

Reflections on the concept, conduct and findings of the producer-led Cicerone Project

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Abstract. The Cicerone Project began as a producer-led partnership that sought, over a period of 8 years, to enhance the profitability and sustainability of livestock enterprises by improving the connection between those producers, research and extension. Following a detailed survey, the research and extension needs of livestock producers were identified and several applied investigations were conducted to meet those needs and delivered through a range of extension activities. This final paper of the Cicerone Special Issue reflects on the entire Project from a wide array of perspectives, including livestock producers, researchers, extension specialists and staff employed by the Project, all of whom are authors of this paper.

A notable early successful outcome of the Project was the improved precision of footrot diagnosis, which has been of value to the entire sheep industry, and that flowed from a field investigation of benign and virulent footrot combined with detailed genetic investigations, which led to an improved testing regime.

This paper also reflects on the findings of an unreplicated agricultural ecosystem research trial, which measured the impact of pasture renovation, increased soil fertility and grazing management on the profitability and sustainability of three different 53-ha farmlets. Valuable findings from this whole-farmlet trial included the need for a high quality feed supply for increasing stocking rate and animal liveweight; the ability and utility of satellite imagery to detect changes in pasture growth, composition and recent grazing pressure; the value of short grazing and long rest periods for controlling Barber's pole worms of sheep; the impact of increased stocking rates on whole-farm profitability and risk; methods of optimising decisions relating to pasture renovation, fertiliser applications and grazing management; and an integrated analysis of all key measured components of the farmlet management systems. Collectively, these findings were powerful as they were demonstrated at a scale credible to livestock producers using the 'compare – measure – learn – adopt' approach, which was the key philosophy adopted by the Cicerone Project.

By comparing and measuring different whole-farm systems, and by ensuring that producers had ownership of the trial process, the Project successfully delivered objective findings that producers trusted and which increased our understanding of important drivers of complex grazing enterprises under variable climatic conditions. Some of these drivers included: the influence of soil phosphorus on botanical composition and subsequent livestock production, the role of pasture renovation and soil fertility on herbage supply, herbage quality and stocking rate, and the improved gastrointestinal nematode control delivered by intensive rotational grazing.

The beneficiaries of the Project included the 180 farmer members who participated in some 61 field days and workshops; the research and extension collaborators including four postgraduates who completed their research investigations in conjunction with the Project; and some 500 undergraduate and 300 technical students who benefited from coming to understand the applied field comparisons of the three whole-farmlet systems. Having livestock producers play a significant

leadership role led to valuable outcomes achieved with research collaborators; this should encourage the development of other learning partnerships which aim to explore complex farming system issues.

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Introduction

The Cicerone Project commenced on the Northern Tablelands of New South Wales (NSW), Australia, in 1998, following a series of meetings during which it was acknowledged that there was a substantial 'disconnect' between livestock producers and the research and extension community (Sutherland *et al.* 2013). With the support of the funding body, the Australian Wool Research and Promotion Organisation, the Project set out into 'uncharted waters', under producer leadership, to find out what the needs of livestock producers in the region were (Kaine *et al.* 2013) and then, to address those needs through a collaborative Project with research, extension and consultant partners.

The principal needs identified included the management of the pasture feed supply, especially during droughts, in order to allow the condition of livestock to be maintained, particularly during pregnancy, without excessive expenditure on supplementary feed (Kaine *et al.* 2013). Another concern related to the resistance of gastrointestinal nematodes to several drenches. After the Project commenced, an important issue arose when livestock producer members reported that the testing regime for virulent footrot was in need of improvement (Gaden *et al.* 2013). This led to field trials which were conducted in two localities to explore the severity and transmission of footrot from sheep flocks identified as having different levels of field expression of the disease, followed by DNA identification of the various disease strains (Cheetham *et al.* 2006).

The issues relating to the pasture feed supply and intestinal nematode management were examined through a whole-farmlet study of three systems: first, a farmlet (A) focussed on sown pastures and increased soil fertility with flexible grazing management; second, a farmlet (B) representing typical management of the region, consisting of moderate inputs and flexible grazing management; and a third (C) also with moderate inputs but which practised intensive rotational grazing. The farmlets were each 53 ha in size thus providing the 'credible' scale sought by livestock producer members. The farmlet treatments have been described in detail by Scott *et al.* (2013d) while the results have been reported in several related papers in this Special Issue.

Although the treatments in the farmlet experiment remained fixed over time and were explicitly defined (Scott *et al.* 2013d), some adaptive management was encouraged by the management Board, as this reflected realistic farm practices. For example, in the first year of the trial, when it became clear that the initial 17 paddocks on farmlet C were insufficient to achieve long grazing rests for the intensive rotational grazing treatment, permission was given to increase the number of paddocks to 37.

Many early studies of grazing management used fixed rotation lengths and/or stocking rates (Moore *et al.* 1946; McKinney 1974; Schlegel *et al.* 2000). The livestock producers involved in this Project decided that these were inappropriate management constraints, especially as this environment is subject to a

variable climate. Thus, both stocking rate and the frequency of drenches for internal parasites were treated as emergent properties of the farmlet management treatments rather than fixed treatment factors, again because this accorded with realistic farm practices.

Also, the use of continuous grazing or 'set stocking' as a control treatment, was rejected, as few graziers in this region practise 'set stocking' as it has been applied in other experiments (Earl and Jones 1996; Lodge and Orchard 2000; Waller *et al.* 2001). Thus, the control grazing management treatment chosen was flexible rotational grazing based on pasture and animal conditions. The grazing management question asked by Cicerone members was: compared with *flexible* rotational grazing (with moderately long graze and rest periods), what are the benefits of *intensive* rotational grazing (with short grazing and long rest periods)?

The approach adopted by the Project, expressed in its adopted motto, was to 'compare – measure – learn – adopt'. This reflected the desire by all participants to see objective evidence from comparisons rather than rely on the claims made by proponents of various, more prescriptive systems (Scott *et al.* 2013d). In addition, the livestock producers wanted investigations to take into account the risk of adopting different technologies compared with their traditional practices. They appreciated that individual farmers cannot hope to intensively measure their whole farms and thus looked to the farmlet comparisons to provide evidence at a credible scale that they could trust. The 'whole-farm' approach adopted reflected the livestock producers' understanding that decisions regarding sowing pastures, fertilising and grazing management have impacts on all aspects of a farm including profit, capital, cash flow, labour, as well as affecting pasture growth, persistence and the sustainability of the enterprise.

