REFLECTIONS ON THE CICERONE PROJECT – AN EXPERIMENTAL PARTNERSHIP EXPLORING THE SUSTAINABILITY AND PROFITABILITY OF GRAZING ENTERPRISES

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Abstract

The broad agricultural ecosystem approach developed some 50 years ago by Roe and McClymont and further developed by Willoughby for the study of grazing systems has been an appropriate model for the conduct of whole farmlet system studies carried out by the Cicerone Project on the Northern Tablelands of NSW from 2000 to 2006.

This project has seen the development of close links between livestock producers, researchers and extension workers, all of whom have learned considerably from each other. The project has undertaken studies comparing three adjacent farmlets by considering as many aspects of complex farm systems as possible using an approach summarised as 'compare-measure-learn-adopt'. This 'living laboratory' has provided an opportunity to investigate the sustainability and profitability of grazing enterprises at a scale which is seen as credible by both producers and researchers. A brief overview of results collected to date is presented, including soil, pasture, livestock, economic and sustainability findings.

The nature of short-term funding of research and development programs is a threat to the continuation of farmer-scientist partnerships. The power of farmer leadership can also be seen as a threat by some in research and extension agencies as well as within research funding bodies.

There is a role for governments to assist in the development and delivery of objective evidence of sustainability and profitability over an inter-generational timeframe through 'fact farms' located across the many agroecological regions of Australia.

Such farms need to be focused on issues of relevance to local farmers as well as to research and extension partners. Partnerships comprising farmers, extension professionals and research teams need to see funding provided to all partners if the maximum value of the partnership is to be realised. Real ownership by producers is seen as a necessary condition for achieving substantial practice change.

The considerable challenges of developing an integrated, long-term, multidisciplinary approach to resolving issues of sustainability and profitability should not of themselves be a deterrent to attempting to realise this objective. Creating and maintaining 'sustainable' farmer-scientist partnerships will assist in this endeavour.

Introduction

We are honoured to have been invited to present this talk in honour of Professor Bill McClymont, who actively worked with livestock producers as cooperators and whose legacy has been deeply ingrained in many graduates of Rural Science over the past 50 years.

This paper presents an unashamedly Australian perspective on our experiences of "Science & Industry - Hand in Glove" through our involvement in the Cicerone Project – a producer-led project which has explored, together with scientific investigations of system components, the practical realities of producing animal products in a way which is financially viable and yet environmentally sustainable.

McClymont and his contemporaries were vitally concerned with understanding how entire agricultural ecosystems function and especially how this translated into running viable livestock enterprises. McClymont's central theme was to explore, through teaching and research, the 'manipulation of (the) soil-water-plant-animal complex for (the) purpose of economic production of animal products' (Southcott and Bindon 1996).

Soon after the formation of the New England University College in 1938, the Warden, Dr. Robert Madgwick, wrote: "if adult education were to succeed it must start by finding out what people were interested in, and then starting out to satisfy their interests". This is very much how the Cicerone Project began – by seeking the opinions of farmers and other interested collaborators.

The Cicerone Project has largely been carried out on land leased from CSIRO on a property called 'Chiswick', 17 km south of Armidale, NSW. This property is steeped in a history of long-term inter-disciplinary research. Early workers in the then CSIR, such as Dick Roe, were vitally interested in ecological approaches to research investigating the continuum from climate to soils, pastures and animals, as interacting factors in whole farm systems, even prior to the arrival of McClymont at the newly proclaimed University of New England as the inaugural Chair of Rural Science in the mid 1950s (Southcott 1997). Roe also wanted the research to be done with 'due regard being paid to the economics of land use in all its aspects' (Hutchinson 1997). A later Officer in Charge of CSIRO's 'Chiswick' research station, Bill Willoughby, was committed to exploring the grazing ecosystem as a '… study of the whole system, based on climate-soil-plant and grazing animal, as the essential experimental unit' (Hutchinson 1997).

Of course, a focus on inter-disciplinary investigations is not limited to this region or era. Vizard and Foot (1993) point out the complex challenges of balancing pasture and animal needs. Their experiences in western Victoria suggested an 'integrated approach to the animal/pasture partnership is necessary to ensure the long-term economic stability of the pasture-based grazing industries'.

In spite of the extensive research which has taken place in the New England region over more than 50 years, livestock production systems remain largely extensive with farmers having to cope with the dual risks of climate and commodity price fluctuations. Today's livestock producers find themselves with a never ending series of challenges, including a need to ensure that any impacts on the natural resources of land and vegetation are benign. Thus, there is an ongoing need for continuing high quality and relevant research that leads to rapid and widespread adoption.

