions are made where future studies in farm management could go, the needs for teaching this subject and what are the challenges to be faced in order to enhance the relevance of *Farm Management* studies for professional farmers.

**Keywords:** Farm management, discipline, field, directions.

### Introduction

Farming is arguably mankind's most important activity and the management of farms has always been critically important for the production of food, fibre and fuel. When man first formed relatively settled societies, farming<sup>1</sup> was essential for survival. Today farming is far more complex and requires the management of enterprises in a sustainable manner, not least because much of the useable land is being exploited. A sustainable farm<sup>2</sup> requires the management of biological, financial

and social resources for the medium to longer-term so that enterprises survive and future generations are not compromised. Fewer farmers now feed the many with the consequence that most people, especially in the western world have little direct connection with farming, but are interested in how farms and the landscape are managed. This interest often translates into regulations that add a further layer of constraints within which farms are managed.

The need for continuing development of higher level management skills among farmers in all societies to produce food, fibre, fuel and other products more efficiently from ever decreasing and, or more expensive resources is obvious. Farmers need to have better skills on or off the farm and new production and management technologies need to be developed to achieve the goals of farming in the 21<sup>st</sup> century. Many educational, research and development programs are in place to help develop

1 This paper is based upon a discussion paper presented at the International Farm Management Congress, Perth, Australia, August 2003.

2 Farming in this paper is defined in the broadest sense, including organised gathering and hunting and extensive grazing systems through to intensive horticulture. 1

3 In this paper the term 'farm' is a bounded biologically based business enterprise and 'farming' is a landuse activity that includes the culture of plants and the systematic control of livestock relying solely on the forage available from 'natural' systems i.e. all those human activities that aim to repetitively produce food, fibre, fuel and other products for the lifestyles of different cultures from bio-physical environmental sources.

these skills and technologies. *Farm Management* is an activity / discipline / field that developed during the 20<sup>th</sup> century (Malcolm 1990) and forms part of the programs supporting farming. *Farm Management* could be seen as providing the central discipline that develops techniques whereby better farming decisions are made, though it may not have achieved this claims.

Where is *Farm Management* going? To play a major role in how farms are managed, *Farm Management* must be contributing to both the development of skills among farmers and to the development of new technologies that improve the management of farms. In 2002 the Faculty of Rural Management at the University of Sydney decided to review the current status of *Farm Management* and to determine ways of advancing this field. This paper offers a brief commentary on this topic and aims to raise some questions for consideration. This paper does not attempt to exhaustively review the literature on *Farm Management*, nor on all the approaches being taken to teaching and researching *Farm Management*. Others have done this over recent decades (Johnston 1955; Dillon 1965; Malcolm 1990, 2001; Mullen 2002; Kingwell 2002) and in this volume. Our aim is more to discuss a few issues that are central to the contemporary debate on the future of *Farm Management* and agriculture-related education.

### **What is Farm Management?**

Farming the land is one of humanities' oldest activities. Plants and animals were domesticated and 'farmed', so that they would produce food, fibre, fuel and other products. The wild harvest of flora and fauna by indigenous hunters and gatherers also often involved modifying the environment (Harlan 1992; Kohen 1995). Gatherer / hunter cultures learnt to systematically control their biophysical environment so that it would continue to provide products for their needs. The principles embodied in those early

developments in landuse are still relevant for agriculture *i.e.* exploiting the bio-physical environment to control risks and improve the efficiencies with which food, fibre and fuel are obtained from other species. Over time the necessities of a survival lifestyle were supplemented with the benefits of trading until today where farm activity is more involved with trading and a commercial business lifestyle than simply satisfying the subsistence needs of those dependent on farming.

