THE WHOLE FARM CASE STUDY AS THE UNIT OF ANALYSIS FOR RESEARCH IN FARM MANAGEMENT ECONOMICS

By

Alex Sinnett[1], Bill Malcolm[1], Claire Lewis[2] and Christie Ho[3]

[1] Faculty of Veterinary and Agricultural Sciences, The University of Melbourne, Parkville, Vic. 3010, Australia.

[2] Agriculture Victoria Research, Department of Jobs, Precincts and Regions, 1301 Hazeldean Road, Ellinbank, Vic. 3821, Australia.

[3] Agriculture Victoria Research, Department of Jobs, Precincts and Regions, Agribio, 5 Ring Road, Bundoora, Vic. 3083, Australia.

Paper presented to the 63rd Annual Conference of the Australian Agricultural and Resource Economics, Melbourne, 12-15 February 2019

1. INTRODUCTION

The abstract 'representative firm' of the theory of the firm has a long and respected history in economic thought (e.g. Marshall, 1890). A related notion is the representative or case study farm of farm management economic theory and research. In this paper, the central role of the whole farm approach in answering questions about farm management economics is canvassed.

Research in farm management economics is not research in agricultural economics or in agricultural science and systems as it is practiced: it has elements of and requires input from each of these types of research, and more. Agricultural economics research has a focus on characteristics of multiples of farms, using key aggregate levels of information about the performance of farms to draw meaning at industry or economy-wide level, e.g. trends in farm productivity. Agricultural science research involves investigating deeply a part or parts of a system – how the bit works, and how bits work together. The main focus of agricultural systems research is on the combined scientific and technical aspects of the farm system, but it commonly neglects or caricatures the economics. More than is the case with agricultural economics or agricultural science and systems research, research in farm management economics is about the whole of the farm in its natural, economic and social environment, involving all the parts and their interactions that make up the innards of the firm, and all outputs and outcomes. Farm management economic analysis more than agricultural economics, more than agricultural science, more than agricultural systems, it is about the important bits of the whole story.

Analysis of case studies in farm management economic research using the 'whole farm approach', adds to these other methods of inquiry by investigating deeply how and why the farm firm works as it does, including the people, technology, management, dynamics, risk, uncertainty and beyond the farm factors. The approach is 'to determine what is'; to 'identify causes and effects'; and to 'imagine and analyse what could be'.

The aim of using the farm as the unit of analysis in farm management economic analysis is economic efficiency of the firm in its widest sense, solving problems that stand in the way of farmers achieving their goals. In doing this, the results of analysing representative whole farms using case study methods of research tests and adds insight to farm management economic theory.

In the remainder of this paper, the role of the approach of using representative whole farm case studies to carry out farm management economic research is canvassed.

2. The case study as a research method

One of the first steps in doing research is to decide the appropriate research method to use. A continuum of research approaches exists in agricultural and farm management economics, ranging from a narrow discipline focus involving sizeable samples of populations through to a multi-disciplinary focus on a small number of 'cases' from a population (Figure 1).

Research continuum

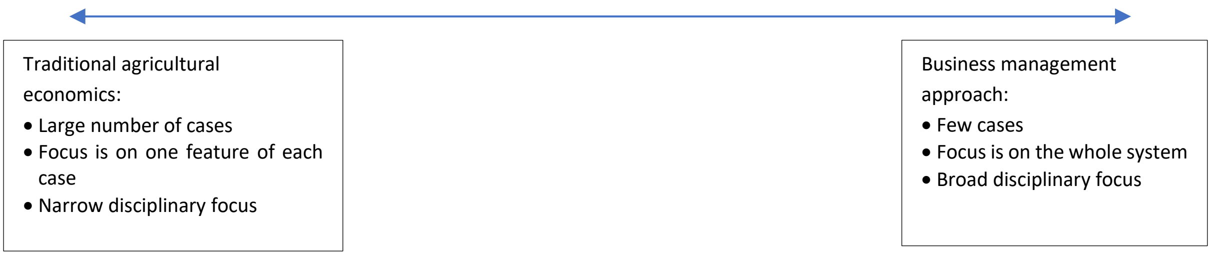

Figure 1. Continuum of research methods (adapted from Crosthwaite *et al.* 1997).

Choice of research method is determined by two criteria: 'What question are we trying to answer' and 'What is the most appropriate technique to use to try to answer that question'. In Table 1, the relevant situation for different research methods is presented. Each method has different ways of collecting and analysing empirical evidence. Each method has its advantages and disadvantages and each method has its own logic and procedures.

Table 1. Relevant situations for different research methods, adapted from Yin *et al.* (1983) and Yin (2018)

Method	Form of research question (seeking to explain or predict)	Requires control over behavioural events?	Focuses on contemporary events?	Can allow many variables in relation to data points
Experiment	How, why?	Yes	Yes	No
Survey	Who, what, where, how many, how much?	No	Yes	No
Archival analysis/ economic modelling	Who, what, where, how many, how much?	No	Yes/no	No
History	How, why?	No	No	Yes
Case Study	How, why?	No	Yes	Yes

Case study methods have an established literature and rationale (Yin 2018). Yin (2018) argues that case study approaches are needed to understand complex social phenomena, because case studies allow researchers '…to focus in-depth on a "case" and to retain a holistic and real-world perspective – such as in studying…organisation and managerial processes'(p.5). In this regard, Schramm (1971) stated:

> *…the essence of a case study,…, is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented and with what result* (Schramm 1971).