Recent research into sustainable pastures and grazing systems

One of the key factors contributing to the commencement of research within a whole-farm context was the perceived lack of adoption of findings concerning pasture sustainability following completion of a major study on the Northern Tablelands within the national Temperate Pasture Sustainability Key Program (TPSKP) funded by the then Meat Research Corporation and Land and Water Resources Research and Development Corporation. This study summarised a matrix of sustainability factors based on soil, water, pasture, animal, production and financial components over time (Scott, Hutchinson *et al.* 2000). It hypothesised that sustainable pastures are based on deep-rooted perennial grasses with a persistent legume component enabling the capture and use of nitrogen and water with minimum leakage. More sustainable pastures were claimed to allow higher per head and per hectare animal production over time.

This perceived lack of adoption may have been due to the fact that there were complex interactions involved. Also, there had been relatively little participation by livestock producers in the experiment. Further, the study was carried out without the investigation of other important whole farm issues such as grazing management and at a scale (total area of experiment less than 6 ha) that may not have generated credible economic outcomes.

The TPSKP was then followed by a larger national project, the Sustainable Grazing Systems (SGS) Key Program (Mason, Lamb *et al.* 2003). In this project, it was recognised before, during and after, that producer participation was vital to achieving practice change.

This national program was assessed to have had a large impact on adoption including 'triple bottom line' outcomes, the definition of elements of a sustainable grazing system, and the impact of grazing method on production and sustainability (Mason, Lodge *et al.* 2003).

Pertinent findings from the SGS program in relation to sustainability included the finding that grazing method impacted on stocking rate as did soil phosphorus, 'soil pH, grazing management (resting), legume percent, and an index of growing season effectiveness'. Sustainability was associated with perenniality and water use; increasing stocking rate did not necessarily reduce sustainability whilst grazing management and increasing soil fertility contributed to sustainable production (Graham, Cullen *et al.* 2003).

Two notable conclusions from the SGS program relating to adoption were that producers need to be 'in control of research and development to maximise learning and on-ground change' (Andrew 2003) and that they benefited from interactions with others especially in a 'non-threatening environment'. Nevertheless, at the conclusion of the SGS program, producers were left with no opportunity to continue their participation in producer activities associated with that program. The close link that had been developed between researchers, extension workers and livestock producers was severed in most regions where a continuing collaborative project was not available.

Continuing problems with adoption

Considering the breadth and depth of the findings summarised above, one could ask why there might be any livestock producers who were not aware of the findings and/or had not adopted the findings. We contend that there are a number of factors that might be involved. Firstly, as pointed out by local New England grazier, Gordon Williams, he managed his farm by attempting to 'balance some 17 management balls in the air' at any

one time. By this, he meant that one factor such as adjusting legume percent, cannot be seen in isolation from many other factors, some of which might include grass dominance, current profitability, the price of fertiliser and grazing management. This challenge of meeting many goals simultaneously in any sustainable grazing enterprise influenced the design of the Cicerone Project so that researchers and producers alike would be challenged with many of the same complex of issues contributing to sustainable farming faced by today's graziers (Scott 2003).

In addition, as stated by Vanclay (2004), scientists do not have a guaranteed 'credibility and legitimacy'. He notes that, as society has become more informed, many have become more skeptical of advice received. This may also be affected by the commercial nature of so much information on offer to farmers today through endless sales brochures, newsletters, advertisements, etc.

Lewis (1996) has stated that the non-acceptance of extension advice by a farmer may mean that the practices being advocated are perceived as inappropriate for that farmer's particular situation rather than 'mere conservatism and aversion to change'. Lewis states further: 'A corollary of this was that the aim of agricultural extension should be to help farmers make better decisions within the *full context* of their operational environment'. We heartily agree with this sentiment; it has been borne out by our experience within the Cicerone Project.

The Cicerone Project

The Cicerone Project began its period of gestation in 1997 at a meeting of about 45 graziers, researchers, extension workers and agribusiness representatives held at CSIRO's property, 'Chiswick'. This meeting resolved to form a producer-led committee, under the chairmanship of Mr. Hugh Sutherland, with representatives of various bodies such as CSIRO and the University of New England, NSW Agriculture, Landcare, TAFE and consultants. The name 'Cicerone' was chosen to imply a learning culture based on the historic Roman orator, teacher and mentor, Cicero.