As noted by Kemp *et al.* (2000), studies relating to perennial grasses and their role in pasture sustainability, as examined in the Temperate Pasture Sustainability program, needed to be tested at a more commercial scale. Research within that program, on the Northern Tablelands of NSW, found that legumes were a necessary complement to deep-rooted perennial grasses in order to deliver characteristics of sustainability such as the capacity to store and use more soil water (McLeod *et al.* 2006), to utilise nitrogen fixed by legumes before it drains below the root zone (Chen *et al.* 1999) and, in general, to bring about greater per head and per hectare livestock production (Scott *et al.* 2000).

Clark (2010) has noted the great value of farmlets for the study of dairy systems as they have improved the adoption of research findings. However, he warned that economic evaluations needed to be realistic and acknowledged the expense and difficulty of measuring and interpreting results from farmlet experiments. A study of the way in which Australian farmers learn, found that farmer-directed groups were an effective way of enhancing farmers' commitment to lifelong learning (Bamberg *et al.* 1997).

This paper will provide an outline of the main elements of the Project and briefly describe some of its findings, followed by reflections from a wide array of perspectives and, finally, a discussion of the challenges and opportunities revealed by the Project. For those readers who are interested, a set of photographic images from the Project have been provided in the Supplementary Material, available on the Journal website.

Historical overview of the Cicerone Project

The Cicerone Project evolved and consolidated over a period of 8 years. The stages of the Project were:

- 1998: the Cicerone Project commenced, led by a Steering Committee which planned to create an environment in which researchers and producers could learn from each other, in the full context of wool growers' operational environments (Sutherland *et al.* 2013). A survey was conducted of livestock producers across the region to determine their views on the most important issues facing them at this time (Kaine *et al.* 2013).
- 1999: the central learning farm was planned to study the effects on the profitability and sustainability of three different whole-farmlet management systems (Scott *et al.* 2013d, 2013e).
- 2000: the farmlet experiment paddocks were fenced, watering points installed and three paddocks of farmlet A were renovated as stocking of the farmlets commenced. A separate trial was conducted on adjacent land to investigate the effectiveness of the existing testing regime for virulent footrot (Gaden *et al.* 2013).
- 2001: the three farmlets became more settled in their operation, with similar levels of production although some differences in pasture production became apparent over the first year. A second footrot trial was conducted to explore the response of different strains of footrot when sheep were moved to a different climate in central NSW (Gaden *et al.* 2013).
- 2002: In common with farms in the region, drought severely affected the farmlet trials, necessitating changes to the grazing rest periods and the sale of all non-reproductive stock to reduce feeding costs. The first of four postgraduate students commenced their research on the farmlet trial.
- 2003: Several field days were run on topics such as pasture assessment, soil test interpretation and stock planning towards developing more precise management of soils, pastures and livestock.
- 2004: Following a review, funding was extended for another year. Many field days were conducted about farmlet performance across different seasons. By this stage, large differences had developed between the farmlets, most notably an increase in stocking rate and livestock performance on farmlet A (Cottle *et al.* 2013; Hinch *et al.* 2013a) and superior worm control on farmlet C (Walkden-Brown *et al.* 2013).
- 2005: Cicerone held its first major symposium to showcase research results. An invited reviewer noted that the farmlets were diverging without any sign of a plateau in performance (Saul 2005).
- 2006: A second symposium was held to deliver results to members. Funding was extended to the end of the year to allow results to be finalised and delivered to stakeholders. A survey of members was conducted to seek ideas for the

future directions of the Project. Overwhelmingly the survey showed that the constituents were pleased with the work that had been conducted and wished it to continue (Edwards *et al.* 2013). As a result the Board compiled a comprehensive 5-year funding prospectus with a focus on providing environmental benefits and improving whole-farm productivity. This was sent to various funding organisations to invite them to continue the work that had been started. As further funding was unable to be secured, the livestock and equipment were sold, the lease of land was terminated and staff ceased employment.

- 2007: The Cicerone Project was formally wound up and collaborators agreed to help coauthor a series of scientific publications presenting results from the Project.

Weather experienced during the trial

Examination of long-term climate records showed that the farmlet trial experienced lower soil moisture levels, more soil moisture stress days and more severe frosts than the long-term average values for these parameters (Behrendt *et al.* 2013c).

Overview of results

Before reflecting on the Cicerone Project, it is useful to consider a brief summary of some of its more notable achievements:

- A field experiment, complemented by laboratory studies, demonstrated differences in field virulence of several footrot strains and showed that results from the common gel laboratory test differed from the results of a more definitive DNA test (Gaden *et al.* 2013). This work stimulated further research, which greatly improved the reliability of the diagnosis of the disease (Cheatham *et al.* 2006). The early success of the footrot trial and several short-term livestock trials (e.g. meat sheep evaluation, post-shearing treatments) are not reported here; however, they helped to retain members' interest in the Project while the longer-term farmlet and tree woodlot studies became established.
- A series of woodlots were established on the south-western corner of an equal number of paddocks across each of the farmlets in order to provide shelter for lambing ewes and also to learn more about the establishment, survival and early growth of several exotic and native tree species and ecotypes (Reid *et al.* 2013).

Some results from the farmlet experiment include

- The differential soil fertility targets were reached within 2 years of the commencement of treatments. Changes in soil phosphorus and sulfur had large and significant effects on numerous parameters including pastures, livestock and stocking rate (Guppy *et al.* 2013).
- Perennial pastures were successfully established over a range of conditions, including during the drought year of 2002, thus demonstrating that changes to more productive species can be readily achieved even in adverse seasons (Scott *et al.* 2013d).
- Significant changes were observed in botanical composition in response to farmlet treatments including substantial differences in sown perennial grasses, warm season grasses, yearlong green grasses and legumes (Shakhane *et al.* 2013b).