Yin (2018) defines case study research in two parts. The first describes the scope of a case study when doing case study research (which encapsulates the thinking above). The second part of the definition explains the features of case study research:

(i) A case study is an empirical inquiry that:

- *Investigates a contemporary phenomenon (the 'case') in depth and within its real-world context, especially when the boundaries between the phenomenon and context may not be clearly evident.*

(ii) A case study:

- *Copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result*
- *Benefits from the prior development of theoretical propositions to guide design, data collection, and analysis and as another result*
- *Relies on multiple sources of evidence, with data needing to converge in a triangulating fashion*

(Yin 2018)

The second part of this definition highlights important aspects of the design and practice of case study research. One of the strengths of the case study method is that it allows a researcher to draw on a broad range of disciplinary knowledge, and to emphasise a balance of this disciplinary knowledge that is appropriate to the question being investigated.

The limit of case study approaches is that only a small number of cases can be analysed. That is, there are trade-offs between the number of cases that can be examined, and disciplinary depth and breadth brought to bear on each case (Crosthwaite *et al.* 1997).

It is worth noting that in the popular press and in teaching, non-research case studies are often used. Teaching case studies are common practice and are designed to establish a framework for student debate and discussion around some professional issue. A teaching case study is not required to have a complete analysis of all relevant events or perspectives. Equally case studies that are referred to in the popular press – the anecdotal case – are often used as though they are research and thus have some general relevance. Consequently, legitimate case study research may be tainted, if one's only exposure to the term case study is in these non-research forms. Researchers doing case study research need to be aware of widespread misunderstanding and misinterpretation and misrepresentation of what they are doing, and, as Yin (2018) explains, case study researchers need to highlight their systematic procedures in doing this research, especially in reporting evidence fairly.

The contention in this paper is that case study methods are appropriate methods for research in farm management economics. This is not a new argument. In 1928, Elliott published 'The representative firm idea applied to research and extension in agricultural economics'. In 1992, Feuz and Skold reported on 'Typical farm theory in agricultural research'. In 1997, Crosthwaite and Malcolm wrote about using case study methods in farm management economics research.

3. Farm management economics research using case study analysis

The working of a farm system is the result of the combination of all the bits in it: farm performance is the result of the combination of all things. Dillon's (1980) definition of farm management gives the framework within which farm management economic research is conducted. Farm management is 'the process by which resources and situations are manipulated by the farm manager in trying, with less than full information, to achieve their goals' (Dillon 1980 p.).

Like all good research, good case study research is time-consuming, labour intensive and difficult to do well. The case study method has been used in farm management economic research to answer questions that add to the literature on such issues as farm growth, to help to understand the farm level impact of policy changes, and to assist farmers making choices about adopting technology. The case study method is the appropriate research method when:

- The research question is about how or why

- The research does not, or cannot, manipulate (or control) events
- The focus of the research is on a contemporary (that is not historic) events or issues.

(Yin 2018)

Understanding farm businesses and analysing how well farm businesses are performing, and even more importantly, how they could perform, requires farm management economic analysis. Farm management economic analysis is an inter-disciplinary process, investigating uncertain dynamic causes and effects, inter-relationships and interactions on a farm, between a farm and other farms, and between a farm and the economy, that occur over time, with everything subject to much risk and uncertainty.

WHOLE FARM APPROACH

Farm economists are always analysing how a farm might look after a change under conditions of risk and uncertainty. They imagine the situation of a farm business if the owners continued to run the farm in a similar way to the way it is currently operated, compared with the state of affairs if some changes are made as inexorable change happens around the business regardless. In a changing world, the status quo is never an option.

Analysing the worth of changing a farm system involves applying the whole farm approach to explore future possibilities, given the goals and attitudes to risk of the people involved, the resources available and the opportunities that await. Candler (1962) described the whole farm approach as being a budgeting approach, where production possibilities of a farm system and changes to production possibilities, are budgeted, based on sound technical foundations, to see if a change is likely to improve the chances of the farm owners achieving their goals.

> *The whole farm approach to management advice refers to 'advice which has been budgeted to ensure that it really does result in an improved farm plan, from the farmers point of view.*
>
> *…*
>
> *Budgeting allows the best proposal from a number of alternatives to be selected. Unbudgeted advice, on the other hand, is simply bad advice. A soil test alone cannot, repeat cannot, tell you whether it would be profitable for a farmer to put on more or less fertilizer, since profitability depends, inter alia, upon the number of stock run.*
>
> *Occasionally one hears a rather peculiar phrase: 'the whole farm approach to farm management'. I say peculiar because this statement implies there is another approach to farm management* (Candler 1962)