This meeting acknowledged that there was a wealth of under-utilised or unutilised research. It was in recognition of these past failures to get sufficient adoption of past research that Cicerone was born. This suggests that there is a serious 'disconnect' between those managing the land and the research literature published in scientific journals.

Funds from the International Wool Secretariat allowed a survey of over 300 local land holders to be conducted to learn of their needs. The need for producer involvement was confirmed by the survey. Of those who responded, some 170 expressed interest in becoming members of the proposed Cicerone project (Anon. 1998).

Some of the key issues which arose from the survey and which influenced planning included:

- The importance of fertiliser and grazing management on pasture persistence, especially through drought,
- Sheep feeding and management of the pasture feed supply, including supplementary feeding, to maintain ewes in 3 score condition and
- Sheep breeding and drench resistance in the management of internal parasites.

A Business Plan was prepared in early 1998 and received funding for an initial 5 year period from the WoolMark Company; this has been complemented with annual subscriptions paid by members of Cicerone, by income from the learning farm and by significant in-kind contributions from partners and support for postgraduates from the Sheep CRC and the University of New England. A review was conducted in 2002 when the management of Australian Wool Innovation changed. A further review was conducted in 2004 which recommended continued funding. In late 2005, approval was given for a 'harvest year' to enable the writing up and delivery of findings up to October 2006.

The original aims of the Cicerone Project were to:

- Create a learning environment in which researchers and producers can learn from each other and create new knowledge for the benefit of Northern Tablelands agriculture,
- Undertake training and increase awareness by conducting field days and skills workshops on topics determined by the project stakeholders,
- Provide access to a Central Farm which will facilitate the uptake of research by trials and comparisons under commercial conditions and
- Provide information, by means of newsletters and other media, of importance to Northern Tablelands farmers.

The purpose of Cicerone was to build communication bridges between the researcher, extension professional, funding organisations and the end user. The motto adopted by the Cicerone Project of 'Compare-Measure-Learn-Adopt' has been most appropriate and is still adhered to by the current management team.

One of the key features of the Cicerone Project that has allowed it to operate at a larger, and therefore more credible scale than traditional experiments, is the recycling of income earned. Under the Business Plan approved by the WoolMark Company, the funds earned from the farmlets were able to be returned to help 'self-support' the sizeable farmlet experiment which required considerable farm management input. When one gets to the scale of measuring 150 hectares, the capacity to fund such work from traditional Research and Development agencies is limited. In the case of the Cicerone farmlets, the income from wool and livestock sales has meant that the farm manager's salary has been met by the farmlets themselves which has allowed the work to be carried out at a more credible scale and with a considerable reduction in the funds required from other funding sources.

The Cicerone farmlets

The concept for the farmlet comparisons evolved at the same time that a major national research program, the Temperate Pastures Sustainability Key Program, was being completed and the findings published. That program demonstrated the substantial benefits of perennial grasses, both in terms of production and environmental outcomes, and explored management options for retaining perennial grasses in pastures.

The Cicerone farmlets are each 50 ha and are described in some detail in Scott (2003). In brief, Farmlet B is the control treatment and aims to represent a typical grazing enterprise with a target stocking rate of 7.5 dse/ha. It has little focus on replacing pastures, has 8 paddocks, fertilises the soil to levels of 20 mg/kg phosphorus (bicarbonate extract) and 6.5 mg/kg sulfur, and attempts to employ flexible grazing management according to PROGRAZE principles. Farmlet A has the same number of paddocks and grazing management approach as Farmlet B but has a target stocking rate of 15 dse/ha by focusing on high inputs with a target of 100% sown species and soil fertility levels of 60 mg/kg phosphorus and 10 mg/kg sulfur. Farmlet C has the same target soil nutrient levels as Farmlet B but focuses on intensive rotational grazing management with short graze and long rest periods. Initially it had 16 paddocks which increased to 33 to allow for longer rest periods. It is aiming at a stocking rate of 15 dse/ha.

The three farmlets were designed such that the paddocks of each farmlet were distributed across the landscape in a 'patchwork quilt' style allocation of new paddock boundaries after six iterations of a GIS mapping exercise (Munro and Scott, unpublished) which took into account those variables of the landscape and natural resource capacity that are most difficult to change (Scott 2003). A key advantage of having all of the farmlets co-located with contiguous paddock boundaries is that all farmlets experience the same climatic conditions.

