How Farmers Learn

Getting better value for research and development dollars through better extension

A report for

By Chris Reichstein

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Scholar Contact Details

Chris Reichstein

Mount Burdett

PO Box 526 Esperance

6450 WA

Phone: +61 429101970

Fax: +61 8 90767049

Email: creichstein@bigpond.com

NUFFIELD AUSTRALIA Contact Details

Nuffield Australia

Telephone: (02) 9463 9229

Mobile: 0431 438 684

Email: enquiries@nuffield.com.au

Address: PO Box 1021, NORTH SYDNEY, NSW 2059

Executive Summary

Extension of agricultural research has been impacted worldwide through cuts to public research, development and extension funding over the past decade.

Australia has traditionally used a 'Top Down' model for R&D in which publicly funded research organisations such as state or federal agricultural organisations, universities and levy-funded bodies have identified research and development priorities. These priorities have resulted in a mix of basic and applied research.

The goal of this Nuffield Scholarship was to investigate the most effective ways to extend agricultural research and development outputs to achieve practice change on-farm.

Specifically, objectives included gaining perspective on the impact of research, development and extension on grains sector productivity and profitability, understand what drives and impedes practice change on-farm, assess the effectiveness of different extension methods, discover ways to bring researchers and farmers closer together for mutual benefit and use case studies from different countries to demonstrate the value of different extension approaches.

Farmers will have different attitudes to adoption of innovation and risk-based on a wide range of previous experiences and personality types and as such, a range of criteria need to be met for change to be embraced

Key findings from the scholarship include:

The individual farmer is perhaps the greatest variable between enterprises when it comes to the financial and physical performance of a farm. Extension needs to take into account the individual's nature and attitude to change, along with impediments to adoption, whether they be cultural, economic, social, political or legislative.

Farmers learn by a range of styles; any extension efforts need to vary in delivery method (e.g. face-to-face, written, on-line) to cater for the diversity of individuals involved.

There are two basic models for R&D extension; the 'Top Down' model, which is supply driven and the 'Bottom Up' model, which tends to be more demand driven.

Benchmarking helps drive change because it highlights areas of poor performance, which can then be owned and addressed at the individual farm level.

Peer learning is undervalued as a learning tool and when combined with benchmarking can be a powerful driver of change at an operational, tactical and strategic level.

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Foreword

I have had a strong interest in agricultural research, development and extension since returning to the family farm in Esperance, Western Australia, after completing tertiary studies.

The Esperance area was settled in the 1960s by farmers lured from other parts of Australia by the promise of cheap land and opportunity. Due to the risk taking and progressive nature of these early settlers, the area has a long history of innovation and early adoption.

My return to the farm coincided with the completion of land clearing in the Esperance region, the advent of chemical usage, high input farming systems and the decline of tillage cropping. It was a time of rapid change and innovation.

Learning and information sharing has been a key focus during my farming career, initially at a local level through neighbourhood field days and later at a district and State-wide level through local grower groups and involvement with Grains Research and Development Corporation (GRDC) and former Department of Agriculture and Food Western Australia (DAFWA) projects, now renamed Department of Primary Industries and Regional Development - DPRID.

Through my participation in the DPIRD/DAFWA ‘Bridging the Yield Gap’ project and the GRDC’s Regional Cropping Solutions Network, it became apparent that significant and valuable research and development was not resulting in practice change at a farm level. This, combined with my concern regarding diminishing public dollars for agricultural research and development along with changes to the extension landscape, provided the impetus for my Nuffield proposal.

My Nuffield travels highlighted that many developed nations are reducing their public expenditure on agricultural RD&E and that this has resulted in organisations grappling to determine the most effective extension techniques to implement to prompt practice change on-farm.

I have always been concerned about farmers not adopting practice change and innovations, and part of this report is therefore aimed at investigating the drivers and impediments to adoption. The report also examines different extension models, via Australian and international case studies using the ‘Bottom Up’ or participatory learning extension approach compared to the more traditional ‘Top Down’ or supply-driven approach.

Due to the nature of my farming business and the fact the GRDC are my sponsors, this report is unashamedly grains focused, however the basic principles covered in the report will also apply across a wide range of agricultural industries.

Acknowledgments

I would like to thank and acknowledge Nuffield Australia for its confidence in awarding me this Nuffield Scholarship. The Nuffield organisation brings together an extensive range of people from broadacre agriculture, horticulture and aquaculture, all with a common interest in advancing their industries through innovation and practice change.

It has been a privilege to take part in the scholarship and meet such a wonderful group of people from around the world in a range of industries, while benefiting from the opportunities extended through being a Nuffield Scholar.

My thanks to the team at Nuffield Australia from the National and State Boards to Jim Geltch and his staff and volunteers and everyone who gives time to Nuffield to ensure that the organisation is so successful and held in such high regard.

To the rest of the 2014 Scholars and especially my Global Focus Group, it's been a great journey, most enjoyable, and I look forward to many more years of contact, travel and learning. The conversations and debates on planes, trains and automobiles were memorable and immensely valuable.

Many thanks to all those who agreed to meet and share their knowledge and hospitality; it's what makes Nuffield work.

Most importantly, it wouldn't have been possible to undertake the Scholarship without a great team at home comprising firstly, Adam den Engelsen, who rose to the occasion in managing the farm in my absence, treating the property as if it were his own, and doing the job with such commitment. It made leaving for extended periods so much easier, thank you. Also, Ritchie Arnold, who assisted Adam, a big thanks for your help, along with Luke Marquis from South East Agronomy Services who liaised with Adam on agronomic issues.

Having always had sole control of the business side of the farm, handing over the responsibility to Tracy Minchin of Rural Bizassist was a gigantic leap of faith, but Tracy was invaluable, introducing me to new systems and undertaking the role with the utmost efficiency and integrity. Many thanks, Tracy.

One of the overriding lessons I've learnt during my time away from the business is the value of delegating and stepping back to allow others space to grow. No doubt it will have a profound effect on my farming into the future.

Abbreviations

AACREA	Argentine Association of Regional Consortia for Agricultural Experimentation
CREA	Argentine Association of Consortiums Regional Agricultural Experiments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DDG	Dairy Discussion Groups
DAFWA	Department Agriculture Food Western Australia
DPRID	Department of Primary Industries and Regional Development
DDG	Dairy Discussion Group
GFP	Global Focus Program
GRDC	Grains Research and Development Corporation
HGCA	Home Grown Cereals Association
NZ	New Zealand
PA	Precision Agriculture
RD&E	Research Development and Extension
TFP	Total Factor Productivity
US	United States
VRT	Variable-Rate Technology
WA	Western Australia
WANTFA	Western Australian No Till Farmers Association

Objectives

This Nuffield Scholarship allowed significant expansion of prior learning in the area of extension and adoption of research and development outcomes.

The author was keen to investigate how best to deliver information to farmers to effect practice change and improve profitability and sustainability.

The objectives were to:

- gain perspective on the impact of research, development and extension on grains sector productivity and profitability;
- understand what drives and impedes practice change on-farm;
- assess the effectiveness of different extension methods;
- discover ways to bring researchers and farmers closer together for mutual benefit; and
- use case studies from different countries to demonstrate the value of different extension approaches.

Chapter 1: Introduction

The Australian grains industry: historical production

The Australian grains industry has seen large increases in production over the past forty years. Annual grain production is currently (2017) at about 45 million tonnes from an area of approximately 20 million hectares. Increases in grain production over the last four decades have resulted from an increased area under cultivation and a significant improvement in productivity per hectare. Increases in productivity have come via farmer innovations and the adoption of public and private research and development outputs. This has resulted in the development of production systems that are both efficient and unique to the Australian environment.

Australian grain exports for the period of 2009-10 to 2015-16 generated more than $10.6 billion per year. Grain production has a strong multiplier effect throughout the economy because it is integral to the food processing and livestock sectors. As a result, the contribution of the Australian grains industry to the milling, malting, brewing and intensive livestock industries generated a further AUD$14.6 billion per year for the same period (ABARES, 2016).

From the mid-1970s to the mid-2000s the Australian grains industry delivered an annual increase in total factor productivity (TFP) of 1.9%; a figure well beyond most other agricultural sectors. However, since the mid-2000s TFP growth and profitability appear to have been in decline, suggesting that the 'innovation system' described above is declining in effectiveness (Figure 1). TFP is the ratio of market outputs to market inputs. Improvements in TFP result from adoption of best practice and economies of scale and exit of less efficient operators from the industry. TFP is therefore a reflection of technological and practice change.

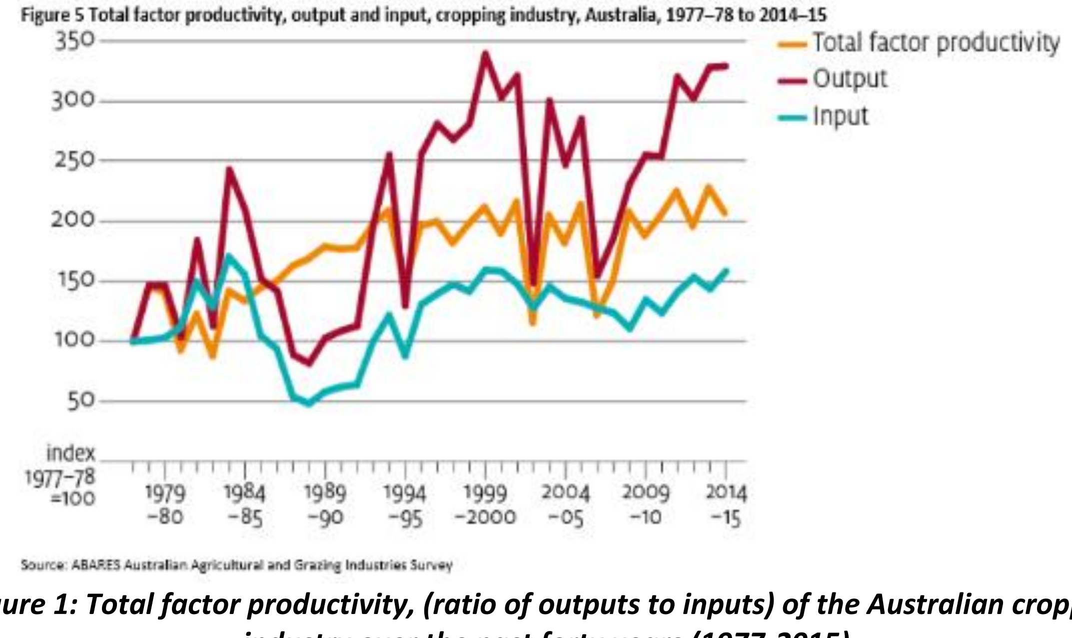


Figure 1: Total factor productivity, (ratio of outputs to inputs) of the Australian cropping industry over the past forty years (1977-2015)

Source: Historical reasons for total factor productivity (TFP) growth rates (from the *Grains Industry National Research, Development and Extension Strategy, 2014*).