Farm management is not simply about the exploitation of other species for food, fibre, fuel or other products. It requires more than that. To produce products of value other species need to be able to grow and that means in turn their basic biophysical needs have to be attended to. Farming then involves the controlled use of environmental resources from diverse landscapes (*e.g.* nutrients, a physical space to grow, water and an atmosphere) to support the productive growth of other species that are then harvested and processed for products. Management in this context means systematically controlling the plants, animals and other factors to produce goods that satisfy market demands as well as deciding upon the alternative allocation of resources and of sustaining the environment (Robertson and Pratley 1998).

The primary component of farming as a social and institutional practice is then the culture of plants and animals for food, fibre and fuel. In addition the character of the farmer, the vision of the farm and what constitutes farming in diverse earthscapes is embedded in these cultural practices *i.e.* in how they manage their farms. These factors then significantly influence how farms are perceived by others and the standing that farmers have within the wider community (Eckersley 1992). The cultural shocks, clashes and struggles between the green environmental movement and farming communities meeting the mass market demands of

western lifestyles and their urban habitats has arguably marginalised farmers and farming and are influencing the ways people farm.

Technical know-how and technological capability in farming is built into the western farmer's practical ethos. You cannot produce goods for mass consumption by simply sitting in an office or having discussions. However, production capability alone is inadequate in today's world. Developing western liberal democratic countries like Australia still rely very heavily for national economic growth on earning income from the exploitation of biophysical environmental resources, but there is no point producing goods unless there is a market of consuming customers. Farming is very much a biologically-based business activity now aimed at satisfying the consumer wants associated with communities and their lifestyles *i.e.* a demand-driven activity compared with the supply-driven approach that characterised earlier historical periods.

Farm management shaped by western cultures, their lifestyles and consumption habits then embodies the integration of the technical know-how, skills and cultural factors with the control of risk required to run a commercial business within a monetarised, competitive market economy. Successful farm management implies the integration of all these factors such that the business and biophysical resources survive over the medium to long-term. In many ways farm management is synonymous with the systematic control of agricultural systems – at a farm level – and is the key to successful agricultural industries and their contribution to national economic growth.

Farm management is a land use activity that is still vitally important to the Australian economy and the norms and standards of living demanded by its western lifestyles. However, it is not clear that as an important social and institutional practice, farm management

has been able to adapt and be seen as a desirable, highly valued, occupation in an urban-centred popular mass media shaped by the philosophies of green environmentalism (Hay 2002).

*Farm Management is an activity that integrates technical know-how and landuse technologies with commercial business practices meeting the demands and tastes of western materialist lifestyles, BUT has the balance between these components in the research and teaching of Farm Management been right so as to produce graduates and research outcomes that are seen as highly desirable by the wider community?*

### **Farm Management as a discipline or a field?**

The management of farms as an occupation and field of authoritative knowledge and expertise emerged over recent centuries, but the study of *Farm Management* as a field is somewhat shorter (Malcolm 1990). The view of *Farm Management* presented here argues that it is both a multidisciplinary and interdisciplinary field of academic and practitioner practice, rather than a singular discipline. Because it behaves as a field of study it has then been harder to define what *Farm Management* seems to be about in ways that a wider community understands and wants to support *i.e.* recognition is more difficult than *e.g.* for medicine. Within this context it is important to also consider disciplines relevant to the field of *Farm Management*. Considering other areas of contemporary interest such as farming systems studies and agronomy can help understand some of the current perceptions and potential directions wherein *Farm Management* as a field of enquiry, teaching, research and practice can develop.

*Farm Management*, when it developed over the last century, tended to be viewed narrowly as an agricultural branch of micro-economics of the firm (Dillon 1965). This probably resulted in a somewhat over-simplification of what

was involved in managing the complexities of 'the farm' as an enterprise. The implicit assumption was that all decisions could be reduced to financial decisions about how to allocate resources; this now of course poses some limitations within the current interest in making enterprises more sustainable, as discussed later.

*Farm Management* within agricultural economics, came to be defined often as the study and statistical modelling of on-farm decision making. These trends are evident in the alignment of *Farm Management* economists with the study of production economics.