An electromagnetic (EM) survey was conducted of the entire property and used in conjunction with a detailed soils map in order to classify areas into soil conductivity groupings. Equivalent areas of each soil type were allocated across farmlets. Similarly, land was distributed according to its topography so that no one farmlet would be compromised by being allocated more low lying, flood-prone land than any other farmlet, in the event of flooding occurring. Likewise, the third factor used to allocate land to each farmlet was the prior fertilizer history of the original paddocks.

After 6 iterations, the plan for all paddocks of each farmlet was finalised. New paddock boundaries were drawn and, where necessary, fencing was removed, modified and added along with re-arranged watering points. The farmlet treatments commenced in July 2000 when the first pasture establishment and differential fertilizer applications were carried out.

The farmlet management treatments were decided upon through a process of negotiations with producer members and other interested parties over a number of meetings. The management guidelines have grown from the original two-page specification to a detailed statement of guidelines comprising some 20 pages (Anon. 2005) which specifies most aspects of management including policies on supplementary feeding, drought management, fertilizer applications, weed control and the sowing of pastures.

The total area of land leased from CSIRO by the Cicerone Project is approximately 200 hectares with 150 of that being allocated to the three farmlets; the remainder is used for maintenance of some animals with a suitable quarantine status, in case any of the farmlets need to purchase animals.

Results

One of the most notable early achievements arose following a well-attended workshop involving graziers, veterinarians and researchers that resolved to explore the issue of claimed false positives determined using the gelatin gel test for sheep footrot. In an extensive field experiment, UNE researchers and staff of the Cicerone Project and the Armidale Rural Lands Protection Board were able to demonstrate different status of footrot from gel positive strains which could be distinguished by a DNA test (Hall, Cheetham *et al.* 2001). This work has led to the further development of a DNA test for footrot which is likely to bring about more reliable diagnosis of the disease (Cheetham, Katz *et al.* 2005).

The results from the farmlet studies exploring the profitability and sustainability of different farm management treatments have been presented in a range of fora. This study involves a wide array of disciplines and the development of an overall synthesis of the findings remains a challenging 'work in progress'. Summaries of the

some of the results relating to pasture composition, sheep and fleece weights were presented by (Gaden, Scott *et al.* 2004) whilst early results relating to faecal egg counts were summarised by (Healey, Hall *et al.* 2004).

A summary of the time trend relationships (from 2000 to 2004) relating to soil, pasture, animal, health, product quality and financial information was presented by Scott, Gaden *et al.* (2004). A series of journal papers is being prepared for future publication.

Recently, the results of all component parts of the project have been presented to two symposia attracting some 80 attendees in May 2005 (Scott 2005b) and 65 attendees in May 2006 (Scott 2006). The breadth and depth of the results from these whole farm system studies are demonstrated in some of the findings extracted from the symposium proceedings which are listed below:

- The differential soil fertility targets were reached within two years of the commencement of treatments
- Perennial pastures have been successfully established over a range of conditions, including during the drought year of 2002, thus reinforcing known principles of establishment
- A bioeconomic modelling approach has been developed to determine the optimum rates of application of pasture improvement technologies
- Different rates of degradation of botanical composition have been observed in response to farmlet treatments
- In spite of the higher soil fertility levels and the sowing of legumes, there has been relatively little legume persistence since the treatments commenced, reflecting in part the dry seasons experienced thus far
- According to simulations based on long-term climate records, the trial area has experienced plant available water levels below the long-term median value since the commencement of the trial in July 2000
- The changes in fleece characteristics between farmlets have not resulted in significant changes in fleece values per head
- The principles linking fat score to reproductive performance and lamb survival have been confirmed
- Short grazing and long rest periods have resulted in a dramatic decline in the numbers of internal parasites leading to less reliance on anthelmintic drenches
- Pasture improvement has allowed significantly higher per hectare production of wool and beef
- The balance between the supply of pasture and the demand of grazing animals has been addressed through calculation of the metabolisable energy balance on each farmlet
- Detailed financial records have been kept of all input costs, including labour, and income to allow computation of gross margin and cash flow budgets for each farmlet.

Some of the learnings reported by producers at the symposia include:

- The need to focus on maintaining the legume component of pastures and the challenges of getting sown pastures to persist long enough
- The value of the objective evidence collected on the effects of grazing management systems
- A better understanding of soil fertility and plant nutrition
- The different farmlet treatments accurately reflect the situations faced by many producer members
- Intensive rotational grazing can assist in developing successful parasite management strategies
- The difficulty of managing changes in stocking rate and stock movements to adequately take into account changes in supply and demand for feed
- Questions remain about the environmental sustainability and profitability of the different systems.