- Significant differences between farmlets were observed in liveweight per head for weaner sheep, ewes and wethers as well as for cattle (Hinch *et al.* 2013a).
- The importance of maintaining minimum fat scores for reproductive ewes was supported by the trial (Hinch *et al.* 2013b).
- The changes in fleece characteristics between farmlets did not result in substantial differences in fleece values per head but, because of differences in stocking rate, wool production and thus wool value per hectare differed substantially (Cottle *et al.* 2013).
- Short grazing and long rest periods resulted in a decline in the numbers of Barber's pole worms in sheep leading to less reliance on anthelmintic drenches (Colvin *et al.* 2008; Walkden-Brown *et al.* 2013).
- The detailed financial records which were kept of all input costs, including labour, and income allowed computation of gross margin and cash flow budgets as well as financial risk for each farmlet, which were then scaled up to allow comparisons relevant to commercial-scale whole farms (Scott *et al.* 2013a, 2013b).
- A bioeconomic model was developed, utilising the farmlet data, which showed how optimal decisions can be made in relation to pasture renovation and fertiliser applications to increase net worth over the long term (Behrendt *et al.* 2006, 2013b).

It is noteworthy that many important results from the farmlet trial were only partially understood at the end of 2006, the formal end of the Project. In fact, it took a further 6 years of considerable effort, all of it provided 'in-kind', to organise, quality assure and analyse the data and publish the findings. It was not until the preparation of this Special Issue that any of the participants, members or collaborators were able to consider all of the results and findings and contemplate their overall significance. This highlights the substantial challenge of publishing the results of complex, multi-disciplinary trials involving many participants, within the life of any project. No doubt, without the substantial efforts of the many coauthors of this Special Issue, an integrated publication would not have eventuated. Although part of the reason for the delay in publishing results in an integrated fashion was due to resource constraints during the Project, it is also noteworthy that there were few examples or templates where results have been delivered from complex farmer-research-extension partnerships in a timely way. A notable exception was the Sustainable Grazing Systems Project, which was published following the funding of an extra year to allow for analysis and writing by the scientists involved (Andrew *et al.* 2003).

Reflections

The following claims are the considered views of the authors who represent all categories of participants in the Project. Thus, in our view, they do not require further supporting evidence.

Reflections from the livestock producers

The fact that the Cicerone Project provided graziers with a source of objective information, free of 'agendas' or ideology, was widely appreciated by producer members of the Project, as

confirmed in the numerous survey results reported by Edwards *et al.* (2013). However, it was also clear from feedback received that several producers found the research process to be too slow in delivering results.

Early in the life of the Project, trials confirmed the validity of producers' 'hunches' about the inadequacy of tests for benign and virulent footrot (Gaden *et al.* 2013). This led to the development of a more reliable diagnostic tool resulting in a substantial animal health benefit for the sheep industry, nationally. Without doubt, the impetus provided by the Cicerone Project accelerated the development of this more reliable test for footrot. The finding of the importance of foot conformation on the susceptibility to footrot was also valued by producers.

The three farmlets allowed for a credible demonstration of the effects of pasture renovation and increased soil fertility with their flow-on effects for pasture nutrition, digestibility, livestock growth, production per head, stocking rate and production per hectare. Another facet that impressed producers was the accumulation of so much data, that they considered valuable and trustworthy, on soils, pastures, animals, worm egg counts and economics that allowed for valid conclusions to be drawn (Edwards *et al.* 2013). Also of great value, were the economic analyses of investments in soil fertility, pasture renovation and intensive rotational grazing, which allowed for realistic comparisons at a whole-farm scale as well as exploring issues of risk over variable time frames (Behrendt *et al.* 2013a, 2013b; Scott *et al.* 2013a, 2013b).

The demonstration of successful pasture establishment, even under challenging climatic conditions, and the influence of grazing management on the persistence of sown perennial grasses enhanced the knowledge of livestock producers. Also of great interest to them were the importance of maintaining the legume component of pastures (Shakhane *et al.* 2013a) as a source of protein needed for meat (Hinch *et al.* 2013a) and wool products (Cottle *et al.* 2013); the significant differences observed between farmlets, in spite of the years being relatively dry; and the challenges of getting sown pastures to persist long enough to be worthwhile investments (Behrendt *et al.* 2013a).

The value became increasingly clear of regular monthly assessments of the status of green and dead herbage mass and pasture digestibility across every paddock as an aid to making adjustments to stocking rates over time. Producers appreciated the difficulty of managing changes in stocking rate and stock movements to adequately take into account changes in supply and demand for feed. The difficulty of getting the right balance is a challenge well known to producers who commonly run mixed livestock enterprises. For example, as decisions were made to increase the stocking rate on farmlet A, it became clear that the levels of green digestible pasture were insufficient at times, resulting in excessive feeding becoming necessary later in the trial period on that farmlet. The consequences of the differences in green digestible herbage on livestock weights, especially of weaners, ewe scanning percentages and wool growth were important findings.

The objective evidence collected on the effects of grazing management was especially valued by producer members. Whereas the studies into intestinal worm burdens showed great benefits from intensive rotational grazing (Colvin *et al.* 2008; Walkden-Brown *et al.* 2013), it was also obvious that

excessively long rest periods resulted in lower individual animal performance, which required the adjustment of graze and rest periods to overcome this disadvantage (Hinch *et al.* 2013a).

Topics covered by the more than 60 seminars, field days and symposia organised by the Cicerone Project over its duration often arose following suggestions from producer members who generally found these activities to be highly informative (Edwards *et al.* 2013). The result was that a diverse array of learning activities was successfully conducted.

The different farmlet treatments investigated accurately reflected the situations on producers' farms. There was widespread agreement that the chosen conditions for the 'typical' farmlet (B) provided an appropriate control treatment against which to measure differences on the other farmlets (higher inputs on farmlet A and intensive rotational grazing on farmlet C), both of which producers also readily identified with (Edwards *et al.* 2013). Over time, it became clear from feedback that livestock producers were adopting practices of most relevance to them; they also reported that many employed different management strategies, such as those on farmlets A, B and/or C, within one farm system (Edwards *et al.* 2013). As the Project matured, it became obvious that it was attracting the interest of many commercial-scale livestock producers who ran farms some 50% larger than the average property size for the district, as found from a survey of members in 2006 (Edwards *et al.* 2013).