Industry opinion indicates that past increases in TFP have been driven by:

- Government investment in research, development and extension (RD&E).
- A strong extension effort by the public sector.
- Adoption of minimum tillage.
- Improved agronomic packages, crop rotations and crop varieties.
- Improved weed, pest and disease control methods.
- Larger farm sizes creating economies of scale.
- Exit of less efficient operators from the industry.
- Better management of farm resources including labour and time.
- Greater access to information through electronic and traditional means.

The 2013 Australian Farm Institute report on extension (Keogh, 2013) states that:

"Of the contribution of R&D to productivity growth, about one-third has been attributed to genetics (varieties) and two-thirds to farm management and agronomy systems (practices). Productivity growth has been greater in the western region, but for the cropping industry as a whole, productivity growth has greatly slowed since the mid-1990s."

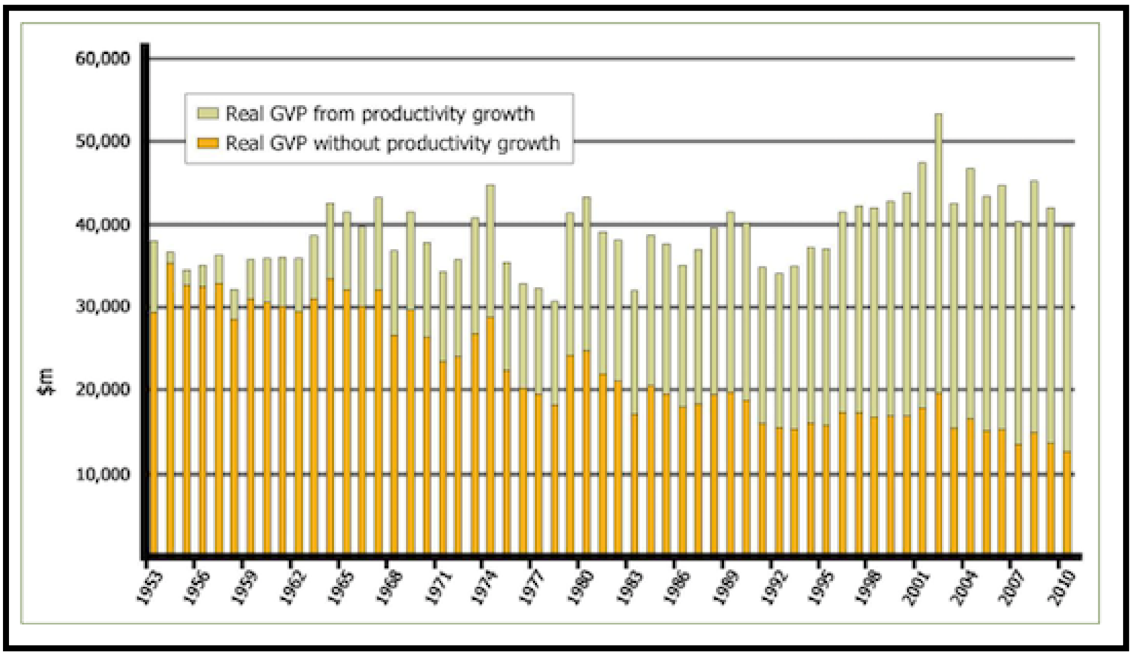


Figure 2: Comparison of agricultural production against real GVP with and without productivity growth 1953-2010 (A$2010) (Source: Mullen and Keogh, 2013)

Figure 2 shows that productivity growth contributed, on average, about $25 billion dollars per year to the Australian economy between 2005-10. The graph also demonstrates the strong link between farm productivity increases and profitability.

Reasons for recent reductions in TFP growth rate

TFP growth has been declining in recent years (ABARES, 2015) which may be due to:

- The negative impact of drought conditions on production and profitability.
- A lack of investment dollars for new technology to lift productivity.
- Growers becoming more risk averse and less inclined to adopt practice change due to poorer economic circumstances.
- Many of the easy gains from RD&E having already occurred, making any future gains smaller and more incremental.
- Reduction in R&D expenditure at both a State and Federal level.
- State governments reducing their extension effort.
- Slower rate of adoption of new technologies, particularly precision agriculture.

To remain competitive, the Australian grains industry must accelerate productivity growth rates over the next two decades. A target of 2.5-3 per cent productivity growth per annum has been discussed by industry, which is a substantial increase from current rates (Keogh, 2013). While the focus has long been on R&D, it appears that an increased effort in targeted extension to bring about practice change and improve productivity is now essential to lift TFP growth.

The changing nature of research, development and extension

Traditionally governments have been large contributors to RD&E efforts in Australia. However recently there has been a decline in public expenditure on RD&E due to government economic constraints and, one could argue, the declining political influence of the agricultural sector allowing agricultural R&D to be an easy target for cutbacks.

Between 1953 and 1980, growth in agricultural R&D in Australia averaged 6.5% per annum (DAFF, 2010i), which coincided with increases in TFP of 1.9% per annum. However, since the 1980s, expenditure has grown at just 0.6% per annum (Regan, 2014). The lag time between research investment and realising productivity gains has meant that until recent times, the decrease in R&D investment had little impact on productivity gains and competitiveness. The pipeline of outputs and innovations from previous investments sustained productivity for a significant period (Nossal et al., 2009), but declines in new outputs have occurred since the 2000s.

Agricultural extension involves the transfer of results from research and development activities, in the form of new technologies and innovations, to growers on-farm. The aim of extension is to lift farm productivity and profitability and improve sustainability. Extension can be facilitated by the public or private sector, and is delivered through a range of methods and networks.

Australia has traditionally used a 'Top Down' model for R&D in which publicly funded research organisations such as state or federal agricultural organisations, universities and levy-funded bodies have identified research and development priorities. These priorities have resulted in a mix of basic and applied research.

Traditionally, state agricultural departments were the main agents of extending research outputs to farmers. In the past, this was done via extension officers, whose role was to consult one on one with farmers. However, as government and staffing cutbacks are implemented such extension is more likely to occur via field days and group activities (Figure 3).

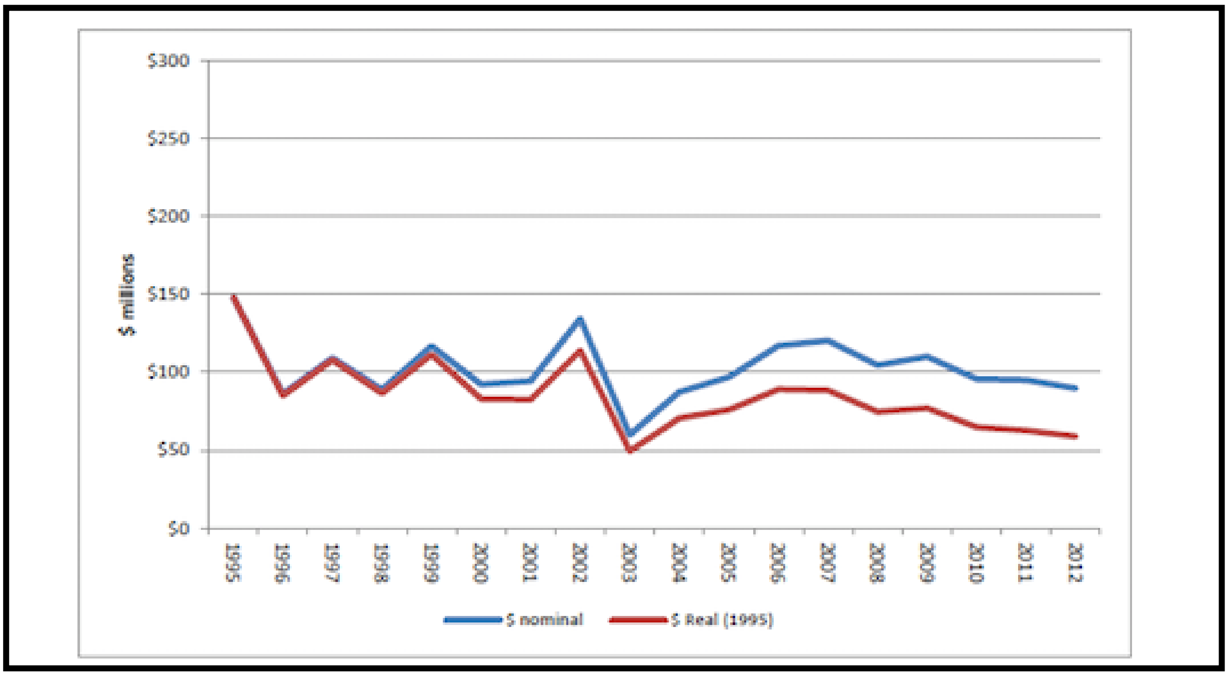


Figure 3: Australian state government expenditure on agricultural extension (Source: Keogh, 2013)