The demonstration of the importance of foot conformation on susceptibility to footrot was a finding that has been especially important to Terry Coventry, the current Chairman of the Cicerone Board (Coventry 2005). In addition, he believes that the parasite control investigations are proving to be of great value to wool producers. The work done on strategies to minimise weight loss following shearing as well as the large differences in sheep weaner and cattle growth rates observed between farmlets have also been of interest. Coventry notes the need for more understanding of pasture utilisation and its relationship to supplementary feeding within winter feeding systems. The demonstration of successful pasture establishment and the delicate balance needed in grazing management decisions has also affected the knowledge of farmers, according to Coventry.

The foundation chairman of the Cicerone Board, Hugh Sutherland, reported that he had learned different things from each of the farmlets that he was adopting on his own enterprise (Sutherland 2005). He finds the balance needed between pasture inputs and grazing management is particularly relevant to his enterprise which is

principally a Merino breeding operation with trading cattle as an opportunity enterprise. Sutherland reports that he has also learned a lot from the more than 35 seminars run by the Cicerone Project over the past 6 years including subjects as diverse as footrot, the management and disposal of the wool stockpile, Occupational Health and Safety issues, pasture management, animal health and many others. He also points out that, without the impetus provided by Cicerone, a more reliable test for footrot would still be a long way off.

Sutherland also emphasised that the Cicerone Project has acted as a bridge between research scientists and livestock producers, leading to valuable cooperation and considerable changes in attitude by both parties. He states that extension and adoption are a vexed issue for which we may never achieve industry consensus and notes that the research funding organisations are also struggling with this issue. He believes that some representatives of funding bodies grossly underestimate the value of producer-led groups such as the Cicerone Project in breaking down barriers and achieving trusting relationships (Sutherland 2005).

In presenting an overview of the results of the farmlet comparisons presented at the 2005 symposium, Saul (2005) stated that the project had been able to confirm known principles at a scale credible to farmers and researchers and noted that the comparisons are "just getting to the interesting stage". He pointed out that studies of entire grazing systems take some years to 'settle down' and that the project had reached a stage where sizeable differences between farmlets have occurred. Saul noted that systems trials highlight the complexity of farming enterprises.

Discussion and Conclusions

Credible and trusted outcomes

Among the many successes of this producer-led initiative, perhaps the most notable to date has been the footrot trials which confirmed the validity of the 'hunches' of producers relating to benign and virulent footrot. This is already leading to the development of a more reliable diagnostic tool.

Another positive feature of the project is that, according to producers attending a review of the project in September, 2004, and confirmed at the May 2005 symposium (e.g. Dobner 2005), it is providing graziers with a source of objective information free of 'agendas'.

The motto chosen as a guiding principle of the project – "Compare-Measure-Learn-Adopt" - has proven to be invaluable in maintaining the quest for objective information over the years. Producers acknowledge that comparisons need to be made against relevant benchmarks and there is widespread agreement that the chosen conditions for a 'typical' farmlet (B) have provided an appropriate control treatment against which to measure differences.

Management of farmlets

Changes in farmlet management guidelines have been required over time. This has resulted in the initial farm guidelines expanding from just 2 to almost 20 pages over the past five years. This is to be expected as the opinions of the various stakeholders need to be discussed, challenged and then put into a framework that the farm manager can implement without ambiguity.

A difficult issue has been to achieve similar levels of grazing intensity on each farmlet as the treatments have brought about changes in plant species, pasture growth rates, quality of herbage and stocking rate. It is well recognised that early studies of grazing management with fixed rotations and stocking rates are inappropriate models, especially in this environment which is subject to erratic climatic influences. In general, researchers associated with Cicerone have favoured reducing stocking rates in favour of pasture persistence, whilst farmer members have often favoured increasing utilisation of feed on offer. Being producer-led, the opinions of the latter group have held sway thus far!

This tension has highlighted an important issue of fodder budgeting that needs to be developed and implemented in such a way that the capacity of each farmlet is tested equitably so that the consequences on pasture persistence and long-term profitably can be adequately assessed. It is suggested that, with further development of this approach, paddock and grazing management could be improved using at least monthly assessments of the energy balance between supply and demand. By using energy balance calculations, adjustments to stocking rate and stock movement decisions may be able to be improved so that the impact on pastures and animals is better balanced.