Producers understood the need for the Board to differentiate the farmlets quickly and hence accepted that the high rate of pasture improvement experienced on farmlet A (29% in the first year) (Scott *et al.* 2013d) was not typical of the region, especially given the dry conditions experienced which imposed additional risks. This made the calculations of the longer-term returns from pasture investments at a whole-farm scale by Scott *et al.* (2013a) and Behrendt *et al.* (2013a) all the more important.

It was clear that the sustainability of the different systems received less focus than was planned at the outset. Questions remained about the longer-term effects of management on ground cover, legume and perennial grass persistence, and subsequent effects on water infiltration, runoff, erosion, deep drainage, soil organic matter and soil pH over time. A paper by Scott *et al.* (2013c) has discussed the sustainability characteristics of the three farmlets at greater length.

As found from several surveys of producer members (Edwards *et al.* 2013), there was widespread agreement that the Project should have continued for a longer period, especially to enable measurements to be taken over a period when the annual rainfall was greater than or equal to the average. This would have permitted the evaluation of the three alternative management systems to be more representative of long-term climate expectations, especially for practical producers who prefer measured results to predictions based on computer models.

The majority of producer members were disappointed when they learned that the Project was to be discontinued. It would appear that, even though the Australian Wool Research and Promotion Organisation boldly entered these 'uncharted waters' when they initially funded the Project (Sutherland *et al.* 2013), subsequent management teams within the funding body had different and shorter-term funding priorities. We contend that the value of producer-led groups such as the Cicerone Project, which broke down barriers and achieved

trusting relationships, is often underestimated. The 'start-stop' nature of most research project funding results in the frequent severing of these trusted relationships.

It was only after the commencement of the Cicerone farmlet trial, when it was clear that interesting farming system comparisons were being carefully carried out, that several supporting organisations provided sufficient cash and in-kind support to enable four postgraduate students to undertake their research in conjunction with the trial. In brief, they explored issues of pasture composition and the feed supply, the effect of farmlet system on gastrointestinal infections of sheep, comparisons of whole-farm profit/risk, and optimal decision making within a variable climate. The producer members of the Project were appreciative of the efforts of these scientists as they produced some of the most important results from the trials, most of which are published within this Special Issue.

It was also obvious to the producer members that the trials conducted by the Cicerone Project succeeded in stimulating researchers as well as the consultant and extension specialists to commit to the Project with great passion, which became infectious to all participants. The 'bottom-up' approach adopted in this field research by seeking the views of producers was appreciated by them more than some of the 'top-down' research, which is often promoted by researchers and funding bodies to producers.

The sometimes slow decision-making process of the management team frustrated some producer members of the Cicerone Board as they are used to making rapid decisions on their own farms. Nevertheless, most of the decisions made were debated thoroughly and a consensus was usually reached.

Reflections from the researchers and extension specialists

Conducting research within a whole-farm context proved to be a challenge to the researchers and especially to the four postgraduates involved who had to make sense of changes in paddock and/or grazing management decisions, which at times led to altered experimental conditions. Nevertheless, the researchers learned of the importance of the 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 Willoughby that 'you can't hang your sheep on sky hooks' (Hutchinson 1997) alluding to the problems of some prior experiments, which allowed 'put-and-take' movement of stock in a fashion that is not practised on commercial farms. In the farmlet experiment, livestock numbers changed with seasonal conditions as stocking rate was considered an emergent property of each system. Also, during pasture renovation, especially on farmlet A, management had to cope by moving all livestock to the remaining paddocks, just as on real farms.

Researchers developed a better appreciation of the skills possessed by producers in the management of their farms as a whole-farm system such as their understanding of a wide range of livestock issues including assessing livestock condition, managing animal health, nematode infections and drench types, supplementary feeding, protection during lambing and risk assessment. When faced with climatic challenges such as drought, the advice from experienced producers on the Board facilitated more appropriate short- and long-term decisions to be

made. Other benefits to researchers included the broadening of their practical knowledge about farming and risk management and exposure to a breadth of disciplines, some of which were outside their fields of expertise, such as soil science, pasture agronomy, livestock physiology, parasitology and animal behaviour. Also, researchers were able to observe changes in systems, which developed over longer periods than the usual 2 or 3 years common in many field experiments. Larger sized plots also meant that researchers had to adapt their methods to cope with these greater dimensions.

Of considerable importance to researchers, including the postgraduates, was the manner in which statistical analyses could be conducted on this unreplicated farmlet trial. This presented significant challenges to researchers and their paradigms as discussed by Murison and Scott (2013). Given that there was credible evidence of similar starting conditions from the farmlet planning process (Scott *et al.* 2013e), the lack of replication was not considered to be a fatal flaw, especially as appropriate methods are available for inferring causal inference (Murison and Scott 2013). And yet convincing scientists of the validity of producer-led trials like Cicerone is just one requirement; arguably, a more important requirement is that producers have sufficient confidence in the findings to use them and have an impact within the wider industry.

The considerable value of the extensive and regular measurement of soil fertility and pasture assessments, fleece weights, animal weights and fat scores, and trends over time became more obvious to researchers as the data analyses were carried out. The data from before or early in the trial showed little difference between the initial farmlet conditions (Scott *et al.* 2013c) and so the observed differences in trends over time among the farmlets could be inferred to have arisen due to the different management systems imposed (Murison and Scott 2013).

The climate experienced during the trial taught researchers a lot about the climatic realities of this area such as the frequent dry periods (Behrendt *et al.* 2013c) and the occasional bursts of pasture growth that were so short-lived that it was difficult to measure their effects (Shakhane *et al.* 2013a).

One of the most notable successes was the enthusiasm that Cicerone generated in Technical and Further Education (TAFE) and undergraduate students who visited Cicerone and also in the postgraduates who had to grapple with its complexity. Undergraduates appreciated observing paddocks from different farmlets side-by-side and measuring pastures over several visits while the large amount of empirical data made available to them helped to secure their interest in the trial. For the postgraduates, conducting research that producers saw as valid and interesting was of great benefit to their studies.