Disciplinary specialists, especially some scientists in agricultural science disciplines who are not 'old-style agriculturalists', often favour partial technical-focussed approaches to analysing why a farm system is being run, and is performing, the way it is; heading down the widdershin of individual 'drivers of profit' on farms, searched for in vain by those bereft of farm management economics expertise, sure they can provide farmers with a 'simple' recipe to apply to increase farm profit. Such efforts unfailingly perpetrate an impressive number of fallacies. Average responses are used when it is marginal responses that matter for change, and it is not possible to infer marginal productivities from average productivities (unless the response is linear, in which case more is better). Commonly there is the fallacy of regressing an individual or compound average or total input against a whole farm output such as profit or return on capital. This has the highly unlikely assumption that seldom stands scrutiny in agricultural production systems: each causal factor is assumed to operate independently of other factors. Or, the implied production function fallacy which holds 'this farm business used this quantity of input 'X' at level 'Z' and achieved yield 'Y'. Therefore, the story goes, this other, different farm too could achieve yield 'Y' by using input 'X' at level 'Z'. It is not so: each farm has its own unique set of production functions for individual inputs and unique combinations of inputs and own unique whole farm production function representing the combination of all things. Ho *et al.* (2013) make the point:

While strong correlations are often demonstrated by plotting pasture consumed per ha versus stocking rate, feed conversion efficiency versus feed intake, or cost of production versus pasture consumed, the logic of doing so is flawed, as correlation is not causation. Apparent correlations between partial average technical measures for levels of single inputs (e.g. nitrogen per ha) and system output measures (e.g. milk per ha), on individual farms are often mistakenly thought to suggest that better performance in these single input measures on other farms should also lead to improved return on assets or operating profit. This is not the case because each farm is operating on different input response functions (Ho *et al.* 2013).

Applying the whole farm approach to research means examining all the significant input-output relations of a farm system and the interrelationships between these component parts, all in light of the farmer goals and the risks and uncertainties of the farm system that are important to the question(s) under scrutiny. This means it is not possible to identify and solve a problem in a farm system by looking only at one or a few parts of it. To identify and solve a problem for a farm family, it is necessary to first start with the goals and resources available, then look for and identify all parts of the business and then consider how the parts that seem to be 'the problem' relate to all the other parts that make up the rest of the system. Then bring to the analysis the balance of disciplinary knowledge needed to solve the problem(s). For example:

The problem might seem to be poor reproduction performance of breeding animals. This could be caused by poor nutrition which could be caused by inadequate pasture supply at critical times during the year. This could be caused by some key paddocks not having been renovated and pasture replaced. This could have happened because there is not enough cash in the system or enough capacity to borrow more capital to invest. This could be because the business already has borrowed a lot of capital and has high debt compared with other similar farms. The high debt could be because the owner/manager is a high risk-taker and/or does not get the main farm jobs done on time which causes poor production of all activities. The point is: Cannot explain performance of the 'whole' by focussing only on one (or a few) parts(s).

This point was made by Candler (1962):

To a farm management analyst the question 'what fertiliser should I use?' or 'which ewes should I cull?' is unanswerable in isolation since to answer these questions one needs to know the level at which other factors of production are to be used. That is, is the current feed being grown being utilised fully? Are flock numbers such that a culling policy is appropriate at this stage? Whole farm budgets demonstrate the possibility of a preferable way to run the farm (Candler 1962).

ECONOMICS AS THE CORE DISCIPLINE

Farm management research has economics as the core discipline (Malcolm 2004). While the appropriate production economics theory underlying the whole farm approach includes the key principle of equi-marginal returns from all inputs, farm management economic research is more than just production economics (e.g. Johnson 1963, among many). The importance, and limits of production theory were recognized by Heady (1952), the champion applying production theory to agriculture. Heady stated '...in starting out with this simple framework, we are avoiding the real complex and difficult problems involved in choice and decision-making' (pp.25-26). 'Start with the farm family' was Makeham's dictum (Makeham 1968). Define the goals. Establish sound technical foundations of the situation. Add the risk, and uncertainty and the dynamics and time. That is, applying the whole farm approach recognizes that a farm business is made up of many parts (human, technical, economic, financial, risk, and beyond the farm gate) and that each part of the farm system affects other parts of the system.

MEASURING

There is a saying 'you cannot manage what you do not measure'. This is true, in part. More accurately, 'you cannot manage what you do not understand'. Johnson (1999) discussed problems of quantitative measurement.

He argued that accountants and economists are guilty of assessing ‘the numbers’ of businesses at a distance from the actual business. Johnson (1999) related such an analysis to the analogy of a river, whereby he saw accountants and economists as camped beside this 'metaphorical Mississippi' picking up the river data and compiling measurements. Johnson (1999) went on to say that, if sitting far away from where the numbers are coming from these accountants and economists are losing vital information. Johnson (1999) argued that there is need to move further 'upstream' (continuing with the river analogy) and looking in detail at the components and the work and management practices, which were producing the data that were further analysed downstream. In addition, by moving 'upstream' and into the actual business, Johnson (1999) believed that you could look for the 'underlying assumptions that lay beneath the layers of abstraction that conventional measurements had generated' (pp.3). Johnson (1999) went on to paraphrase W. Edwards Deming:

> *Perhaps W. Edwards Deming was resonating with this point when he said that 97 percent of what matters in an organisation can't be measured* (Johnson, 1999).

A unique feature of case study methods is that they can help ‘uncover’ information about the motivations and strategies behind decision making within a business (Deakins 1996; Sterns *et al.* 1998). Johnson (1999) added that the result of conventional measurement was ‘tampering’: manipulation without genuine understanding (Johnson 1999, pp.4).

Hence the saw: Not everything that can be counted counts; not everything that counts can be counted. The common response of making count in analyses what can be counted because it can be counted, regardless of whether it counts or not, is not helpful.