*If Farm Management as a component of agricultural economics is simply about the process of decision making, has that defined this 'field' as too narrow and therefore of limited interest to many practitioners and academics?*

A multidisciplinary and interdisciplinary approach to the field of *Farm Management* would suggest that making appropriate decisions on resource allocation requires an understanding of the technical know-how in each alternative. A deeper understanding of technical issues often exposes those subtle and diverse elements that become critical in the success of different farming practices. The technical know-how required of farm managers now goes beyond a simple understanding of the immediate production process. The introduction of the 'flexible specialisation' model of 'lean production' in large, complex agribusiness and farming enterprises and the notion of 'production' in many contexts being replaced by 'operations and logistics', means that the farm enterprise models that adequately describe the context and practices of farm management need to dramatically change. These models also need to now incorporate the multi-faceted aspects of sustainable systems (Kemp *et al.* 2002, Mullen 2002). We are still attempting to understand many of these 'new' issues and how best to fit them into a farm management context.

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*One reason that current models of Farm Management struggle to incorporate the many components of contemporary businesses could be that many involved in farm management have a specialised background in traditional areas of e.g. agricultural economics, agronomy and horticulture and lack the skills to develop more effective integrated management models?*

A reduction in technical know-how within *Farm Management* courses and studies, potentially exposes such courses and studies to the perception that they are not practical and thus irrelevant, particularly to those who see in farming the central issues of the technical know-how plant and animal production for food, fibre and fuel. This is not to argue that many of the research studies done under the title of *Farm Management* are irrelevant, rather that they may appear to be too narrow for those not closely involved with the field.

While *Farm Management* as a field developed narrowly within agricultural economics and arguably has declined over recent decades, there has been an increasing interest in farming systems studies *i.e.* descriptive research and modelling about how farms as systems and subsystems actually function and relate in practice. This was often more at a research level than in undergraduate teaching. Some economists are involved in farming systems studies but probably more proponents are technically based in the biophysical sciences. An outcome of farming systems studies is often a model (conceptual or numeric) of parts or all of a farm. One finds that many researchers with agricultural biophysical science knowledge and expertise who are interested in farm management prefer to say they are interested in farming systems. The irony is that many farming systems studies incorporate economics (Brennan and McCown 2001).

One of the interesting *Farm Management* related disciplines is agronomy, which is arguably a more popular career as indicated by the number of job

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advertisements in Australia. The first definition of an agronomist is that they are a 'rural economist' (Oxford English Dictionary, 1814 definition) and probably predates the development of agricultural economics. While the meaning of agronomy varies with regions, local customs, etc., it is interesting that this earlier definition probably accords more with what many Australian farmers have considered to be the case. That was apparent when NSW Agriculture reduced the number of extension agronomists a few years ago. This generated more concern among farmers than the loss of extension *Farm Management* economists, livestock officers and others. It emerged that many of these farmers viewed the extension agronomists in a wider context than simply the cultivation and management of pastures and field crops and did regard them as *Farm Management* specialists. When rural trading houses appoint specialised staff to support their merchandising arms, invariably they appoint an *Agronomist* rather than for example, a formally tertiary qualified *Farm Management* specialist. Many of these *Agronomists* have had some formal training in economics, commerce and other organisation / managerial studies. It has also been interesting when discussing their role with some appointments in 'farming systems' they have commented that they often see it very much as being agronomy (in the broad sense) and, or farm management.

*A connection with farming technology is arguably seen within the practical ethos of farmers as being more relevant, than simply having the know-how of commercial business?*

There are also other closely related bioscience disciplines in the study of horticulture and livestock that include a farm enterprise focus as part of their study. Experts in these disciplines however, do not necessarily see themselves as being aligned with *Farm Management*. The same can be said of many agricultural economists. Many of

those who have done a science or applied university degree in agriculture would claim to be involved in farm management, but they don't claim to be part of the field of *Farm Management* or identify strongly with the occupation of farm manager or *Farm Management* consultant.