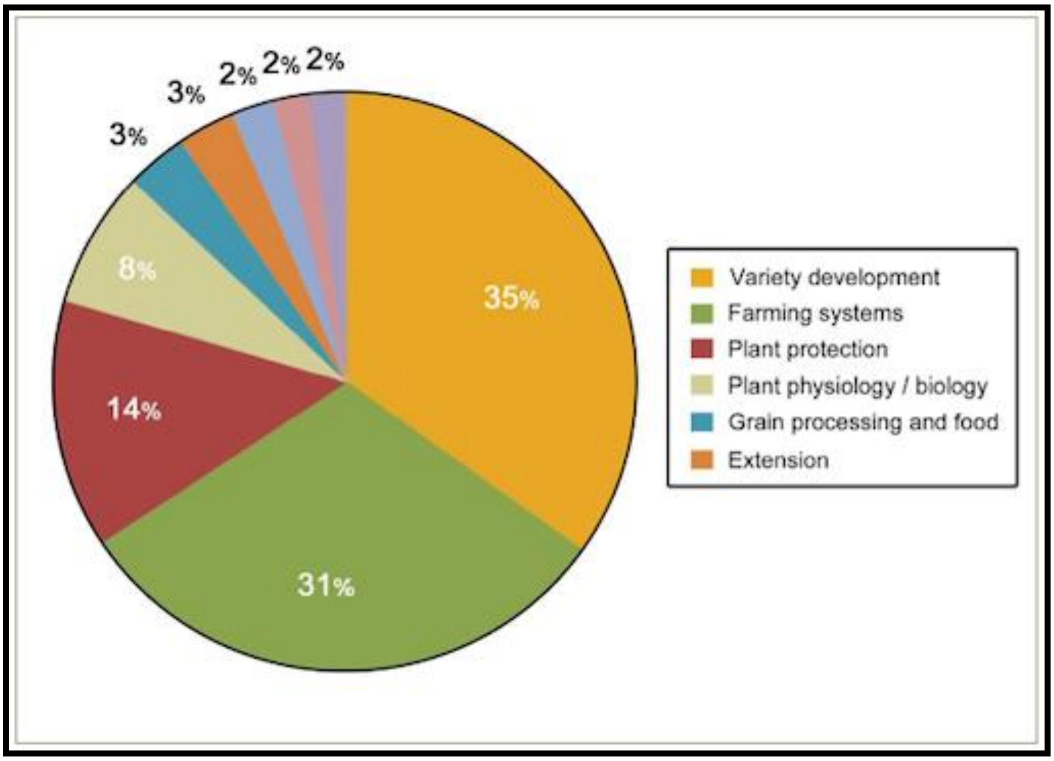


Figure 4: Relative levels of 'fulltime equivalent' employment across various areas of the Australian grains industry in 2010-11 (Source: Regan, 2014)

About one third of TFP growth has stemmed from crop variety development, and this is reflected in the proportion of total agricultural funding allocated to this endeavour (35%) (Figure 4). In contrast, extension attracts just three percent 'fulltime equivalent employment' (FTE) positions within the public sector (Figure 4).

Reduction in public RD&E expenditure has seen the levy-funded Grains Research and Development Corporation (GRDC) take a greater role in extension. This has been achieved both through GRDC-specific activities and through project funding of state agricultural departments, universities, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and, increasingly, grower groups and private researchers. The move to private research has seen public institutions allocate an increasing percentage of their expenditure to environmental, regulatory and sustainability outcomes, and less on extension.

GRDC and other public extension organisations have effectively become 'wholesalers of agricultural information' to private extension specialists who engage with farmers on a more frequent basis.

A reduced public extension effort has resulted in farmers changing the way they access information. Grower groups now facilitate and carry out localised and targeted research and extension and there has been an increase in the use of private extension and consultancy services.

The number of grower groups has increased markedly since the 1990s. Some of these, such as the Birchip Cropping Group in eastern Australia and the Liebe and Mingenew Irwin Groups in Western Australia, have arisen due to a lack of RD&E at a local level. Other groups have formed to tackle specific issues, such as the various no-till associations, the Southern Precision Agriculture Group (implementation of precision agriculture technology) and the South East Premium Wheat Growers Association, which has addressed grain quality issues in the Esperance port zone.

There are about 5,000 farmers now engaged with grower groups across Australia, with 40% of the groups in Western Australia. Due to the success of such grower groups and their focus on local research and extension, there has been a push by public institutions and GRDC to establish larger-scale groups, such as the Mallee Sustainable Farming Systems and Southern Farming Systems organisations.

Declining public expenditure on extension has seen an increase private sector engagement with farmers. This engagement occurs in two ways:

- **Via a fee-for-service model, in which the farmer contracts services from an advisor or consultant based on a range of factors (per hectare, hourly or annual contracts).** Typically, these consultants are small businesses and considered impartial as the only product being sold is knowledge. Farmers work closely with their consultants who are seen as gatherers and filters of information and often become integral to the farmer’s decision-making, especially during times of stress and adversity. Professional development can be an issue for small operators, so increasingly consultants are forming alliances to keep abreast of the latest innovations and technologies. These consultancy networks are often used as a conduit of information by research and commercial organisations.
- **Free advice via input suppliers and marketers**. Advice from these sources tends to be more operational, with advisors being less integral to the farm business. Large chemical and fertiliser resellers are increasingly becoming the training ground for such advisors, with some running graduate training programmes. In general, these ‘sales’ agronomists tend to be less experienced than their private agronomy or consultancy counterparts.

The farming community is increasingly using consultants, due to the lack of public extension, the need for impartiality and the increasing complexity of farm businesses requiring a greater level of expertise (Figure 5).

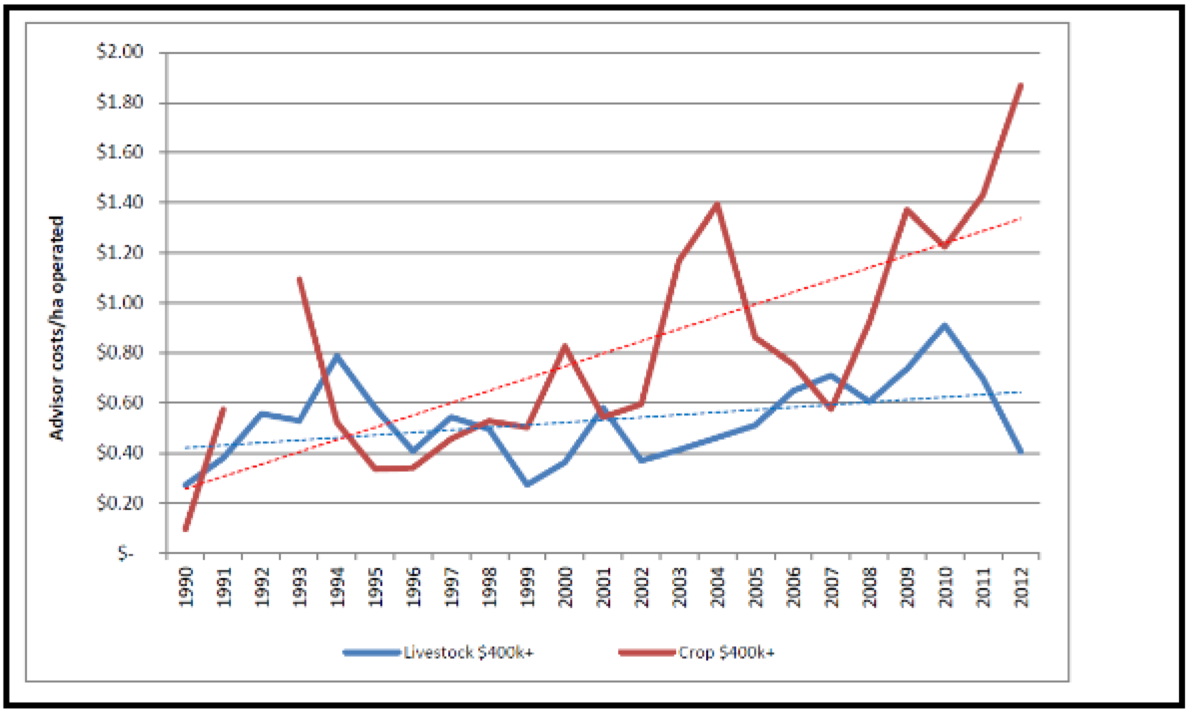


Figure 5: Advisor costs for broadacre farms with more than AUD$400,000 output per annum (Source: ABARES Agsurf, 2013)

Approach to the study

The main goal of this Nuffield Scholarship was to identify the drivers and impediments to practice change at the farm level.

Two models of agricultural RD&E were examined:

1. **The 'Top-Down' approach** in which organisations and scientists, external to the farm, plan, implement and review agricultural RD&E and;
2. **The 'Bottom-Up' method**, which uses local knowledge and dialogue between scientists, organisations and farmers to build agricultural RD&E programs.

Four 'Bottom-Up' case studies were examined across the world as part of the scholarship:

1. Expansion of the New Zealand dairy industry. This was chosen due to the industry's rapid growth and success. The investigation focussed on how farmers previously inexperienced in dairy farming were able to gain skills and expertise quickly, and the role that Dairy NZ and discussion groups played in this success.
2. Knowledge transfer in the New Zealand kiwi fruit industry. 'ZESPRI' is the peak body for the kiwi fruit industry in New Zealand and has been very successful in knowledge transfer using the 'bottom up' approach. It has recently dealt with a major disease crisis threatening the industry.

3. Irish Dairy Discussion groups, which have been instrumental in improving producer returns.
4. 'CREA', an Argentinean not-for-profit organisation, which has been very successful in extension, to the point where it now operates across South America and was recently contracted to work on agricultural extension in the former socialist republic of Georgia.

The 'Top-Down' case studies examined were:

1. The American system of research and extension.
2. The role of major corporations such as Monsanto in agricultural RD&E via the 'Field Scripts' program.
3. The new extension methods developed by the Home Grown Cereals Authority in the United Kingdom, 'Monitor Farms' and an extensive benchmarking program based on productivity and profitability.