Challenges for researchers

Conducting research within a whole farm context has proven to be a challenge to the researchers and especially to the four postgraduates involved (Shakhane, Healey, Behrendt and Scott) who have to make sense of changes in paddock management which occur frequently enough to severely test measurement protocols. Nevertheless, the researchers have learned of the importance of so many issues vital to graziers that have not often been part of 'traditional' research programs. Chief among these realities is the aphorism attributed to Bill Willoughy that "you can't hang your sheep on sky hooks" alluding to the problems of 'put-and-take' experiments (Hutchinson 1997).

Of considerable importance to researchers, including the postgraduates undertaking research, is the manner in which valid statistical analyses can be conducted on this unreplicated farmlet trial. This has presented significant challenges to researchers and their paradigms. To date, the farmer members of Cicerone have had no trouble accepting the data presented from hundreds of soil, pasture and animal measurements; however, it is vital that the statistical analyses conducted are appropriate so that any conclusions drawn have validity. Modern statistical methods are well suited to the analysis of such data trends (R. Murison, pers. comm.).

The baseline conditions at the commencement of the experimental farmlet treatments are crucial to ensuring that systematic effects are not associated with the land chosen for each farmlet. The initial data indicate little difference between the initial farmlet conditions and so the observed differences in trends over time amongst the farmlets can be tested as a systematic effect.

Where appropriate, the data have been analysed using Generalised Linear Mixed Models where systematic effects are farmlet, time and their interactions. The random effects comprise measurement error, plot effects and plot:time interactions. The distribution of random effects can also be assessed by bootstrap sampling of the residuals from initial trends from prior to commencement of treatments in July 2000. This strategy has been used for other unreplicated experiments (Costa, Dwyer *et al.* 2000).

Project continuity

It is noteworthy that, even though it has to date been positioned outside most major funded programs, the Cicerone Project has survived from 1998 to at least 2006. Nevertheless, the Cicerone Board is of the opinion that it has been subjected to too many reviews. Recently, the Cicerone Board and its partner institutions have put forward a funding prospectus to a range of funding bodies to enable the studies to be continued and especially to permit the environmental aspects of different management systems to be adequately assessed.

Striving for sustainability and profitability

The measurement of sustainability at a credible scale is a challenging endeavour (Scott 2003). Even though an 'environmentally sustainable Australia' is one of four national research priorities for the current government, it is difficult to find funding for research to assess the sustainability of land use options over what might be considered an 'inter-generational' time-frame. Nevertheless, the Cicerone Project has attempted to measure a number of components of sustainability (e.g. soil, pasture, animal, production, and economics) over time and has already accumulated significant data over almost six years in a central database.

An experiment conducted with the Sustainable Grazing Systems national experiment showed some of the complexities of rotational grazing consequences (Chapman, McCaskill *et al.* 2003). Whilst rotational grazing led to higher perennial grass accumulation, it resulted in significantly lower legume accumulation which, in turn, affected livestock production. The authors pointed out that there can be no single solution to achieving sustainability (e.g. persistence of deep-rooted perennial grasses) and recommended the development of tactical strategies in relation to grazing management such that farm systems might include both set stocking and rotational strategies on different parts of their farms at different times in order to ensure high per head performance.

The fact that no single optimum grazing strategy for sustainability exists should not be an invitation for graziers to adopt whatever strategy they wish. Rather, it suggests that our current understanding of whole farm grazing systems is incomplete; there is much more to be done to realise the benefits not only of rotational grazing but also the targeting of animal classes to pasture types and herbage benchmarks in ways that take into account as many of the interacting variables as possible.

Reflections on the Cicerone 'experimental partnership'

These farmlets have proved to be an interesting vehicle for the coming together of researchers, extension workers and farmers who are very much in control of the direction and the strategic management decisions that are taken. Having a high level of ownership by producers has resulted in a continuing high level of interest and membership of approximately 120 farmers who manage more than 180,000 ha on the Northern Tablelands of New South Wales in at least 4 catchment areas. As differences between farmlet systems have become more apparent, there has also been increasing interest in the project from research and extension agencies as well as from students who regularly conduct learning exercises on the farmlets.