The large number of field days, seminars, workshops and newsletters held the Project together. They attracted both local producers and several visitors from far afield. Cicerone became a major disseminator of trusted and relevant information for commercial livestock producers. Over time, the reports from the Farm Manager responded to the Board's need for regular, factual reports at each Board meeting on aspects such as liveweights, fat scores, pregnancy scans, stocking rates, worm egg counts, drenches used and supplements fed. The needs of the pastures and the animals had to be balanced and, inevitably, compromises had to be made.

Reflections from the Cicerone staff (Executive Officer and Farm Manager)

The Cicerone Project provided staff with an opportunity to use their training and skills in a way that was highly valued by all those who visited the Project. The dynamic nature of the Project stimulated many ideas and led to important, meaningful and practical results. But there were frustrations for staff who were impacted directly at times by funding constraints.

The Cicerone Project became well accepted by all producers, in spite of some misgivings expressed by a few early in the Project. Because it took a long time to set up the farmlet trial, the scientific approach adopted was seen by some as a negative. Nevertheless, the success of the footrot trial helped to gain the trust of Cicerone members.

It became clear over time that there was no single 'magic' management system; this finding was readily accepted by most producer members. The producers also learned to appreciate some of the reasons why research can appear to be so slow.

Researchers and farmers demonstrated that they were able to work together in a successful relationship. However, at times, practicality had to take precedence over scientific needs. Researchers also gained a greater appreciation of what a difficult balancing act whole-farm management can be.

Both the undergraduate and postgraduate students benefited from the Cicerone farmlet experiment which was, in effect, a large, living laboratory. The conduct of trials through Cicerone allowed ideas put forward by producers to be tested without them taking on the risk associated with a new technology on their own farms.

The Board needed to take into account the needs of all of the partners from producers to researchers and extension specialists, which meant that, at times, considerable compromises were needed. Resource constraints meant that the specialist database expertise needed was not continuously available to the Project. This resulted in considerable difficulties in updating data and interrogating the database by Cicerone staff.

Collective reflections

When the Cicerone Project began in 1998, there was relatively little shared vision of what might be feasible regarding collaborative research. However, after seeing the initial survey results (Kaine *et al.* 2013) turned into research on the three farmlet systems it became obvious, during the many field days and farm walks, that the results were interesting and credible. We suggest that farming system research is successful when it presents objective evidence that leads to greater understanding which then affects the response of land managers in ways that result in positive benefits on their farms. That the objective evidence often challenges some beliefs, strengthens the outcomes.

The relationship between participants changed over time, with attitudes changing and mutual respect developing between all parties, leading to increasingly valuable collaboration and trust. The Project encouraged all participants to realise that, while they may have different interests in the grazing industries, the result was valuable collaboration that helped all to gain a better understanding of grazing enterprises and their role in them.

The implementation of both pasture and tree establishment efforts were impressive. The success of the pasture renovation efforts confirmed the well established principles of direct drilling, which include weed control, saving moisture, waiting for the annual weeds to germinate, spraying again, and then sowing (Keys and Orchard 2000).

Because intensive rotational grazing has polarised the opinions of many (Saul and Chapman 2002), having a farm manager who was knowledgeable about this grazing system (and of the other farmlet systems) was an advantage for conducting the research in a manner which was seen by producers as a fair comparison of treatments. Because of the great interest within the Project in grazing management, the Cicerone Board members, when inspecting the three farmlets, spent more time visiting paddocks of the intensively grazed farmlet (C) than either of the other two farmlets which, with their fewer number of paddocks, were easier to visit. In addition, the farm manager received some training in grazing management and a considerable amount of informal advice from Cicerone members who were committed to intensive rotational grazing systems. Thus, it was clear to all involved that the performance of the intensive rotational grazing farmlet (C) did not suffer due to any bias against such a system nor from a lack of management interest or attention. The same can also be said of the typical (B) and higher input (A) farmlet systems, which generally were perceived as less controversial.

It is notable that the Cicerone Project addressed all the key issues identified in the original survey (Kaine *et al.* 2013) and therefore directly responded to the needs of graziers in the region. Because producers became closely and actively engaged, there was a high degree of satisfaction with the Project and a strong desire to see it continue (Edwards *et al.* 2013). As pointed out by Trompf and Sale (2006), getting the active engagement of graziers is a necessary condition if adoption of extension messages is to be successful.

Setting up and operating the Cicerone Project as a not-for-profit, independent, incorporated body was not a trivial matter. While it allowed great freedom for exploring producer-generated ideas, it also came with significant responsibilities, some of which consumed long hours of meetings among Board members. This caused frustration for some and may have contributed to the relatively high turnover of producer members of the Board that occurred over the life of the Project. Nevertheless, the Project was conducted with a minimum level of 'bureaucracy' and in a way that efficiently delivered many substantial outcomes, in direct response to producers' demands.

It was of great significance that the Cicerone constitution stated that there had to be a producer majority and a producer as Board Chairperson (Sutherland *et al.* 2013). Also, representation on the Board of personnel from various organisations was vital in ensuring that the producers were made aware of existing knowledge and could be assisted in project submissions and the conduct of projects. The early conduct of a broad survey of producers (Kaine *et al.* 2013) proved to be of great value for developing confidence and helping the Board choose overall aims for the Project.

The Cicerone Project is proud to have tackled some difficult and 'thorny' issues. Challenging the *status quo* with respect to the testing of virulent footrot was not an easy task for a group of

farmers who had a 'hunch' that a laboratory test was responsible for some false positive results – but that hunch was vindicated (Gaden *et al.* 2013). Then, by examining both pasture inputs and intensive grazing management under whole-farmlet conditions, we were able to see first-hand, the multiple differences between farmlets which, when integrated, showed large differences in many aspects of system performance (Scott *et al.* 2013c). Thus, the farmlet trial demonstrated the benefits of short graze/long rest periods on the control of gastrointestinal nematodes and of the effects of higher levels of soil fertility and sown pastures on stocking rates and production per head and per hectare and whole-farm economics. The farmlet trial also challenged information which has been promulgated by some proponents of intensive rotational grazing systems concerning the potential for doubling of stocking rates (McCosker 2000) and increased levels of available phosphorus, as well as nitrogen and potassium, without added fertiliser, as reported by Cawood (2004). The farmlet trial demonstrated that, compared with the typical farmlet (B), there was no increase in stocking rate nor in soil fertility due to intensive rotational grazing employed on farmlet C (Guppy *et al.* 2013).