BOTH RETURNS AND RISK MATTER

When using the whole farm as the unit of analysis for research, the performance of the farm business should be assessed in terms of returns and risk. Additional net benefits, profits, wealth, cash, achievement of goals, has no meaning when expressed separately from the change in risk associated with the change.

Risk analysis is used to generate information about the probability of farm system changes being profitable, to aid producer’s decisions about whether they perceive the change to be a bet worth taking. For example, after accounting for price and seasonal risk, in their case study analysis investigating the profitability of sowing different proportions of a dairy farm to the forage crop chicory, Lewis *et al.* (2018) found that:

> *For the 2.5 cows/ha system, running the 40% chicory system for the 15 years resulted in a AU$39 000, or 16%, average increase in NPV compared with the Base Case 20% chicory system (AU$244 000). Comparatively, removing chicory from the system and grazing perennial ryegrass reduced total NPV by AU$59 000, or 24%, on average for the 15 years. At 2.5 cows/ha, there was a 5–10% chance that growing 20–40% chicory would return a lower NPV than would growing no chicory (*Lewis *et al.* 2018*).*

BIAS

Concerns exist that case study approaches are open to researcher bias. As in any research, such failings are not a failing of the method, rather they are a failing of the researcher for not following systematic procedures or the researcher allowing equivocal evidence to influence the direction of the findings and conclusions. There is no fudging the need of researchers to be transparent and explicit about limiting (or even eliminating) biases. Note, as Yin (2018) explains, bias can be a problem in other research methods ‘…such as in avoiding the experimenter effect…, in designing unbiased survey questions, or in searching for evidence when doing historical research.’ So, the challenge of avoiding bias are not different: being aware of bias risks and ensuring a systematic and rigorous approaches will help to eliminate or at best limit the bias. Some strategies of Yin (1994) to ensure rigorous research is to:

- Create a case study database. This is where the data collected, and the actual reports created are two separate pieces of writing. This means that the database can then be the subject of separate, secondary

analysis, independent of any reports by the researcher. This increases the reliability of the case study, which is one of the tests Yin (1994) believes is needed for case study research.
- Maintain a chain of evidence. Yin (1994) states: 'The principle is to allow an external observer – the reader of the case study, for example – to follow the derivation of any evidence from initial research questions to ultimate case study conclusions' (pp.98).

The key to rigorous and reliable results from case study research is having a rigorous research protocol and multiple sources of evidence, i.e. come at the question from a range of viewpoints/angles, sometimes called triangulation.

Unique but similar, similar but unique

Traditional farm management case study research is about knowing a lot about small numbers of the population. Farm management economists are always working at individual farm level, not populations that lend themselves to statistical analyses (Nuthall 2011). The reason for this is that each farm (and farmer) is unique with unique pasts, presents, and futures.

Malcolm *et al.* (2012) explained further:

> *This process of whole farm analysis recognizes that each farm family is unique in terms of the resources they control, their history, stage of life, psychological make-up, attitude to risk, and goals. However, elements of the biophysical systems at work on farms, and important influences external to farms, are common. The problems, relationships and adjustment possibilities faced by managers of similar farms are not unique. However, the goals of farm managers, their preparedness and capabilities to learn about and implement new knowledge or technologies, and their willingness to bear risk, all differ* (Malcolm *et al.* 2012).

Cult of the Asterix

Case study research is often viewed as not being sufficiently rigorous. A common point of contention is the fallacious thinking Dillon (1971) described as 'the cult of the asterix'. This refers to the quite reasonable requirement for establishing scientific truth being that there is only 5% or so chance (95% certainty) that the result of an experiment could have been achieved by chance. Managers though employ different odds: they are willing to bet on actions in their farm system that are less than 95% certain to achieve the result they desire. Depending on their attitude to risk, a farm manager may be prepared to back a change to the farm system that has 60% or 70% probability of success.

Generalising

Farm economists seem to be always defending the use of case studies of representative farms to disciplinary researchers whose focus is on the empirics of generalising to populations. A common view is that, unlike the standard agricultural economics empiricism, no general principles can be derived from individual case studies.

The apt response by practitioners of case study methods of analysis is that far from pretending to generalise to populations, they instead aim to generalise to theory, i.e. test the practical reality of the behaviour of the subject of the study against the tenets and propositions of current theory about the behaviour of such subjects.

It is common to be asked, when doing case study research, how can the results be generalised. That is, how can a limited number of observations be used as a basis for generalisation? Generalising to populations (statistical generalisations) is only one type of generalisation (Yin 1994; Gummesson 2000). Generalisation from case studies needs to be approached from a different angle. A case study does not attempt to represent a sample, rather findings to challenge, expand and generalise to theory. This difference is illustrated by Gummesson (2002) who quotes Normann (1970):

If you have a good descriptive or analytic language by means of which you can really grasp the interaction between various parts of the system and the important characteristics of the system, the possibilities to generalise also from very few cases, or even one single case, may be reasonably good. Such a generalisation may be of a particular character; it might be possible to generalise a statement of the type "a system of type A and a system of type B together comprise a mechanism which tends to function in a particular way." On the other hand, one cannot make any generalisations about how common these types of systems and interaction patterns are. But the possibilities to generalise from one single case are founded in the comprehensiveness of the measurements which makes it possible to reach a fundamental understanding of the structure, process and driving forces rather than a superficial establishment of correlation or case-effect relationships (Normann 1970).