*Why then is Farm Management seen to have a narrow focus, rather than being the central field around which many others can associate and co-operate?*

To develop as a field of study *Farm Management* needs to be contributing new technologies and skills to practitioners. Is it making this contribution? An overview of the papers presented at *Farm Management* conferences could suggest that they are mostly a catalogue of what is being done, rather than developing new techniques that then need to be implemented and tested? If this is true would it be better to call farm management conferences, 'farming' conferences?

*Is Farm Management merely describing what farmers are doing and being a follower, rather than leading with the development of new techniques?*

### **Teaching Farm Management**

The teaching of *Farm Management* as a specialist field of study has obviously waned over recent years with fewer university lecturers in *Farm Management*. This then raises the issue about why that has occurred when there is still an obvious need for farm managers and for service professionals who understand how different types, scales and complexities of farms are managed.

One of the possible reasons for the reduced interest in *Farm Management* as a field may have been the too close an alliance with commercial business management, limited economics and reduced linkages with the technical know-how of the applied bio-science disciplines in e.g. agronomy, horticulture and livestock. As argued earlier the

primary component of farming is the systematic control of risks and improvement of efficiencies in the production of plants and animals to produce food, fibre and fuel. While many courses have tried to integrate the technical know-how associated with the applied biophysical sciences, economics and commercial business disciplines, that (arguably) hasn't always been achieved. Continuing attempts need to be made to use common case studies and multi- and inter-disciplinary examples to strengthen the systematic understanding of *Farm Management*. The depth of study in each component discipline may also need to be improved.

The rise of farming systems studies and continuing importance of the applied biophysical science disciplines such as agronomy and horticulture, possibly at the expense of the field of *Farm Management*, does raise some issues that need to be addressed. The first is that technical know-how at a reasonable level is obviously of interest and utility to farm-orientated students, occupations and professions. Courses that do not include an appropriate level of technical know-how for *Farm Management* will be seen as being of limited labour market value to many interested in farm management as a vocation. A second point is that more research advances are probably being made and applied models developed within farming systems, economics and applied science studies such as agronomy and animal production, but they are not seen as being within the field of *Farm Management*. This means that few fresh ideas are identified with and claimed to be within the field of *Farm Management*; the advances are being claimed elsewhere. Without being able to lay claim for the development of new knowledge as the basis of identity and expertise, a field can be seen as 'stale' and will then have difficulties attracting a community of students and academic staff.

Longer-term biophysical environmental sustainability has become a major focus for Australian and much western agriculture. This does then need to be incorporated within specialist *Farm Management* degree programs and as a theme in related courses. Any incorporation does though need to be done in ways that identifies its relevance to farming and the farm as a predominantly bio-business enterprise.

*Is the current teaching and research focus in Farm Management seen as too narrow by potential participants?*

This is not meant to imply that it is too narrow, but that it may be perceived to be, especially in terms of the perception of future employment outcomes and occupational status?

#### **Possible directions for Farm Management**

The importance of responsible farm management for Australian agriculture is not a point in dispute, especially in terms of the sustainable biophysical health of diverse earthscapes and the people and other species that inhabit them, but the better ways of developing professionals with the required skills may be. The development of these professionals can be considered at two levels; first teaching undergraduate students and second for postgraduate research. Graduates may be employed to manage farms as generalist, executive or operational farm managers depending on types, scale and complexity of farming activity, while others are likely to be employed in servicing agriculture where their applied knowledge and technical expertise of how farms work will be important.

There has often been the argument that technical know-how and, or commercial business skills for farm enterprises can be learnt on the job – like an apprentice craftsman. However, the failure rate among farm businesses (particularly over the medium to long-term – as applies with many other categories of small businesses) suggests that line of

argument doesn't survive a close examination and that on the job skills do not always provide the range of experiences, skills and knowledge required to be successful. Small business owner-operators, including family businesses, have preferred informal workplace training and resisted participating in education and training that was too costly and too long from their perspective. However, farmers with tertiary training often have higher incomes than others, suggesting that how they learnt rather than necessarily what they learnt at University does pay dividends when owning and managing farms. It is uncertain how many of the tertiary trained farmers have done a *Farm Management* degree in Australia or overseas (e.g. in New Zealand). Many have probably done agriculture science, other applied science or economics degrees. It is difficult to discern a common theme but it may be that a strong practical understanding needs to be combined with an ability to define and analyse problems to some depth for the successful management of farms.