In presenting an overview of the results of the farmlet comparisons to 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 were '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 were evident.

Evidence has been presented that both the scale of the farmlet investigations was considered credible by producer members and that the farm management systems were representative of real systems found on members' farms in the region (Edwards *et al.* 2013). Spedding and Brockington (1976) pointed out that issues of scale and relevance are essential to whole-farm ecosystem studies involving grazing animals.

Having a high level of ownership by producers resulted in a continuing high level of interest and membership of ~120 farmers who managed more than 180 000 ha on the Northern Tablelands of NSW in at least four catchment areas (Edwards *et al.* 2013).

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. It is also important for producers to understand the many tasks that need to be carried out in a Project such as the Cicerone Project, which were 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 use planning, GIS data management, relational database construction, soil test interpretation, agronomic and veterinary advice, preparation of animal ethics proposals, existing extension information, assessment of relevant research literature, statistical analysis of data, project management and writing of project applications, milestone reports, publications and website materials. Many of these functions were provided as significant in-kind contributions by the partner institutions and by individuals. There is little doubt that considerably more could

have been achieved from the Project if the research and extension partners had been able to secure parallel funding to support their active participation.

We recommend that funding bodies need to give greater consideration to the value of improved producer-research-extension relationships such as those brought about by this Project and the long-lasting benefits that can be gained when trust and engagement are the key attributes of those relationships.

Reflections from collaborating institutions

Over time, the relationships were strengthened between livestock producers and the collaborating institutions including CSIRO, NSW Department of Primary Industries, TAFE and the University of New England. However, it should be noted that while there was considerable goodwill extended towards the Project, none of the institutions had a strong or contracted commitment to the continuation of the Project. If however, the Project's funding had been directed through one or more of the partner institutions to earn research 'quantum', or if significant parallel funding could have been arranged for the participating institutions, then no doubt a greater level of support and involvement would have developed.

The challenge of securing and maintaining funding support

As noted in the first paper of this Special Issue (Sutherland *et al.* 2013), issues of funding took up enormous amounts of time for staff and Board members. While being accountable for any funding received is a normal part of any project, the participants found themselves responding to frequent reviews that were not anticipated in the original funding agreement. These activities distracted staff and the Board considerably due to the additional workload involved.

The issue of commercial sponsorship was considered several times by the Board. However, it became clear that this Project differed to some in the cropping zone where commercial companies frequently support farmer groups. For example, the cropping group Southern Farming Systems (<http://www.sfs.org.au>, verified 7 December 2012), which commenced in 1995 and now has 600 members, has some 60 commercial partners. We suggest that this phenomenon is related to the finding from qualitative research by O'Keeffe (1992) that there are large behavioural differences between annual cropping farmers and livestock graziers due largely to the delay between a decision and an observable outcome in the two different farming sectors.

In the opinion of the Board, the issues studied by the Cicerone Project, namely the testing regime for footrot, the value of investments in sown pastures and soil fertility, and intensive rotational grazing, were not likely to attract significant commercial funders. In addition, several members suggested that it would be preferable for Cicerone to remain at 'arms-length' from commercial sponsors in order to secure a reputation for conducting research with independence and objectivity. The end result was that commercial sponsorship was neither sought nor received; nevertheless, several companies supplied some significant in-kind assistance.

With the benefit of hindsight, we acknowledge that the goals set by the Cicerone Project to investigate issues which

were known would require long-term investigations, such as the farmlet trial of different management strategies, were ambitious. However, these goals were acknowledged by the funding body at the time to be worthwhile and worthy of funding, at least over the initial 5-year period.

In 2005, in light of the apparent success of, and the perceived value-for-money being realised by the Project, the livestock producer members obviously felt some degree of 'entitlement' to continuation of the funding as their livestock levies were contributing to research and development which could have implications for other high-rainfall zones of Australia because the issues studied were of interest across many areas. At times, the Project experienced interruptions to funding payments, making conditions stressful, especially for staff who occasionally had to go without salary payments for short periods.

Details of funding

Because funding was such an important issue to this Project, and because some 28% of the funds were generated internally from the farmlet study, we consider it of value to provide sufficient details to inform those who may consider a similar Project in the future as well as provide the basis for some discussion of producer levies below. Table 1 provides a summary of the overall expenditure on the Project over its duration together with the level of in-kind support received.

In order to better understand the sense of entitlement referred to above, that was felt by many producer members located in this Northern Tablelands region which is an important wool production region within Australia, we have estimated the approximate amount of compulsory livestock levies paid by producer members of the Project. The 2006 survey of Cicerone members (64 respondents) showed that the average size of respondents' farms was relatively large (1544 ha) with substantial numbers of sheep (average of 6070 per farm) and cattle (average of 481 per farm) run on the average member's farm (Edwards *et al.* 2013). Using estimates of the proportion of those livestock which would normally be sold in any one year (from the 2010 ABARE survey of livestock producers in the Northern Tablelands region), we have estimated that the total livestock (both sheep and cattle) and wool sales levies from those Cicerone members would have been ~\$273 000 per annum [\$164 800 to Australian Wool Innovation (AWI) and \$108 200 to Meat and Livestock Australia (MLA)] or some \$2 185 000 over the

Table 1. Summary of sources and amounts of funding support over the duration of the Cicerone Project (1998–2006)

Source	Income
Australian Wool Innovation	\$978 000
CRC for Australian Sheep Industry ^A	\$200 000
University of New England ^A	\$70 000
Subtotal of income from funders	\$1 248 000
Cicerone farmlet income (sale of wool, livestock, etc.)	\$344 000
Cicerone members' fees	\$40 000
Total cash income	\$1 632 000
In-kind support (1998–2006)	\$1 049 000
Total support (cash and in-kind)	\$2 681 000

^AFunding of postgraduates.