For example, Heard *et al*. (2012) used case study analysis over a 10-year period to examine five potential changes a dairy farm in south-west Victoria could make to their system to deal with expected 'cost-price squeeze':

The five changes were: (1) reducing leased non-milking area by 100 ha; (2) converting 60 ha of non-milking leased area to milking area, reducing leased non-milking area by 100 ha and reducing stocking rate on the milking area; (3) converting 187 ha of leased non-milking area to milking area, increasing herd size to 800 cows and reducing stocking rate on the milking area; (4) discarding all leased area, reducing herd size to 370 cows and reducing stocking rate; and (5) converting 127 ha of non-milking leased area to milking area, discarding all other lease arrangements and reducing stocking rate. Mean ± standard deviation of nominal owner's equity at the end of Year 10 was $2.59M ± $1.33M, $5.42M ± $1.26M, $5.76M ± $1.21M, $7.47M ± $1.64M, $6.01M ± $0.78M and $6.10M ± $1.19M for the status quo and development options 1–5, respectively (Heard *et al.* 2012).

The key message from the analysis was not that dairy producers would maximise profits by replicating the farm system of the most profitable Option 3, but rather as surmised by Malcolm *et al.* (2012), that *'as theory would predict, the larger, more intensive system promised greater wealth achieved by taking on more risk*':

Heard *et al.* (2012) continued:

For most but not all of the development options, the risk associated with the profit, cash and equity as measured by a range of indicators improved markedly over the performance of the farm system under the status quo. Both substantial increases and decreases in herd size were attractive. Irrespective of the direction of change in herd size, the most profitable options involved reducing stocking rate per ha and reducing purchased supplementary feed compared with the status quo. Significantly, changing to increase productivity greatly reduced the risk of having less equity at the end of Year 10 than the starting equity. Optimising the amount of home-grown grazed feed, and using purchased supplements efficiently are important, particularly if the milk being sold is subject to export market prices and variation. The most appropriate changes to dairy farm businesses in response to changes in the operating environment will vary from farm to farm – but maintaining the status quo in the face of change is not an option that meets farm family goals (Heard *et al.* 2012).

In this way, Heard *et al.* (2012) generalises the findings from the individual case study farm analysis to theory to then inform the decision making of other producers who have their own resource availability and goals. The possibilities are raised; analysis of the possible changes in any particular case is then required.

Gummesson (2000) observed that generalisation has two dimensions. One dimension refers to the use of quantitative studies based on many observations to determine how much, how often and how many. The other dimension involves in-depth investigations to identify underlying phenomena. Thus, undertaking case study research the goal is to expand and generalise theories, it is not to extrapolate probabilities.

Platt (in Blaikie 2000, pp. 224) stated that 'case studies can be used to generalise' providing that case studies are specifically and critically designed, rather than being chosen by accident or for convenience. Further, in his examination of case study methodology, Perry (1998) stated that case study analyses help 'build' theory by investigating the "how do?" rather than 'testing' theory by investigating the "how should?" like many scientific and statistical research methods do. Finally, Malcolm *et al.* (2012) observe that:

> *The results of a real case study analysis are either consistent with theory, and add support to the explanations of current theory, or they are not consistent with theory and challenge accepted wisdoms* (Malcolm *et al.* 2012).

4. Application of whole farm analysis and case studies in farm management economics research

Farm management economic research is farm benefit cost analysis of changes to the way the farm operates and of the implications for the farm of change in the environment – economic and natural – in which it operates. The challenge, and key, to benefit cost analysis is getting the counterfactual right and imagining alternative futures under changed conditions, with rigour.

Conducting farm management economic research involves first establishing what is the situation of the farm business in question, imagining alternative possible futures for that farm business, and analysing how those futures might look, considering all benefits and costs and risks.

Malcolm *et al.* (2012) provides a graphical representation (Figure 2) of one approach to research in farm management economics. The result of this form of research method is that some important lessons have been added to theory. In brief, the approach involves:

- Obtaining input from a group of industry experts to define the research questions, select farms that are representative of the population under study, test assumptions used in the analysis and review the results from the analysis. The use of such a group ensures that particular views do not unduly influence the analysis of the case study farms and therefore the conclusions drawn; a limitation of case studies as identified by Yin (1994).
- Choosing case study farms that are well managed businesses with good information about the inputs and outputs of the farm system.
- Interviewing the farmer, asking open-ended questions, to develop an in-depth understanding of the production system.
- Modelling and analysing the alternative futures available for the selected farms and judging these against economic and financial aims as well as non-pecuniary goals.

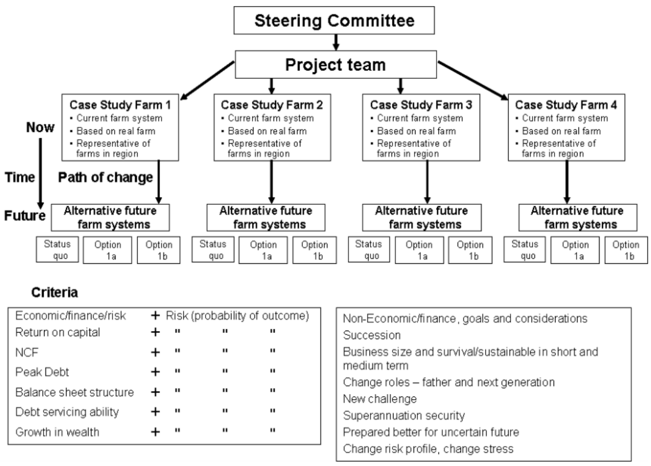

Figure 2. Whole farm analysis approach used in the Dairy Directions project as described in Malcolm *et al.* (2012).