With the benefit of hindsight, it is worthwhile to consider both the positive and negative aspects of the Cicerone Project experience. The fact that the Cicerone constitution states that there must be a producer majority and a producer as Board Chairperson has been of great significance. Also, membership of the Board by representatives of various organisations was vital in ensuring that the producers were made aware of existing knowledge and could be assisted in project submissions, conduct of projects, etc. This broad representation on the Board assisted in getting considerable 'ownership' by a wide range of both producers and representatives of other organisations. The early conduct of a broad survey of producers was critical for developing confidence in the early aims set by the Board. This evidence of need was no doubt important in securing funding through the

initial Business Plan. We contend that this team approach has led to research which is firmly focused on pragmatic outcomes and is well worth continuing, not only in this region but more broadly as well.

On the negative side of the ledger, managing a complex project with a relatively large Board, has meant that some decisions took a long time to be finalised. At times, there was a lack of a shared vision in what might be achieved, and this no doubt resulted from the diverse background of many members of the Board.

Whilst all members and collaborators in the Cicerone Project are enormously appreciative of the funding support from the wool industry, through Australian Wool Innovation, there is now a growing recognition by some Board members that more could have been achieved if the research and extension partners were also able to secure funding to support their more active engagement. This lack of funding resulted in less support being provided, for example, to enable data management and interpretation than would otherwise have been desirable.

The perspective of researchers has been challenged by the Cicerone Project (Scott 2005c). Some of the rewards for researchers have included the confidence gained by researchers when farmers show their appreciation of seeing results obtained at a 'credible' scale. Also, researchers have a growing appreciation of the skills possessed by producers and their families. Other benefits to researchers have included: the broadening of the practical knowledge of researchers about farming and risk management, exposure to a breadth of disciplines not normally encountered in research, the benefits of seeing changes in systems develop over more than the usual two or three years of experimentation which most projects are restricted to, and seeing well established scientific principles demonstrated within realistic farmlet scenarios.

Some tasks which are necessary components of many successful projects today are not able to be carried out by producers. The skill base that needed to be employed to bring about this project included experts in aerial and soil survey, land planning, GIS data management, relational database construction, soil test interpretation, agronomic and veterinary advice, animal ethics proposals, in-depth knowledge of existing extension information, assessment of relevant research literature, statistical analysis of data, project management, writing of project applications, milestone reports, publications and web site authoring and management, etc. Most of these have been provided as significant in-kind contributions.

It is perhaps not sufficiently well understood by some producer members how important some of these functions are. In the case of the Cicerone Project, due to a lack of experience by some producers in aspects of the planning and execution of research and extension projects, the 'in kind' contributions of some of the organisational partners (university, extension, training and consultant members of the Board) have, at times, been taken somewhat for granted.

If science-farmer partnerships are to flourish, it is vital not only that researchers understand producers but that producers understand the operational and funding constraints placed on research and extension collaborators by their respective managements to focus on what those managers see as their core business. Providing a budget allocation to those partners who carry out significant components of the project would result in more effort leveraged to the ultimate benefit of any producer-led project. The responsibility for seeing that this happens in an equitable fashion must lie with all partners, including the funding agencies.

Lessons from other science-farmer linkages

Attempts to engage scientists and producers in research and adoption which allows significant 'ownership' by producers have included the recently completed Sustainable Grazing Systems Key Program described earlier (Mason, Lamb *et al.* 2003). This was a substantial national project in scale, in the level of resources contributed by a number of research funding bodies as well as the substantial in-kind contributions from a large number of research and extension agencies and consultants. Although this project has left a significant and lasting legacy, the goodwill the project developed in 11 regional producer groups was largely dissipated upon the cessation of the project after 5 years of active engagement. Many producers felt let down when the collaborative efforts and linkages developed could no longer be sustained.

Farming system groups involved in catchment studies have also seen partnerships develop between farmers and scientists although most work is conducted on components of the system rather than whole farm systems which include the full array of factors governing sustainability (Ridley 2005). She points out the need for farming groups to continue to work towards resolving the complexity of sustainability issues at a range of scales.

Sustaining the partnerships

One important but unresolved issue concerning getting the best out of partnerships such as the Cicerone Project, those in the SGS program or with Catchment Management Authorities, is the sustainability of the science-farmer partnership itself. In an era of mostly short-term project funding, it is difficult to see how these groups can continue to deliver over the long-term.

One of the oldest cropping groups in Australia, the Birchip Cropping Group (McClelland, Gartmann *et al.* 2004), has grown considerably in scale since it began in 1992. However, in spite of its continuing success, including substantial support from agribusiness, the long-term continuing financial viability of such groups is questioned

by McClelland; without continuing support from research funding bodies such as the Grains Research and Development Corporation, he suggests that it will be difficult for farm groups to continue to be effective over the long-term.