The final investigation done as part of the scholarship was a visit to the University of Waginінen in The Netherlands, which specialises in the science of decision making and knowledge transfer.

Chapter 2: The Theory behind Change and Adoption

To determine why some extension techniques are more effective than others and why some innovations are adopted while others are not, it is necessary to examine what drives and impedes change in the decision-making process.

Several theories have been developed to better understand the science of change and adoption. These include:

1. Bennett's Hierarchy, which outlines the steps required to design and evaluate extension programs;
2. Maslow's Hierarchy of Needs, one of the best-known theories behind motivation; and
3. Rogers' Theory on the Diffusion of Innovations, a theory that seeks to explain how, why and at what rate new ideas and technology spread.

It is important to consider 'motivating factors' when examining attitudes to adoption of innovations. Maslow's Hierarchy of Needs (Maslow, 1943) (Figure 6) outlines the factors driving human motivations. At a primary level, our needs are purely physiological – food, shelter, rest. Each level of need must be satisfied before we can progress to a higher order need. For example, if someone has poor health, which is a second order need, it is likely that a higher order need, such as self-esteem, which may include achievement and recognition from others, will be sacrificed to address this lower order need.

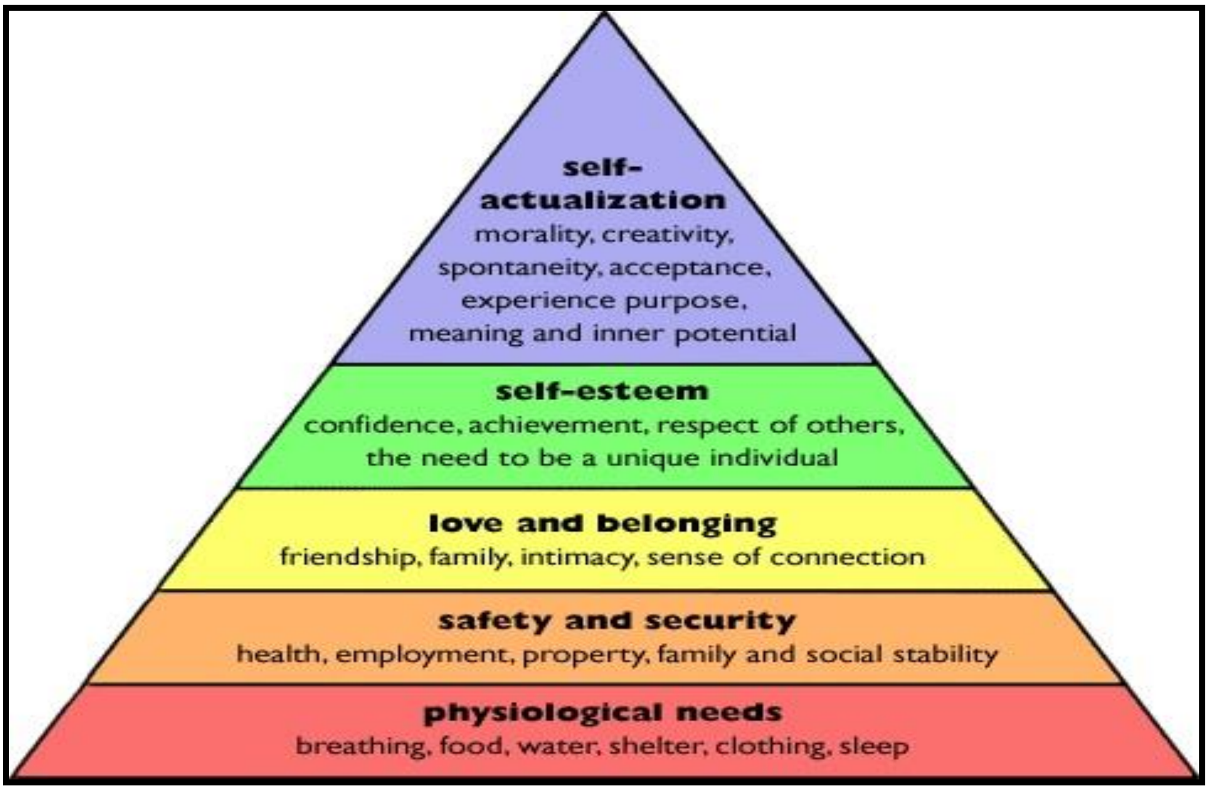


Figure 6: Maslow's Hierarchy of Needs

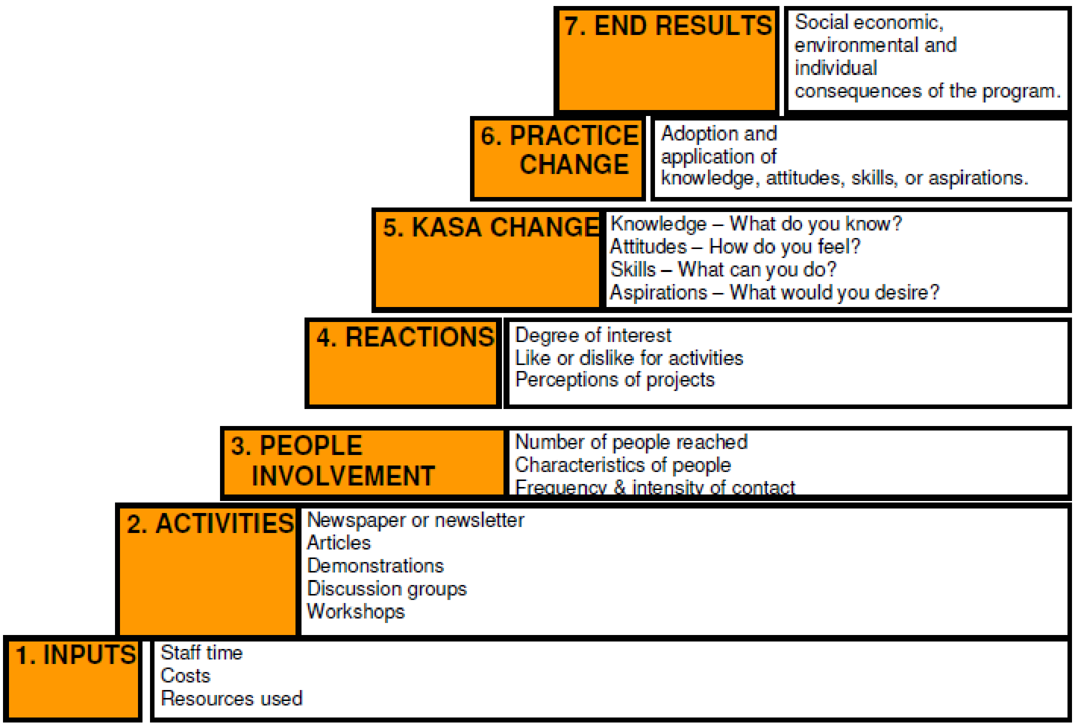
The drivers and impediments underlying farm management decisions are many and can be varied. Adoption of farm innovations can be influenced by the family situation, individual and community attitudes to risk, age, previous experience and future aspirations, financial and personal health, stage of the business cycle (e.g. expansion or winding down).

Simon Sankey, Dairy NZ, believes it is important for extension specialists to understand where clients sit within the Hierarchy of Needs to ensure the advice being delivered is relevant to the farmer's requirements.

For example, a farmer may feel the need to be an early adopter of the latest innovation in order to gain the respect or admiration of others, rather than for any specific economic reason.

Bennett's Hierarchy is a model used by extension specialists in planning and evaluating the effectiveness of extension programs (Bennett and Rockwell, 1995) (Table 1). The Hierarchy comprises seven steps. Step 5 is particularly relevant to this Nuffield Scholarship as it considers the changes in knowledge, attitude, skill and aspirations resulting from an extension program. While planning an extension program is important, assessing its impact on farmer knowledge, attitudes, skills and aspirations is critical to ensuring success in facilitating practice change.

"As extension agents, we expect farmers to learn from their mistakes but we don't learn from ours." Neel's Botha (Rural Sociologist, Agrisearch New Zealand)



Bennett, C. F. 1979, *Analyzing Impacts of Extension Programs*. Washington, DC, U.S. Department of Agriculture.

Table 1: Bennet's Hierarchy

Targeting extension resources for the best outcome requires an understanding of farmers:

1. Knowledge; are they aware of the innovation or change? Have they even identified the need to change?
2. Attitude; are they receptive to new ideas or change?
3. Skill; do they have the necessary skills to undertake the change?
4. Aspiration; do they have a desire to improve or change?

"Knowledge is not a motivator for practice change" Gavin Sheath AgResearchNZ

While a farmer may have the knowledge, attitude, skill and aspiration to change, sometimes they can lack confidence in making decisions. This lack of confidence can be due to many factors including: the integrity of the advice, attitudes to risk and whether or not peers have undertaken the change. In many cases, peers and trusted others, who could be family members or business associates, provide validation and support to undertake the change. The paid consultant, whether it be technical or financial, is increasingly seen as a filter of information, and is relied upon for support and affirmation when undertaking change.

"Fear of change is the greatest impediment to innovation" Norman Borlaug, 1970 Nobel Peace Prize winner

Case Study 1: New Zealand kiwifruit industry emergency response

In 2010, the New Zealand kiwifruit industry was threatened by an outbreak of a potentially devastating disease known as PSA. Combating the outbreak required a combined approach between Plant and Food Research in New Zealand (NZ) and Zespri, which is effectively the single desk marketer for New Zealand kiwifruit. As little was known about the disease a great deal of research work was undertaken to develop methods to control the disease. Plant and Food Research and ZESPRI developed management strategies that involved removing susceptible cultivars and replacing them with new resistant varieties.

While there was a strong desire for change due to threat to the industry, many growers were paralysed by fear and consequently lacked the confidence to act. To counteract this, ZESPRI and Plant and Food Research brought in psychologists to help guide farmers through the change process.