The keys to this research method, is grounding the analysis in real farms and defining rigorously the 'types' of farms that are to be analysed as the representative farms. If needed, the unique human component of the system (e.g. individual goals, skills, risk aversion, stage of life) can be 'abstracted' out to allow greater capacity to generalise aspects of the case study and examine changes that the farmer may not actually implement. This also removes the variability inherent in different farm operators' ability to implement and manage a change to the farming system.

For those seeking a 'how to' on whole farm case study analysis, Malcolm *et al.* (2012) describes and explains this research approach in more detail, including applied examples. Nuthall (2011) also provides guidance and examples on the choosing and using case study farms for investigating questions about farming.

In the sections that follow, some of the more common challenges faced when applying whole farm case study analysis to farm management economic research questions are discussed.

INVESTIGATING FARM SYSTEMS THAT INVOLVE SCALING UP

Constructing plausible modes of operation of changed farm systems under changed conditions requires taking the data about the farm system as it currently operates then using sound biological, economic, financial and risk relationships and simulating the changed operation and performance of the farm system. Scaling up a model of a current farm business to a larger farm business holds particular traps for tyros.

The world does not come to us in straight lines – 'the sky is the limit' linear relationships do not apply. The Law of Variable Proportions (diminishing returns) tells that as new inputs are introduced to a farm system, placing it on a higher whole farm production function and the relative proportions of inputs in the farm system change as a result of adding more of some inputs, the responses of additional output are not linear but subject to diminishing marginal returns. Thus, the extra costs of extra complexity or extra exposure to risk that comes with intensification of farm systems requires careful consideration. For example, more complex farm system requires better management, paid more.

Timeliness of operations remains imperative, and increasingly so as a farm business expands. Ensuring timelines of operations in larger more complex systems has extra costs – either costs to achieve extra timeliness or costs of not achieving the required timeliness. Growth and intensification increase costs, average returns and variability of average returns, called risk. These changes with growth and their implications need to be incorporated in scaled-up farm businesses.

INCORPORATING VARIABILITY IN FARM CASE STUDY ANALYSIS

When the farm is the unit of analysis and intensification increases exposure to risk, such as increased reliance on purchased inputs including feedstuffs, fertilizer, fuel or chemicals, or increased gearing, the firm is also exposed to increased volatility of costs of inputs, including capital. The effect of these forms of additional volatility of costs, which ends up as increased volatility of profit and net cash flows, need to be incorporated in analyses. All risk has a cost.

One way of including some of the additional cost associated with intensification and increased volatility of costs and income is to include the cost that would be required to offset this volatility. Take an intensified grazing animal business. Feed shortages will be more frequent and severe than for the status quo, less intensified, system.

Regardless of what tactics and strategies the farmer will take to manage the increased volatility of feed supply, a proxy for the additional costs can be to include a cost of purchased feed to fill feed deficits and maintain a more stable level of output, profit and cash flow. Though this strategy may not be followed by the farmer – other actions such as destocking and restocking may be more attractive – 'pretending' to buy the extra feed required is a simple proxy for the risk-related costs of any strategy that may be followed. The point is that it is better to allow, in some way, for extra cost of extra risk associated with farm businesses growing and intensifying than to leave out of the analysis the, often hidden, but nevertheless significant extra costs associated with added risk or complexity.

Another trap for young players in farm budgeting is double counting of risk. This happens when risk effects on risky variables are built into the numbers in a budget/model and then risk is allowed for again in a risk-adjusted discount rate. Including risk in the discount rate implies risk is an exponentially increasing function of time. The further future is more uncertain, but is this exponentially increasing? A general rule is to include risk in the 'numbers' and in the scenarios, but not in the discount rate. Another form of double counting risk is to include risk in the numbers and also using probability distributions of the risky variables as is done using a risk program, such as @Risk to generate distributions of outcomes.

FARM BUDGETING

It is important to recognise that a budget or model of the operation of a farm system is only as good as the numbers that the model is based on – 'poor information in – useless information out'. This is why researchers audit closely the budgets/models their analysis, to ensure that the 'numbers' that are used pass practical tests of common sense.

Equally important is to think about correlation between risky variables. If a correlation matrix is not included between variables, the assumption is that the variables are independent of each other. In building budgets/models, it is necessary to consider how well this assumption aligns with reality.

Another significant assumption in farm budgeting/modelling is projecting constant price:cost ratios. Doing this is implicitly saying 'productivity gains, other than the one we are analysing, will offset any future declines in the ratio of real prices received to costs.' If this is not believed to be correct, then the effects of a cost-price squeeze are included in the budget/model.