8 years that the Cicerone Project existed. If these numbers were extrapolated to cover the number of Cicerone financial members in 2006 (120), then the livestock sale and wool levies paid would have been ~\$512 000 per annum or some \$4 097 000 over 8 years. Given the relative proportion of AWI and MLA levies shown above, this suggests that AWI levies paid by financial members may have totalled some \$2 473 000 over the 8 years. Thus, Cicerone members who paid AWI levies saw some 40% of that amount re-invested in the Cicerone Project by AWI.

Attempts were made to secure funding for a second phase Project titled 'Improving Environmental and Whole-Farm Outcomes' from a range of funding bodies but the applications were unsuccessful. It seemed that the priorities of the Cicerone Project were no longer consistent with the priorities of any funding body or Catchment Management Authority with interests in the region.

Tensions and their resolution

We believe that it is important to not only point out the benefits and positive features of this producer-led Project but also to reflect on some of the tensions and disagreements that occurred. As noted by McClymont (1970), in relation to setting up large, challenging projects, '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'.

To some, the Project may have been excessively dominated by producers' needs. On the other hand, others may have felt that the researchers were too dominant in the conduct of the research trials. In any event, the leadership role adopted by producers in the Cicerone Project was in contrast to the more common consultation roles producers have in many other research projects.

While some tension can result in beneficial outcomes from groups with different initial opinions, there were occasional problems brought about by differing priorities for staff and/or their institutions. In addition, there was some confusion when one partner sought parallel research funding (unsuccessfully) to investigate environmental aspects of the farmlet experiment that, had it been successful, was feared by some might have impacted negatively on Cicerone's own continued funding. In contrast, some observers expressed the view that the funding that had gone to this producer-led Project would have been better spent supporting dedicated research organisations.

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, as well as the relatively high rate of turnover of Board members, which for some may have been linked to particular decisions. For example, in 2003, communications concerning the results being observed on the farmlet experiment were controversial for some, as it was becoming clear that farmlet C animals were tending to have lower pregnancy rates, liveweights and wool cuts. To overcome such tensions, members were reminded that the guiding principle of the Project was to 'compare – measure – learn – adopt', and that all members would benefit by considering the objective evidence collected. It appeared that there were differences in the nutrition of animals, both in pasture quality and in the freedom of animals to choose their diet under the different systems. The response of members, and of the Board, was to consider what might be

changed in the management of farmlet C; a decision was taken to shorten the grazing rest period which, during the drought of 2002 had extended to more than 200 days. In the ensuing years, this shorter rest period resulted in an improvement in the per head performance of animals on farmlet C, in some years reaching similar levels to animals on the other two farmlets (Hinch *et al.* 2013a, 2013b).

One example of a minor difference of opinion between producers and researchers related to grazing strategies. Whereas producers often wanted to increase the stocking rate whenever green feed was apparent, researchers argued (unsuccessfully) to retain higher levels of green herbage mass to help increase persistence and maintain or increase growth if higher amounts of green leaf were retained (Shakhane *et al.* 2013a).

At times, some tensions arose between the research needs of postgraduates and the farmlet guidelines developed by the Board. For example, over time, farmlet C ewes and lambs were moved less during lambing to facilitate maternal bonding and minimise lamb losses. This led to some challenges for the postgraduates in explaining the changes in grazing management that occurred over time, as these stock moves were not always under their experimental control. Nevertheless, the Board was committed to maintaining the integrity of differences between the farmlets in terms of fertiliser input, pasture renovation, grazing pressure and graze and rest times. The Board wanted the management of the farmlets to be dynamic, wherever possible, so that problems could be corrected as soon as measurements provided evidence of the need for changes to management.

Some missed opportunities

There were missed opportunities from not expanding or continuing the Cicerone Project. It would have been feasible, for example, to carry out more intensive measurements of the soils (e.g. carbon and nutrient cycling) and pastures, animal intake, and satellite imagery over a more frequent and/or extended period. In addition, techniques for advanced animal management such as those developed by the Australian Sheep CRC to allow automatic weighing of livestock, integrated management of internal parasites, automated data capture, agroforestry, soil water measurements, soil biology and erosion studies could also have been conducted.

As acknowledged by Edwards *et al.* (2013), the Cicerone Project would have benefited by demonstrating the degree of practice change it brought about within its constituency but this was constrained by lack of resources. Benchmarking exercises on members' farms and surveys could have been carried out over time in order to quantify the change that may have occurred in farming practices as a result of this Project. A concept was developed to allow the comparison of members' farm data with that derived from the farmlet experiment via an Internet-accessible 'information dashboard' (Scott 2003) but no funding could be found to support its development.

From the point of view of improved parasite control, testing of alternative strategies would have been beneficial to the development of more robust solutions. For example, the prospects of reducing parasite loads through alternate grazing of cattle and sheep (Southcott *et al.* 1997) deserved more thorough

investigation as part of an integrated approach to management of animal health.

While speculating on the opportunity costs and rewards that would have flowed from continuing the Project is fraught with difficulty, we are of the opinion that continuation, (which would have involved the modest expenditure of some \$110 000 per annum) would have reaped considerable further interest on the substantial human and financial capital already laid down.

Discussion and conclusions

This Project demonstrated the great value that can flow from producer leadership, which leads to real engagement between producers, researchers, extension specialists and funding bodies. The clearest proof of this value was shown within a relatively short timeframe through the field studies of benign and virulent footrot which, when linked to more specialised DNA research, resulted in an improved testing regime for an important animal disease. The Project also provided one of the most comprehensive studies of whole-farmlet management systems and, in particular, the effects of the intensity of rotational grazing on a wide array of measured parameters which no doubt will influence graziers in their management decisions. A recent national project, the Sustainable Grazing Systems Project, identified the importance of 'ownership' by producers of the research and extension process if adoption was to be enhanced (Mason *et al.* 2003). The desire for greater scale, relevance and collaboration in research and adoption is not unique to Australian farmers. A survey of growers associated with a large, long-term conservation farming experiment in Washington State, USA, found that they valued the Project's 'whole-system' approach as well as its larger, commercial-scaled plots, and the collaboration that took place between the growers and scientists (Forté-Gardner *et al.* 2004). Ensuring that a range of stakeholders work closely with scientists has also been found to be successful with land use studies, including soil and water studies in the Netherlands, where Bouma *et al.* (2008) found that exploring the needs of land managers led not only to innovative ideas but also to greater commitment of collaborators and better definition of the areas of research to be undertaken. As noted by Carberry (2001) in Australia, it is feasible to meet the needs of farmer clients for relevance while conducting rigorous science.