From a position of a dramatic decline in kiwifruit production and orchard values, the NZ kiwifruit industry has since recovered to the point where orchard values are from 40-100% higher than before the 2010 PSA outbreak.

The success in countering the PSA outbreak was due to the strong cooperative mentality and a desire to change among growers along with well-targeted and consistent messaging, which gave growers confidence. The close relationship between ZESPRI and growers and strong linkages between science and extension also underpinned the industry's success in combating the disease.

The resources and effort required in extension programs depends on the nature of the change being sought, which in turn can be divided into three categories:

1. Technology transfer, such as the adoption of a higher-yielding wheat variety, which is:

- Easy.
- Incremental.
- Stand alone.

2. Knowledge exchange, such as a move to no-till farming, which is:

- More difficult.
- Disruptive to system.
- Requires systems approach.
- Higher risk.
- Confidence essential.

3. System change, such as a move from conventional to organic production, which is:

- Most difficult of all and requires enormous motivation.

Rogers' theory on the Diffusion of Innovation (Rogers, 1995) identifies five drivers of change:

Relative advantage: The extent to which an idea is perceived as being better than the idea it supersedes, the greater the relative advantage and the faster the rate of adoption. This advantage could be in terms of economic return or time saving – the 'show me the money' factor!

Compatibility: The degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of potential adopters. An idea that is compatible will be adopted faster than an innovation that is incompatible, e.g. knife points in a no-till system.

Complexity: The degree to which an innovation is perceived as difficult to understand and use. New ideas that are simpler to understand are adopted more readily than innovations that require the adopter to develop new skills and understanding. An example of complexity impeding adoption could be Variable Rate Technology (VRT) adoption in Precision Agriculture (PA).

Trialability: The degree to which an innovation can be tested before full adoption (e.g. comparing the performance of new wheat varieties). Trialling an innovation reduces uncertainty for the farmer and enables learning while trialling.

Observability: The ease with which the impacts of an innovation are visible to others. The easier it is for farmers to see the results of an innovation, the more likely they are to adopt it. For example, the results of deep ripping have high observability, whereas the benefits of lime application are less visible.

One of the most important aspects of Rogers' Theory on the Diffusion of Innovation relates to the range of individuals within a social system - from the innovators to the laggards (Figure 7). Knowledge of this range is essential as it enables change managers to better understand where individuals sit within the system and their motivations and requirements for change. Identifying where individuals sit within the system enables extension messages to be targeted more effectively.

An area called the 'adoption chasm' falls between the innovators/early adopters and the more conservative mainstream (Figure 7). 'Adoption chasm' individuals require a different extension approach. An example of the adoption chasm can be found in the Victorian dairy industry's attempt to change the way dairy effluent was being managed on-farm. While the effluent management changes were adopted speedily by some producers; broader industry adoption of the changes soon stalled. There was a need to repackage the effluent messages to appeal to the various motivations of the 'adoption chasm' individuals. For some, this meant the messages needed to be framed from an animal health perspective (healthier livestock), for others an economic perspective (save money), and for the others an environmental perspective (healthier environment).

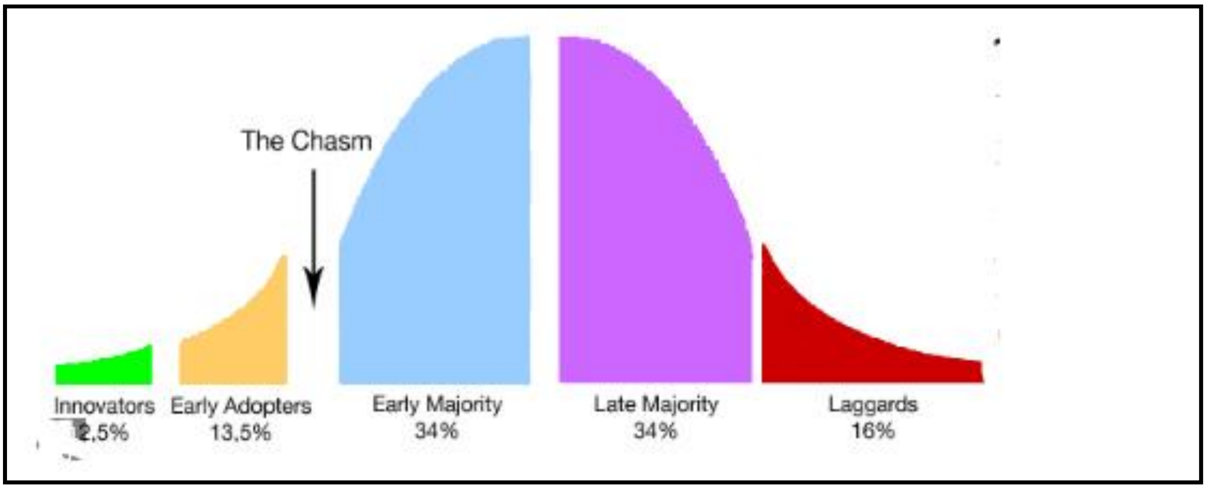


Figure 7: Rogers' theory on the Diffusion of Innovation

Characteristics of groups within the innovation adoption system

Innovators:

- Venturesome – almost an obsession with innovators
- Technology enthusiasts
- Risk takers
- Poor opinion leaders - can be considered too elite and too change oriented

- Able to understand and apply complex technical knowledge
- Play an important role in the system by introducing new ideas
- Tend to operate in cliques of innovators irrespective of geographical distance

Early adopters:

- Opinion leaders – not too far ahead of the average in terms of innovation adoption, so can serve as role models
- Visionaries
- Utilised by extension agents to enhance the diffusion and adoption of innovation
- Favourable attitude to change
- Generally successful
- Early adopter reduces uncertainty for others by adopting an innovation then conveying a subjective evaluation of the innovation to local peers and colleagues

Early Majority:

- Deliberate thinkers
- Pragmatic
- Adopt new ideas a little earlier than the average
- Interact frequently with peers but seldom hold positions of high influence
- Comprise one third of the population
- Adopt innovations with deliberate willingness but seldom lead

Late Majority:

- Sceptical
- Conservative
- Make up one third of population
- Generally late to adopt innovation after pressure from peers
- Risk averse

Laggards:

- Traditional
- Sceptical
- Last to adopt - if at all
- No opinion leadership
- Socially isolated
- Point of reference is the past
- Suspicious of innovation and change agents
- Limited social and economic resources

Once farmers have made the decision to adopt an innovation or make a change of great complexity, one of the critical factors to ongoing success is the availability of peer and professional support systems.

Case Study 2: A tale of two technologies

Over the past thirty years, broadacre agriculture in Australia has undergone enormous changes in grain marketing, land use, enterprise mix, the adoption of high-input cropping systems, stubble retention, no-till farming and the adoption of precision agriculture. Some of these innovations and systems have been adopted faster than others. Below is an examination (in light of the theory outlined above) of two of these innovations, which have had contrasting rates of adoption.

No-till farming was widely adopted quite quickly while precision agriculture (or variable rate technology) has had a relatively slow adoption rate.

No-till farming

During the 1980s, the south coast of Western Australia experienced a run of very dry and windy years which, combined with the region's sandy soil types and traditional farming techniques (a combination of crop and stock), created scenes such as those in Figure 8.

Figure 8: Impact of drought and wind on paddock condition at Esperance, Western Australia, in the 1980s

During these difficult seasons the need for farming practice change was clearly observable due to the highly visual nature of the problem. From there, the innovative farmers started adapting machinery and developing systems to enable sowing to be achieved with less soil disturbance to minimise wind erosion, maximise water usage and improve sustainability.

In the case of the ‘no-till’ system it was very easy to appreciate the *relative advantage* of adopting the new system, as it required fewer tractor hours, was more efficient and productive and reduced wind erosion, so the economic and environmental benefits were obvious.

In terms of *compatibility*, the fact that no-till would reduce erosion and improve environmental and economic sustainability aligned with the values of farmers.

While no-till farming requires a change at a systems level; farmers were able to trial the new system on a paddock by paddock basis without great expense. Only a few changes were required to their existing machines and cultural practices. They were therefore able to minimise the *complexity* of the practice change and easily quantify the impact of the no-till work through yield data. In other words, the new technique was easily *trial-able* and the results easily measurable.

The *observability* factor that drove the change to no-till was very strong, with farming country changing from highly eroded to stable and sustainable with the implementation of the new practice. Being able to easily see the results of the new practice underpinned the adoption of the new tillage system at an individual farm level.

While the implementation of no-till happened very successfully on early-adopter farms, broader industry uptake required input from industry and scientific groups. The original innovators of the no-till system formed the Western Australian No Till Farmers Association (WANTFA) to collaborate on research and development, share information and promote no-till farming. At this point, scientific organisations were engaged to validate the new system and help explain some of its interactions and benefits and the machinery industry worked alongside the innovators to commercialise and perfect the no-till approach.

The adoption history of the no-till system in Western Australia mirrors the stages outlined in Rogers’ model of Diffusion of Innovation. Once the no-till system was well proven, the majority of farmers started adopting it willingly, with remaining laggards pressured by farmer peers to adopt the new tillage method to better manage soil erosion.

“Innovation is the ability to see change as an opportunity – not a threat”- Steve Jobs, Apple

Precision Agriculture – Variable Rate Technology

Precision Agriculture (PA), based on GPS technology, was introduced into Australian agriculture in the early 2000s primarily for guidance purposes and later for yield mapping of crops. Since then, there has been a huge increase in the scope of PA and the functions it can perform, ranging from biomass evaluation, auto-steer, elevation mapping, drainage planning, spatially mapping electromagentic levels in the soil and mapping nutrient removal to variable rate application of nutrients.

When PA was first introduced, the main focus was on the savings it could achieve by reducing fertiliser and chemical overlap and the management benefits it provided from yield mapping.