USING FARM SYSTEM SIMULATION MODELS TO REPLICATE REAL FARM SYSTEMS

Simulation models of farm systems are powerful tools for case study analysis. Simulation allows multiple farm scenarios to be explored across different environments and soils types, without the resource-intensity of physical experiments (Chapman *et al.* 2009; Jones *et al.* 2017). For the purposes of economic analysis of whole farm systems, farm system simulation can be particularly valuable where measured datasets are scarce/incomplete. The requirements for scientific research mean the results of experiments may not reflect the full range of complexity and variability that is typically experienced in the farm operating environment (Cullen *et al.* 2008). This is particularly challenging when production risk is an important element of the farm management economic research question. Cacho *et al.* (1995) stated that:

> *Systems models can provide insights which would be difficult or impossible to obtain by other means, and they provide the capability of exploring relationships that cannot be explored any other way... perhaps the main advantage of production systems models is that they allow experimentation with a far greater range of variables than would be feasible in practice* (Cacho *et al.* 1995).

The value of biophysical simulation depends on how well a model represents the physical input-output relationships and inter-relationships of the complex biological systems of agricultural production (Cullen *et al.* 2008). Arguably, the most complex biological agricultural systems are grazing systems because of the presence of diverse plant species, animal-plant interactions and the complex nutrient dynamics (Snow *et al.* 2014): the stocking rate depends on the pasture produced and consumed, and the pasture produced and consumed depends on the stocking rate. These complexities present challenges when trying to replicate the 'status quo' case study farm system in a simulation model, which then allows analyses of alternative futures for that system. The results from initial simulations of a pasture system may not line up well with measured farm/experimental data. The challenge comes when trying to address these inconsistencies, to compare a pasture simulation model to the pasture grown and consumed by animals in reality. As Cullen *et al.* (2008) comment, it can be difficult to quantify how much of the difference is due to errors in the measured data, and, how much is due to limitations of the model. This is complicated by there often being limited measured data points available to compare to the full range of conditions being used in the simulation of pasture supply and demand. Addressing inconsistencies can become a balancing act between variables. For example, inconsistencies in pasture intake in a dairy system may mean the imputed amount of concentrate fed per cow needs to exceed that being fed in reality on the case study farm if the milk production output is to match reality. Ultimately, expert opinion is often relied on to determine when the simulated farm system is a realistic representation of the case study farm, and when it is not, to make it so.

As easy to get it right as wrong

Too often people giving advice to farmers analyse farm information in ways that means the advice is simply wrong. That is, they do not use economics in the analysis and violate basic principles of economics. Yet, the same basis information about the farm business can be used to do analyses that is firmly embedded in the farm management economic theoretical tradition and will produce sound advice for farmers. The 'getting it wrong' phenomenon can too often be found in agricultural science journals in articles ostensibly about farm management economics – but missing the economics or violating economic theory. It is as easy to get it right as wrong: the same data interpreted in the farm management economics tradition or without the farm management economics, is the difference between getting it right or wrong.

If an analysis is done these ways, the results and advice are wrong:

- Implies farms are operating on the same production functions; if farm/farmer A can perform at this level then so too can farm/farmer B simply by replicating on farm B what is done on farm A.
- Uses average input:output responses instead of marginal responses.
- Has maximizing technical ratios – output/input – as an objective and criteria.
- Relates a physical or financial output measure to a single physical input, such as regressing total milk/meat/grain or farm profit against stocking rate or irrigation water, and then compares these ratios for different farms.
- Relates a whole farm measure such as profit to a single input such as hectare: profit is the result of all inputs being combined. Comparing profit per hectare not useful, particularly if used to compare between different farm businesses: different sized farms, different total profit, different total capital, giving no indication of efficiency which is measured as return on total capital.
- Uses net profit as an indicator of farm performance; operating profit as a percentage return on all capital managed is the indicator of farm performance.
- Dollar values from different years are combined, added, subtracted, divided, multiplied as if a dollar in one year has the same value (purchasing power) as a dollar in a different year. They do not, because of (i) inflation affecting nominal values of currency at different times and (ii) benefits and costs have different real values (real purchasing power) in the future because of the time value of money, i.e. a dollar benefit in one year has an equivalent value of $0.90c today if the dollar today could be invested at 10% for the year and thus grow to $1.
- Treats risk as an all bad thing, to be avoided or reduced. Reducing risk reduces profit, risk is something to be managed, to a level the farm manager is comfortable with.
- Analyses changes to a farm system without considering implications for risk.
- Analyses changes to a farm system without looking at economic, finance and wealth angles, the three criteria to judge business performance.
- Extrapolates last year's prices and yields as though last year will happen again next year.

- Fail to compare a farm system change to the appropriate *alternative future.* Understanding and analysing the 'without' change situation is just as important as the 'with change'. The is needed to ensure all benefits, costs and risks associated with the change are accounted for correctly.

5. Conclusion

The case study approach is the appropriate method to use for farm management economic research, using the whole as the unit of analysis. With economics as the core discipline, this type of research brings rigorous thinking about analysing the whole problem, instead of part of the problem. Solutions to parts are not solutions to wholes.

When done in accordance with the tenets of appropriate theory, the information generated by farm management economic research informs the decisions of managers of farm resources in ways that are likely to contribute more effectively to them achieving some of their goals than the far too common alternative approach which is farm management analysis and advice that does not have economics at its core - or anywhere else for that matter.

6. References

Blaikie N (2000) 'Designing social research.' (Polity Press: Cambridge, UK)

Cacho OJ, Finlayson JD, Bywater AC (1995) A simulation model of grazing sheep: II. Whole farm model. *Agricultural Systems* **48**, 27-50.