In some cases, farmlet trials in Australia have had high local impact (Clark 2010), but relatively few have left a significant published legacy due in part to the challenges of publishing such trials (Carberry 2001). We trust that the success of the Cicerone Project in encouraging livestock producers to take on a leadership role in delivering valuable research results to their stakeholders might encourage other regions, farmer groups and research agencies to consider a similar approach.

The substantial effort and care that went into setting up the not-for-profit body and its experiments, the genuine goodwill it engendered, the degree of support from across the farming sector, the generosity of the in-kind contributors, the Project's demonstrable achievements, the massive amount of data collected and the potential relevance of the experiments to future studies such as carbon capture on farms or greenhouse gas studies, were such that it was obvious to all participants, but not those 'holding the purse strings', that the Project

should have been continued until more complete conclusions could have been reached. In our view, the failure to ensure sufficient ongoing support was related to the massive changes that occurred in the management of the primary funding body over the period of the Cicerone Project. Had continued funding been possible, it would have enabled the farmlet trial to experience a more representative climate. More resources would also have allowed critical treatments to be continued, such as the planned maintenance applications of fertiliser. In addition, greater support would have allowed more environmental and sustainability measurements to be taken. Had the research partners received parallel funding, this would no doubt have increased the commitment of collaborators, which would have enhanced the rigour of the experiment.

Longer-term research has been called for by others including Jones *et al.* (1995) who suggested that grazing experiments, especially those focussed on profitability and sustainability, need to be funded over longer periods due to the fact that botanical composition changes can take many years as they are influenced by changes in soil fertility, rainfall and stocking rate. Not surprisingly, the results of grazing trials conducted over drier periods differ from those conducted under wetter conditions (Walker 1988).

It is interesting to consider that, when the Cicerone Project was first funded, the Australian Wool Research and Promotion Organisation was actively exploring the value of producer 'ownership' of projects (Ison and Russell 2000). It had also supported other producer-initiated projects such as the South Australian Selection Demonstration Flocks, which was successful in objectively comparing different systems of breeding of Merino sheep (Brien *et al.* 2005). Nevertheless, the later substantial changes in management that occurred within AWI over the life of the Cicerone Project prevented its continuation, even though this funded project was attempting to 'break out of traditions' (Ison and Russell 2000) by forging a new way of conducting relevant research, extension and adoption.

Thus, the challenge remains to find new ways of funding to enable important long-term field studies to be conducted in the future, not only for the benefit of producers, but also for the benefit of future generations of professionals who are exposed to such experiences. It may be that, as suggested by Clark (2010) for dairy farming systems, a strong argument can be made more generally for 'good investment in a long-term, continual experiment(s) that provide(s) a continuous stream of data for all those concerned with an area so critical to future profitability'. Paine *et al.* (2002) have described a recent national approach to the use of farmlets for farming systems research in Australia. Thus, farmlet studies could be used across a range of agricultural industries and agro-ecological zones in order to test farming system interactions across space and time such as the network of 'fact farms' suggested by Scott (2009).

As pointed out by Bywater (1990), making progress with farming system issues has been held back by the lack of 'hard, objective and quantitative explanations of why the system worked or did not work'. The Cicerone Project has helped address what Bywater called the 'woefully undeveloped' science of whole-farm experimentation as it took into account the 'dynamic interaction of components within systems' with rigour.

The Cicerone Project was a unique experiment in improving the relationships between producers, researchers and extension specialists, between advocates of higher inputs and intensive rotational grazing, between 'young guns' and 'mature masters'. It was rewarding for all involved to see those relationships develop and mature over the years, and to find that people were willing to teach as well as to learn from the large living laboratory that was the Cicerone Project. Some of the social capital which will continue beyond the Cicerone Project lies not only in the producers and collaborators but also in the experiences of the four postgraduates and 500 undergraduate students who no doubt have and will carry their learnings into their professional work.

As noted in the first paper of this Special Issue (Sutherland *et al.* 2013), the Cicerone Project posed two hypotheses: first that participation by livestock producers in the research-adoption process would enhance adoption and second that, having scientists working together with producers would enhance the relevance of the research to those producers. Although some may feel that the first proposition was not adequately achieved within the life of the Project, there is little doubt that the latter proposition was found to be true. Further, based on the substantial evidence provided within this Special Issue, we contend that both of these hypotheses were indeed proven as it is highly likely that there will be substantial flow-on benefits from these publications long into the future, especially as our understanding of our findings was incomplete at the official end of the Project (in 2006).

In the array of related publications, we can now see explained in great detail the interactive effects between soil fertility, sown species and grazing management on livestock production, on both a per head and a per hectare basis, and have come to a better understanding of how to optimise decisions in order to reach economic goals more reliably, even under challenging climatic conditions. And this multi-disciplinary understanding has come about, as proposed decades ago by Bill McClymont (Southcott and Bindon 1996) and Bill Willoughby (Hutchinson 1997), by studying, comparing and measuring grazing ecosystems as '... the whole system, based on climate-soil-plant and grazing animal, as the essential experimental unit'.

In our view, the conduct of this Project has been guided by a commitment to comparing relevant treatments with appropriate controls, within a realistic management environment, while undertaking objective measurements of as many parts of the systems as was feasible. The multiple facets of this Special Issue have covered almost all aspects of the Cicerone Project, from the initial concept, to identifying graziers' research needs, implementation, understanding the component parts, integration and finally reflection. This Special Issue is therefore a substantial legacy, our 'message in a bottle' to all those who follow and who have an interest in developing trusted learning partnerships aimed at better understanding complex grazed farming systems.

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