However, initial adoption of the auto steer and yield mapping systems was low because both systems required technology to be retro-fitted into farm machinery. As demand for the new technology increased, machinery manufacturers started to include steering systems and yield mapping as standard features of new machinery. The PA systems were simplified and became easier to use, resulting in widespread of adoption of the new technology.

An important evolution in the adoption of PA technology was the need to interpret the vast array of spatial data collected via yield, soil and input mapping. This shifted the technology from one that collected data to one that could inform management decisions.

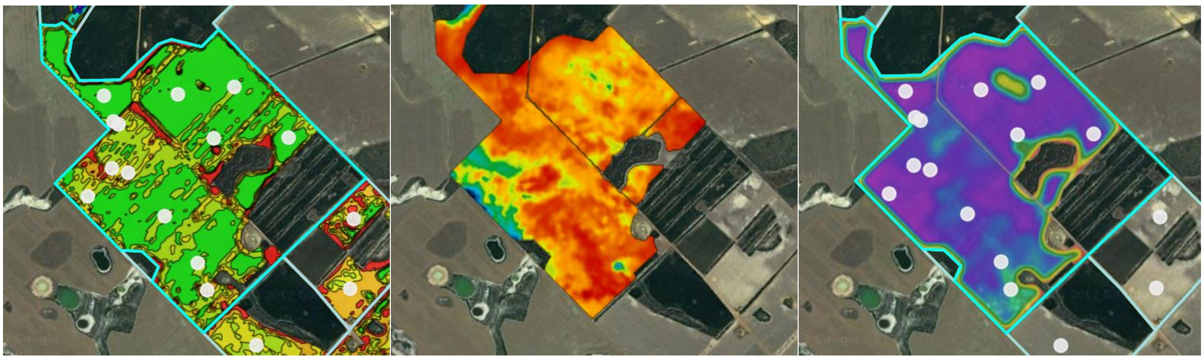


Figure 9: Complexity of different PA data sources Yield vs EM38 vs NDVI

The PA technology and the decision making connected with its use were inherently more complex than the no-till system and, as such, its adoption was slower. Farmers lacked confidence in the decision-making stemming from PA data. For example, "what was the relative economic benefit of adding extra nutrients to better performing zones rather than ameliorating and improving the poorer performing areas?" Interactions stemming from PA data become very complex and gains from the technology tended to be more incremental than no-till technology. It is more difficult to see the relative advantage of using PA vs not using it and the 'show me the money' factor is not as obvious as it is for no-till.

"Outcomes equal confidence by knowledge" Andy Macfarlane, Macfarlane Rural Business Solutions

The complex technical nature of PA and variable rate technology (VRT), makes trialling different applications of the system difficult as it requires expenditure on software and the necessary hardware to run the machines.

There is often a lack of compatibility between PA and VRT systems and professional help is needed to overcome technical difficulties. Unlike no-till, there are no immediate visual results from using PA and VRT, and as such demonstrations and field days cannot easily be used as an extension tool. This, in turn, inhibits peer learning around PA` and exchange of ideas about the technology.

A large part of the widespread adoption of no-till farming in Western Australia can be attributed to a core group of champions for the technology along with support from the no-till industry group WANTFA. Unfortunately, there have not been similar farmer champions to drive the uptake of the PA and VRT technology nor a support group to assist in problem solving and information sharing. This lack of PA support and the inherent complexity of the PA and VRT system has in part contributed to low levels of adoption. As a consequence, private consultants offering PA services have filled the gap to implement PA technology on-farm.

No Till Farming	**Precision Agriculture**
Clear need	Complexity of system
Appealed to values	Low level of confidence in farmer decision making
Highly visual	Non visual
Easily measurable	Small incremental gains
Clear economic benefit	Unclear economic benefits
Champions promoting no-till	No champions for the technology
Sharing of information by peers	Farmers working in isolation - low level of information exchange
Supported by industry	Lack of support mechanisms - incompatibility of hardware and software
Benefits validated by science	Science or industry driven rather than farmer first
Widespread adoption	Low level of adoption

Table 2: Characteristics of no-till farming vs precision agriculture from an adoption perspective

"Adoption is not necessarily a reflection of knowledge" Gavin Sheath AgResearch NZ

Chapter 3: Top Down versus Bottom Up Extension Models

There are two basic models of research development and extension (RD&E): 'Top Down' and 'Bottom Up' (Table 3).

In the 'Top Down' model, scientists set the research priorities, carry out the research and in some cases the development, before using existing extension networks to disseminate the new information or innovation. The Australian grains industry has traditionally relied on the 'Top Down' model, with the setting of research priorities and research work being undertaken by universities, the CSIRO and state departments of agriculture, and dissemination of information and innovations historically done through state government extension agents. One of the problems with the 'Top Down' approach is that it can result in researchers, extension agents, farmers and industry working in 'silos' relating to their particular discipline, with little information sharing and networking across disciplines or up and down the value chain.

Cutbacks to the agricultural budget and a move away from traditional extension agents has required investigation of different extension methodologies and avenues. In recent times, GRDC has implemented a more 'Bottom-Up' approach, via the Regional Cropping Solutions Network. This collaboration between growers, farming systems groups, agribusiness and researchers identifies research priorities at a local level and determines what needs to be done at a local, state and national level to solve the farm management issue.

TOP DOWN	BOTTOM UP
Traditional method	More recent method
Supply driven	Demand driven
Scientist First	Farmer first
Science based	Relies on interaction between science and farmers – more targeted research
Traditional extension channels	Utilises peer learning
Can lead to silos of information	Facilitates information sharing
Validates farmer innovation	Supports innovation

Table 3: Comparison of 'Top Down' and 'Bottom Up' extension models

Case Study 3: Top Down extension in the United States

The United States (US) has a strong and formalised RD&E system, dating back to the late 1800s. In 1887, The Hatch Act established a system of experimental agricultural stations in conjunction with the Land Grant Universities whose charter was agricultural research. In 1914, the Smith-Lever Act created the Cooperative Extension service to be operated by those universities, a system still operating today.

In Oklahoma and Kansas, the overriding impression is that agriculture is well resourced from a research and extension perspective, whether it be through the public service channels or via philanthropic organisations such as the Noble Research Institute in Oklahoma. This Institute is extremely well-resourced and unlike anything found in Australia. It is part of the Samuel Roberts Noble Philanthropic Foundation, which was established after the dustbowl of the 1930s using money generated via the oil industry. From an initial endowment of $10 million, the foundation now has a value of $1.2 billion and is a resource for farmers and ranchers to help rebuild the soil, promote land stewardship, and provide philanthropic gifts

Alongside research work, the Institute takes on a strong extension role, and has enough financial resources to employ several advisors to meet with farmers to address production issues. From this meeting, an action plan is drawn up for the landowner to follow with the plan later reassessed to determine how the implementation is progressing. This model is very 'Top Down', prescriptive and resource hungry with little room for peer learning and innovation.

As in Australia, the US commercial biotech and chemical companies are employing large numbers of graduates at rates far above those available in the public sector, which has traditionally been the training ground for advisors. In Australia, it is typically the input suppliers who employ agronomists. Fertiliser and input manufacturers employ graduates to a lesser extent, with the results of their work being fed to the farmer via the input suppliers.

In America, there is a strong move by the biotech companies to align themselves with growers at most levels of the decision-making process. Perhaps the best example of this is the Climate Corporation, a company purchased by Monsanto. The Climate Corporation uses weather modelling tools, along with the extensive radar, weather data and publicly available soil characterisation information to assist farmers in decision-making through their Field Scripts program.

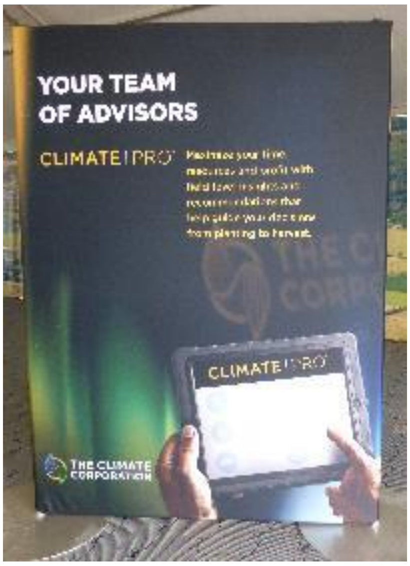


Figure 9: Climate Corporation creating strong linkages to influence farmer decision making- Iowa Farm Progress Show 2014

Using scientific data and modelling, the Field Scripts program makes recommendations on the best production systems and varieties to suit the soil types and environment of particular regions.

Monsanto has acquired machinery manufacturer ‘Precision Planting’, which offers ground-breaking technology. The Field Scripts program can create prescription maps based on the agreed varieties to be sown, and has the capability to switch between varieties depending on topography and soil type. By using the data and modelling available to the Climate Corporation, the advisor can advise the grower on a range of factors, including nitrogen rates, sowing time, soil moisture availability, expected yield, weed and disease presence, harvest timing, field trafficability and profit projections. Post-harvest, the yield data is then analysed by the Field Scripts system to guide future recommendations. This model gives enormous power to Climate Corporation and Monsanto, which is primarily a seed and biotech company, due to its involvement in the planning, execution and analysis of the crop.

Due to the low level of adoption of advanced Precision Agriculture (PA) and Variable-rate Technology (VRT) in Australia, it could be said there is value in the Field Scripts program, as it uses spatial data and imagery along with climate and soil capability information to assist farmers to better allocate resources on-farm. There is a risk, however, that the system reduces the farmer’s search for knowledge and understanding and that this, in turn, curbs innovation.

Case Study Four: ‘Bottom Up’ extension in Argentina

The ‘Bottom Up’ approach to RD&E tends to be driven from the ground up, whether through farmer innovation and research via peer interaction, or through researchers interacting with farmers to assess RD&E requirements.

The CREA network (Argentine Association of Consortiums Regional Agricultural Experiments) in Argentina is a very good example of a ‘Bottom Up’ approach to RD&E.