Candler W, Sargent D (196) Farm standards and the theory of production economics. *Journal of Agricultural Economics* **15**, 282-290.

Chapman DF, Cullen BR, Johnson IR, Beca D (2009) Interannual variation in pasture growth rate in Australian and New Zealand dairy regions and its consequences for system management. *Animal Production Science* **49**, 1071-1079.

Cullen BR, Eckard RJ, Callow MN, Johnson IR, Chapman DF, Rawnsley RP, Garcia SC, White T, Snow VO (2008) Simulating pasture growth rates in Australian and New Zealand grazing systems. *Australian Journal of Agricultural Research* **59**, 761-768.

Crosthwaite J, MacLeod N, Malcolm B (1997) Case studies: Theory and practice in agricultural economics. In '41st Australian Agricultural and Resource Economics Society conference, 22-24 January 1997, Gold Coast, Queensland'. Available at https://ageconsearch.umn.edu/record/135749 [Verified 21 January 2019]

Deakins D (1996) 'Entrepreneurship and small firms.' (McGraw-Hill Publishing Company: London)

Dillon JL (1980) The definition of farm management. *Journal of Agricultural Economics* **31**, 257-258.

Dillon JL, Officer RR (1971) Economic v. statistical significance in agricultural research and extension. *Farm Economist* **12**, 1-15.

Elliott FF (1928) The "representative firm" idea applied to research and extension in agricultural economics. *Journal of Farm Economics* **10**, 483-498.

Feuz DM, Skold MD (1992) Typical farm theory in agricultural research. *Journal of Sustainable Agriculture* **2**, 43-58.

Gummesson E (2000) ‘Qualitative methods in management research.’ (Sage Publications Inc.: Thousand Oaks)

Heady EO (1952) ‘Economics of agricultural production and resource use.’ (Prentice Hall: New Jersey, USA)

Heard JW, Leddin CM, Armstrong DP, Ho CKM, Tarrant KA, Malcolm B, Wales WJ (2012) The impact of system changes to a dairy farm in south-west Victoria: risk and increasing profitability. *Animal Production Science* **52**, 557–565.

Ho CKM, Newman M, Dalley DE, Little S, Wales WJ (2013) Performance, return and risk of different dairy systems in Australia and New Zealand. *Animal Production Science* **53**, 894-906.

Johnson GL (1963) Stress on production economics. *Australian Journal of Agricultural Economics* **7**, pp. 12-26.

Johnson HT (1999) ‘Moving upstream from measurement: A former management account’s perspective on the great dilemma of assessing results’, in The Dance of Change: The Challenges of Sustaining Momentum in Learning Organisations (Doubleday: New York)

Jones JW, Antle JM, Basso B, Boote KJ, Conant RT, Foster I, Godfray HCJ, Herrero M, Howitt RE, Janssen S, Keating BA, Munoz-Carpena R, Porter CH, Rosenzweig C, Wheeler TR (2017) Brief history of agricultural systems modelling. *Agricultural Systems* **155**, 240-254.

Lewis CD, Ho CKM, Jacobs JL, Malcolm B (2018) Benefits and costs of grazing various proportions of perennial ryegass and chicory for dairy production. *Animal Production Science* **58**, 1423-1431.

Makeham JP (1968) ‘Farm Management Economics.’ (Gill Publications: Armidale, NSW)

Malcolm B (2004) 'Where's the economics? The core discipline of farm management has gone missing! *Australian Journal of Agricultural and Resource Economics* **48**, 395-417.

Malcolm B, Ho CKM, Armstrong DP, Doyle PT, Tarrant KA, Heard JW, Leddin CM, Wales WJ (2012) Dairy Directions: a decade of whole farm analysis of dairy systems. *Australasian Agribusiness Review* **12**, 39-58.

Marshall A (1890) ‘Principles of economics.’ (Palgrave Macmillan: Basingstoke, UK)

Normann R (1970) ‘A personal quest for methodology.’ (Scandinavian Institute for Administrative Research: Stockholm)

Nuthall P (2011) ‘Farm business management – analysis of farming systems.’ (CABI Publishing: Wallingford, UK)

Orlikowski WJ, Baroudi JJ (1991) Studying information technology in organizations: research approaches and assumptions. *Information Systems Research* **2**, 1-29.

Perry C (1998) Processes of a case study methodology for postgraduate research in marketing. *European Journal of Marketing* **32**, 785-802.

Schramm W (1971) Notes on case studies for instructional media projects. Working paper for Academy of Educational Development, Washington DC.

Snow VO, Rotz CA, Moore AD, Martin-Clouaire R, Johnson IR, Hutchings NJ, Eckard RJ (2014) The challenges – and some solutions – to process-based modelling of grazed agricultural systems. *Environmental Modelling & Software* **62**, 420-436.

Sterns JA, Schweikhardt DB, Christopher Peterson H (1998) Using case studies as an approach for conducting agribusiness research. *International Food and Agribusiness Management Review* **1**, 311-327.

Yin RK (1994) ‘Case study research: design and methods.’ (Sage Publications: Thousand Oaks)

Yin RK (2018) ‘Case study research and applications: design and methods’ (Sage Publications: Thousand Oaks)

Yin RK, Bateman PG, Moore GB (1983) ‘Case studies and organizational innovation: strengthening the connection.’ (COSMOS Corporation: Washington, DC)