While no one prescriptive recipe would suit all, as individuals vary in their interests, the argument developed in this paper is that *Farm Management*, as a multidisciplinary and interdisciplinary field, needs to encompass both technical know-how and biologically-based business knowledge and expertise and not simply be about business management (Charry and Henry 1993). Courses that do both are more likely to be successful than those that emphasise one component partly or wholly at the expense of the other. Developing the applied know-how of a technical understanding at the same time as a greater appreciation of how farm's function and are managed should reinforce the integrative nature of managing farms and expose students to the need to consider the complexities and challenges presented in the practices of farming. *Farm Management* requires a

holistic decision making model (Charry 1997).

*Farm Management* as a component of agricultural economics does not appear to have made many advances in recent years in exciting great interest in students or in research. Often students are more attracted by economics itself. There have been though many advances in the disciplines of farming systems, economics, agronomy, etc. that have been important for thinking about farm management problems. The theories and models developed in those disciplines are not always being integrated into *Farm Management*. Any work aimed at improving the management of farms, particularly where two or more disciplines are involved could be considered relevant for *Farm Management* or claimed as a contribution to the field of knowledge and expertise of *Farm Management*.

*Has Farm Management taken too narrow a view of itself as a field and in consequence reduced its impact? Is the problem that most farmers are small business owner-operators in agriculture and as a community don't identify as an occupation with aspirations of professional labour market power, high social status and thus lack the need to base their professional knowledge and expertise in university education and research?*

Much agricultural research and development aims to improve the sustainability of farms, but rarely is this described or claimed as *Farm Management* research. A stronger stand could be taken to argue the central case that *Farm Management* can provide a realistic framework for bio-business and biophysical sustainability research. Part of such research needs to be the development of that farm-centred framework. At present the framework is often at a conceptual level and several related models commonly exist, but those models have not been translated into quantifiable management practices. One important area for research in *Farm*

*Management* is how to incorporate these wider components within the farm-centred approach to land use management (Kemp *et al.* 2001; 2002).

Future farm managers will be operating in an increasingly complex bio-business and biophysical environment. The language and concepts involved in constructing and managing systems sustainably will become increasingly important given the contemporary political discourse about the degradation of landscapes. Many farmers would like to have more sustainable farming systems, but the required knowledge and expertise is still very poor. The goals of most environmental perspectives on sustainable farm and farming development for instance, have not been effectively translated into practices that have become central to the management of all farms; they are still peripheral. The newer interest in attending to social factors in farm businesses is probably even more poorly understood and implemented. *Farm Management* as a field does not appear to be making great advances in making claims to its own terrain of authoritative knowledge and expertise, research understanding of exclusively practical concerns linked to technical know-how of farm management practitioners and then incorporating these issues into commonly used management practices in farming and business practices.

*Is Farm Management capable as a field of incorporating wider biophysical, social and other factors into farm management practices, or will that be considered the province of and claimed by others?*

### **Has Farm Management a use-by date?**

Fields of interest in popular culture often seem to proceed in fashions, the consuming passions and desires of the time. *Farm Management* may be highly relevant as a field of research and the work being done valuable to economies, but is it now considered 'old fashioned'? Agriculture often suffers from the perception that it is a 'sunset' group of

industries while at the same time the demands of consumers requires an increasing attention to both quantities and qualities of the products of farming activities. *Farm Management* could be seen as the activity you get into if you are not good enough to get into a more glamorous field like environmental sciences, applied sciences, or biotechnology? In reviewing *Farm Management* as a field of teaching, research and occupational practice, we need to take into account these broader perceptions that seem to permeate popular culture.