The organisation comprises about 1,900 farming businesses in regional or industry sector groups of 10-12. The groups are coordinated by a chairman and employ a technical advisor or facilitator. The aim of each group is to facilitate the sharing of experiences and knowledge while collaborating on decision making. Monthly meetings are held on-farm, with the technical advisor facilitating information sharing within the group and the CREA network. The CREA model is not dissimilar to the New Zealand and Irish Dairy discussion groups.

The CREA network is a multi-tiered organisation with business groups feeding up into eighteen regional level groups. At the regional level, technical advisors work together by sharing the concerns of the regions and developing solutions to issues raised by the business groups within each of the regions. From here, representation at a national level undertakes research and development on behalf of the issues raised. This structure results in coordination across the tiers and up and down the RD&E pipeline. Researchers within the top-level tier receive direct interaction and feedback from farmers, advisors and facilitators who are the recipients of the research outputs. Ricky Negri, Research Manager for CREA, described CREA as a ‘cooperative of knowledge’ and a ‘values-based organisation’, where integrity is vital.

One of the greatest benefits of the ‘Bottom Up’ model is the ability for farmers and researchers to interact, which not only leads to more targeted research but also enables the science to support innovations occurring at the farm level. Laurens Klerkx, University of Wageningen, refers to this as the ‘co-innovation approach’. The goal is to address problems through co-evolution of technologies, practices, policies and market changes undertaken through collaboration and negotiation involving multiple stakeholders.

Chapter 4: Benchmarking and Peer Learning

Benchmarking helps to identify strengths and weaknesses in a business and enables the performance of a business to be assessed in an objective manner. When combined with peer learning it can drive practice change.

One of the key questions when undertaking benchmarking is – what does 'good' look like?

Benchmarking

The dairy industry lends itself quite easily to benchmarking, in that productivity can be easily measured and monitored on a daily basis through milk production. The impact of any management changes can therefore be readily assessed on a daily basis. In contrast, benchmarking in the grains industry can generally only occur on an annual basis once crops are harvested.

Three important elements of benchmarking are the size of the database; the geographical spread; and the integrity of the data collection.

The larger the size of the database, the more accurate the results. Two excellent examples of benchmarking exist in the 'Cropbench' program in the United Kingdom (UK) (2000 data sets) and the Iowa Farm Business Association, which uses a standardised data collection system to benchmark businesses throughout Iowa on a statewide and county basis.

To be of value, it is essential that benchmarking data collection and analysis are done with integrity. Data input must be accurate and datasets need to be compared on a common basis.

Geographic location is also important. For the dairy industry, geography is rarely a problem as discussion groups are generally within a tight area due to the density of farms and their size. However, in the Western Australian grain industry, growers can be more than 1,000 kilometres apart and within different rainfall zones, making benchmarking comparisons difficult.

Benchmarking helps ground-truth business performance by highlighting areas of strength and weakness. Once the weaknesses are identified, solutions can be sought. This change is then driven from within, giving ownership to the farmer. To quote Gavin Sheath from NZ, "motivation must come from within, otherwise it is coercion and generally unsustainable".

Benchmarking the productivity and profitability aspects of a business can stimulate change at an operational, tactical or strategic level. Many operators in the Western Australian grains industry use farm financial consultants, most of whom benchmark their clients. The existence of this benchmarking data provides an excellent opportunity to develop a consolidated benchmarking platform with a large data base. The Home Grown Cereals Authority in England uses a similar data base of information generated via the Cropbench program to identify areas requiring investment in RD&E.

A common theme amongst consultants was that farmers may not necessarily want to be the best performers but neither do they want to be left behind. It is this desire not to be left behind that can improve the overall productivity of a benchmarking group.

Peer learning

A common belief among extension specialists is that farmers learn best from farmers. Discussion groups in the New Zealand and Ireland dairy industries along with the CREA initiative in Argentina, ZESPRI in the New Zealand kiwi fruit industry and the UK farm monitoring system for the Home Grown Cereals Authority were all good examples of peer learning.

"If people don't share information humanity can't progress" Dave Warner, Neuroscientist

Case Study Five: New Zealand Dairy Discussion Groups

The New Zealand dairy industry has experienced rapid expansion over the past decade, with many sheep farmers converting to dairy. Underpinning this expansion is Dairy NZ, an extremely well-resourced organisation with many extension agents trained in extension methodology. These extension agents work closely with Dairy Discussion Groups, which provide a forum for sharing of information among farmers and also between farmers and researchers.

Dairy NZ discussion groups are formed with the aim of involving key influencers or opinion leaders. They also aim to attract farmers ranging from innovators through to late adopters to introduce diversity to the groups. As the groups mature they naturally become more focussed on the requirements, abilities and aspirations of individual members. This is seen as a positive because it leads to the formation of new groups that are more targeted to specific needs.

For example, Neil Bateup a dairy farmer from north of Hamilton in New Zealand was involved with a dairy discussion group in which the farmers traditionally undertook milking twice a day. For a variety of reasons, the Bateups decided to change to once-a-day milking regime. While the change had no economic impact on the Bateup's operation, it was met with a great deal of scepticism from local producers in the discussion group. However, the benefits of the once-a-day innovation were soon appreciated by others in the group and this resulted in the formation of another discussion group being based on a mode of practice (once-a-day milking) rather than geography.

The dairy discussion groups are primarily targeted at the main decision makers in the dairy operation. However Dairy NZ is now rolling out a new series of discussion groups, called progression groups, that focus on specific stages of the business cycle, such as first milkers, share milkers, new dairy conversions and leading farm staff.

The extension system in the New Zealand dairy industry is very well resourced and possesses a clear focus across the whole dairy industry. Extension specialists undergo comprehensive training and the RD&E components are vertically integrated.

"It is not the strongest of species that survives, nor the most intelligent but the one most responsive to change" Charles Darwin 1809

Case Study Six: Irish Dairy Discussion Groups

While the Irish dairy industry has used dairy discussion groups (DDGs) for some time, in recent years the number of groups has increased markedly due to the requirement for dairy farmers to participate in a DDG to qualify for the EU Dairy Efficiency Payment (DEP).

The Irish DDG principles are similar to those of their New Zealand and Argentinian counterparts. Each discussion group involves up to 20 or so milk producers who employ the services of an advisor/facilitator to help conduct regular on-farm meetings. These meetings rotate between group members' properties, with the host property becoming the focus for the day. Before the meeting, the advisor/facilitator collates all the physical and financial information relating to the host farm, and the figures are benchmarked against industry targets and other DDG members.

The format of a DDG day involves all DDG members being given a full physical and financial analysis of the host business. This is followed by an introduction by the group leader (a fellow dairy farmer) who introduces the host farmers and sets the scene for the day. The facilitator then highlights key indicators of business performance to engage discussion among the group.

In one such meeting the host farmers were keen to see where the business could be tweaked to gain efficiencies and which low hanging fruit could be picked for easy gains. With the scene set by the facilitator, DDG members questioned the host on a range of topics from purely operational matters through to machinery requirements for the expansion, tactical decisions regarding the location of a new dairy platform and strategic decisions involving family aspirations (involving both the partner and the children in the conversation).

A farm tour followed to allow DDG members to gain a better perspective of the operation, with questions being asked of the host farmer and facilitator. On completion of the tour, the group divided into four, with each sub-group armed with the task or providing recommendations on how the business could improve its performance. An impressive suite of recommendations emanated from the group ranging from short-term, easily implemented changes, such as disposal of machinery and outsourcing to contractors to allow more time to concentrate on pasture management, through to longer term changes involving the disposal of younger livestock to enable a complete change in herd genetics.

Figure 10: Irish Dairy Discussion Group- County Carlow 2014

Rather than advising, the facilitator successfully drew information from the group while also being able to quickly source information and provide it to the group as required. As the DDG was twenty years old, it no doubt required less direction and technical assistance from the facilitator than newer groups would. While questioning of the host farmer was extensive and intense there was considerable information sharing and transparency among the DDG members.

In 2013, The Irish Agriculture and Food Development Authority (TEAGASC) undertook an evaluation of the impact of participation in DDGs on dairy business performance. It examined the historical performance of DDG members, their motivations for joining and perceived benefits, along with productivity and profitability outcomes from being part of the group.

The report divided DDG members into three different categories:

- Established members – joined prior to the implementation of the Dairy Efficiency Payment (DEP)
- New members – joined post-DEP
- Non-members

An analysis of the 2008 TEAGASC National Farm Data Survey showed that members of DDGs established before the DEP had a higher level of practice adoption than non-members. For example, in 2008, 39% of DDG members used artificial insemination compared to 14% of non-members. On examination of the data, it was revealed that DDG members tended to farm larger, more intensive holdings in more advantaged regions than non-members. However, even when these geographical and farm size differences were accounted for, DDG members were still more likely to adopt technology. Regression analysis showed that even when the initial differences in terms of age, size, location and so forth were provided for, the effect of membership on the probability of adoption of artificial insemination was still positive and significant at 0.21 (Bogue, 2013) In other words, taking two farmers with the same characteristics, the discussion group member had a 0.21 higher probability of using genomic bull semen than a non-member.

The motivations for joining a DDG were examined in a survey of 405 DDG members in 2012, of which 48% were established members and 52% new DEP members. The main motivations were:

- To learn (29%)
- To gain information (23%)
- To attract the DEP payment (21%)

The DEP payment was an important motivation for the most recent members (38% listed this as a reason for joining), and as a result they had lower ratings for wanting to learn (26% versus 33%) and for gaining information (18% versus 27%) than established group members (Bogue, 2013).

Established group members who joined prior to DEP payments therefore had different motivations for joining than those who were more recent members.

The survey also examined the benefits that members attributed to the DDG membership. These included learning, access to the most up-to-date information, a source of ideas, problem solving and a social outlet. Group membership enabled members to harness the knowledge of several other farmers and the group advisor for application on their own farms.

The TEAGASC report then analysed the financial and physical performance of the three membership types.