Government funding could help ensure that Ridley's suggestion of farmer groups broadening their interests to include environmental and even social sustainability issues is realised (Ridley 2005). As she points out, the need to work across multiple disciplines and scales is not a trivial issue and will require considerable investment in skills.

It is clear that achieving an adequate level of environmental sustainability is a complex task, not only for scientists but also for land holders (Ridley 2004). She points out the need for scientists to translate their findings into practical solutions at the farm level. Also, she points out that 'highly participatory approaches (which empower farmers rather merely inform them) can help scientists to understand farmers' needs and motivations, but involve losing control of highly focused research agendas'. Thus, the power of farmer leadership can be seen as a threat to some in existing research and extension providers as well as in funding agencies.

Future opportunities

There is a need for the Cicerone Project to better demonstrate the degree of practice change it is bringing about within its constituency. Benchmarking exercises and surveys should be carried out over time in order to quantify change that has occurred in farming practices.

The goal of achieving a balance between the provision of environmental services and profitable production remains elusive. As pointed out by Kemp and Michalk (2005), there is a need to develop knowledge and tools applicable at the farm level. Developing solutions that are likely to be adopted is best achieved by having real farmer-scientist partnerships from the start of any project.

The Cicerone Project has applied for funds to undertake research to quantify the environmental outcomes from the three farmlets, by measuring variables such as nitrate leaching at depth, soil hydrology changes, runoff, nutrient losses and sediment losses due to erosion, etc.

From the point of view of improved parasite control, more testing of alternative strategies needs to be continued. For example, the prospects of reducing parasite loads through alternate grazing of cattle and sheep (Southcott, Le Jambre *et al.* 1997) deserves more thorough investigation as part of an integrated approach to management of animal health.

There remains much to be done to understand the financial consequences of the differences between farmlets in labour used, pasture persistence, need for drenches, supplementary feeding, changing stocking rates, etc. Also, it is clear that farmers are interested in all costed financial options, including low cost options, as not all farmers have the same view of economic outcomes.

Work is currently underway to explore the scaling up of all financial records from the Cicerone farmlets to a realistic scale so that Cicerone members can relate to the financial summaries (Scott 2005a).

In the future, there may be opportunities for farm members who adopt various management strategies relevant to the farmlet studies to become part of a larger scale 'proving ground' for testing farm management systems.

Finally

The collective experience of various Australian farmer-scientist partnerships provides an opportunity to consider the creation of a broad range of 'fact farms' across the many agro-ecological regions of Australia. These would need to be locally relevant and yet, if inter-linked, could provide a network of objective evidence gathered from farms managed at a credible scale. They could also be of use for national studies of issues such as ground truthing of satellite imagery.

There is also an urgent need to bring about transforming technologies which can assist in delivering to farmers more capability for sustainable land management. Broader society benefits substantially from agriculture and its flow-on industries and should assist in bringing about the transformation needed. The technological capacity for farm managers to benefit from remote sensed information from satellites, to estimate risk using complex decision support tools and simulations, to capture real time information, to make just-in-time production and sustainability decisions, and to choose optimal pathways in the face of climate and market risk needs to be enhanced if Australian agriculture is to remain sustainable and internationally competitive.

Viable partnerships between farmers and scientists will assist in seeing these transformations realised. As argued above, it is vital that livestock producers are engaged in the discovery and demonstration phase of investigations in order to accelerate and broaden adoption of more sustainable practices. Funding needs to be found not only to facilitate the participation of farmers but also parallel funding needs to be provided to researchers and to extension teams if we are to maximise the effort made by all parties. Without adequate funding to all partners, the impact of collaborative work will be severely diminished.

We contend that a strong case has been made in this paper for the broad establishment of *functional partnerships* between farmers, scientists, extension professionals and consultants and for these partnerships to be made '*sustainable*'. We therefore suggest that State and Federal governments should foster the development and maintenance of functional farmer-scientist partnerships in all agroecological regions of Australia.

As noted by McClymont (1970), setting up large, challenging projects and their socioeconomic consequences "requires a long term commitment in which the integrated programme is paramount over (the) short term interests of individuals".

"The problems in ensuring continuity and the necessary integration of disciplines and personalities in what are necessarily long term studies are by no means small". We can only agree. Nevertheless, if we are to see farm systems develop which are sustainable between generations, we *must* find a way for it to happen.

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