*Is a rebranding by name change in order with or without a change in the knowledge and expertise involved? How can Farm Management as an occupation portray itself as a university-trained vocation to attract the best and brightest of academic high achievers?*

*What would be required to make Farm Management exciting to generation 'y'?*

Generation 'y' and their successors generation 'z' have not lived through the really bad times of world wars, deep economic depressions or the tensions of the 'cold war'. They make quick decisions influenced greatly by the media of popular culture and they evidently don't worry if some decisions don't work, as portfolio careers and life-long learning have displaced thinking about a job for life. Their parents worry that they merge advertising and reality in what seem unreal ways, but maybe they are better tuned to consumers and their wants. These often tribal traits could create successful business entrepreneurs and especially farm managers who may be more adaptable to incorporate non-traditional with traditional farm business endeavours, tuned to consumer needs of contemporary lifestyles as dictated through the popular media. They would not be fixed on growing wheat or grazing cattle or sheep in the same paddock for ever, always expecting a good price no matter what else happens.

*Will the next generation of farm managers take agriculture back to a central role in popular culture and make it fashionable again?*

## References

Brennan LE, and McCown RL 2001, Back to the future – Reinventing farm management economics in farming systems research, In *Proceedings of the 10<sup>th</sup> Australian Agronomy Conference, Hobart, 2001*, Hobart.

Charry AA 1997, *Farm Business Management: An Holistic Stochastic Decision Making Model*, unpublished PhD thesis, The University of New England, Armidale.

Charry AA, and Henry ES 1993, The professional farm manager beyond 2000, *Proceedings of the 19<sup>th</sup>-1993 National Farm Management Conference-Workshop Papers*, Australian Farm management Society, Dookie, pp. 1-7.

Dillon JL 1965, Farm management as an academic discipline in Australia, *Review of Marketing and Agricultural economics*, 33(4):175-189.

Eckersley R 1992, Environmentalism and Political Theory: Toward an Ecocentric Approach, State University of New York Press, New York.

Hay P 2002. Main Currents in Environmental Thought, University of NSW Press, Sydney, Australia.

Harlan JR 1992, *Crops and Man* (2<sup>nd</sup> Ed.) American Society of Agronomy, in Johnston GL 1955, Agricultural Economics, Production Economics and the Field of Farm Management, *Journal of Farm Economics*, 39:441-450.

Kemp DR, Michalk DL and Charry AA 2001. The Development of Ecological Performance Indicators for Sustainable Systems, In *Proceedings of the 10<sup>th</sup> Australian Agronomy Conference, Hobart, 2001*, Hobart.

Kemp DR, Charry AA, Whiteley WA and Gardner, MW, 2002. Australian Agricultural Ecosystems: Searching for Biophysical Sustainability Performance Indicators, in *Proceedings of the 2002 International Farm Management Congress*, Netherlands.

Kingwell R 2002, Issues for Farm Management in the 21<sup>st</sup> Century: A View from the West, *Agribusiness Review*, 10, paper 6.

Kohen J 1995, Aboriginal Environmental Impacts, University of NSW Press, Australia.

Malcolm LR 1990, Fifty years of farm management in Australia: survey and review, *Review of Marketing and Agricultural Economics*.

Malcolm LR 2001. Farm Management Economic Analysis: A Few Disciplines, a Few Perspectives, a Few Figurings, a Few Features, *Annual Conference of Australian Agricultural and Resource Economics Society*, Sydney 2000, Sydney.

Mullen JD 2002. Farm Management in the 21<sup>st</sup> Century, *Agribusiness Review*, 10, paper 5.

Robertson A, and Pratley J 1998, From Farm Management to Ecosystem Management, in J. Pratley and A. Robertson, (eds), *Agriculture and the Environmental Imperative*, CSIRO Publishing, Bathurst.