Technical Performance Indicator	**Established Member**	**New (DEP) Member**	**Non-Members**
Milk yield per cow:> 5200 litres	56	54	42
Milk solids per cow:> 378 kg	53	49	37
Protein Content :> 3.4%	54	37	35
Fat Content :> 3.95%	36	33	27
Somatic Cell Count :< 200,000 cells/ml	52	55	23
Concentrate feed per cow:< 750kg per cow	57	41	39

Table 4: Percentage of farmers achieving TEAGESC roadmap targets

Economic Indicator	Established Members	New (DEP) Members	Non-Members
Net Margin (cents per litre)	14.5	12.1	11.6
Costs per hectare (euros)	2,260	2,327	2,150
Net Margin per hectare	1,516	1,234	1,050

Table 5: Economic performance: established, new and non-members

The analysis showed that discussion group methodology combined with peer learning and benchmarking has a significant and positive impact on both the physical and financial performance of businesses (Tables 4 and 5).

Case Study Seven: The UK Home Grown Cereals Authority

The Home Grown Cereals Authority (HGCA) in the UK has recently shifted its extension focus from a 'Top Down' system to a more 'Bottom Up' model, through the introduction of an on-farm monitoring and benchmarking system (Regan, 2014). The model is based on the New Zealand approach and was implemented due to a slowing rate of practice change, which was partially caused by an expensive and depleted extension system. The number of monitor farms is currently 24, but due to a lack of resources will not be increased. However, the aspirational aim is to establish 45 business discussion groups. The HGCA targets farmers who while not necessarily the best farmers in a district are the opinion leaders, which gives the group credibility.

The UK Monitor Farm system differs from the NZ and Irish discussion groups, in that just one farm is chosen as a monitor farm to provide a case study, host field days and provide full disclosure of their business and production to up to 40 group members.

Some UK monitor farmers have a consultant complete a full SWOT analysis of their farming operation before the first meeting. The analysis is then shared with the group, which then assess areas of poor performance and identify possibilities for improvement. The monitor groups meet on a regular basis with a small steering committee, setting the agenda and identifying possible guest speakers. Of the group members, some participate in an HGCA initiative called Cropbench, a UK-wide benchmarking initiative established to encourage participation of 2000 arable farming businesses.

The HGCA run and facilitate the arable business groups. Facilitators are chosen for their communication, facilitation and listening skills rather than their technical knowledge, as the power of the groups is reliant upon participants being able to exchange knowledge. One of the benefits of HGCA facilitating the discussion groups, is that it enables researchers to engage directly with farmers and tap into on-farm innovation.

Grower groups - A uniquely Australian experience?

Australian agriculture has seen a marked change in its RD&E landscape. As a consequence, there has been a significant increase in 'grower groups', which vary in size from very small regional groups with all work being undertaken on a voluntary or part time basis to larger organisations either covering a geographic area or specific agricultural practice (such as No-Till).

Most grower groups are created through local initiative to address local RD&E issues and to facilitate peer learning. However, in some cases, larger groups have been formed with impetus from government or research development corporations such as GRDC.

The groups identify production constraints and either undertake research themselves or feed the issues to relevant researchers, with whom they often work collaboratively, resulting in a strengthening of the linkage between growers and researchers.

As the research is driven by farmers (who in many cases are contributing to the work), there is a strong sense of ownership of outcomes and the work is relevant and timely.

Growers draw on many sources of information in the decision-making process, however grower groups have greater influence on decision making due to their localised or topic specific focus (Figure 13). Grower groups are viewed as credible and trusted sources of information, which is used for long- and short-term decision making. In many cases, farmers gain ideas and information at a grower group level then use consultants and advisors to ground truth these ideas.

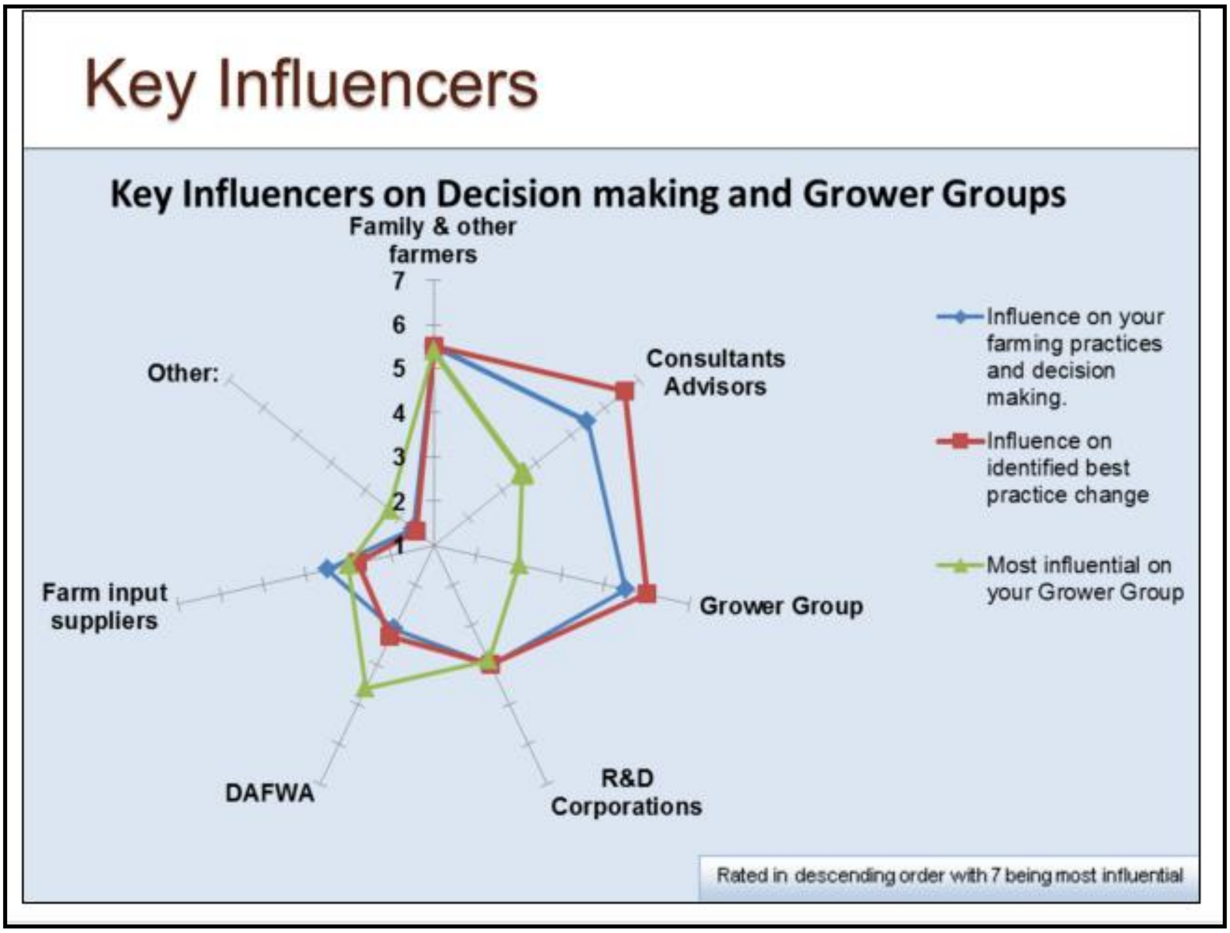


Figure 11: Source Agkowledge report for Grower Group Alliance- Assessing the value of Grower Groups Sept 2017

Research undertaken on behalf of the Grower Group Alliance in Western Australia (WA) demonstrated that every dollar spent by grower groups in WA, generated a direct economic benefit for the WA economy of $10, giving a cost benefit ratio of 10:1 (Peterson pers.comm). This equates to a total benefit of about $120 million per year. Taken over a 25-year period, the research found there was a total cumulative economic benefit ranging from $2.3 to $3.6 billion dollars.

Grower groups also provide significant social benefit and human capacity building via:

- Farmers taking roles within the groups that result in skills and leadership development, in many cases a stepping stone to other leadership roles in the agricultural industry.
- Development of grower group networks allowing for interactions and information sharing beyond the local region.
- Provision of a social support network - especially in times of hardship or emergency
- Employment and skills development for young professional staff.

Conclusion

This Nuffield Scholarship investigated how best to deliver information to farmers to effect practice change and improve farm profitability and sustainability.

Cuts to public sector RD&E funding in developed countries over the past decade or so have resulted in farmers relying more upon paid consultants and industry grower groups to access agricultural knowledge and innovations.

Extension is an inexact science – in order to be effective extension efforts should take into account different adult learning styles, in many cases requiring a multi- facetted extension approach in order to cater for the diverse requirements of the target audience.

Farmers will have different attitudes to adoption of innovation and risk-based on a wide range of previous experiences and personality types and as such, a range of criteria need to be met for change to be embraced.

There is an increasing trend to facilitated peer learning via formal grower groups, which play a vital role in bringing farmers and researchers closer together for mutual benefit, these groups and peer learning also play an important role in the adoption of innovation and when combined with benchmarking of agricultural enterprises can be a powerful driver of practice change.

Recommendations

1. Grower groups need to show a value proposition to industry stakeholders whether they be government, commercial, researchers or farmers to ensure greater recognition of both their economic and social value.
2. Adequate training of grower group staff must occur to ensure scientific rigour and integrity in research work and validity of outcomes.
3. An internet-based portal of all grower groups should be developed with research projects and outcomes.
4. Expansion of business discussion groups must occur in the grains industry, (this had previously had seed funding under the GRDC Grain and Graze project) on a user pays basis using commercial consultants with either extension training or a support system behind them.
5. GRDC should collaborate with Australian Association of Agricultural Consultants WA Inc to agree on a data collection method and range of key performance indicators to evaluate business performance with consolidation of benchmark results on a regional level.
6. An internet-based benchmarking portal should be developed to allow data input and examine business performance.
7. Increase the investment from industry and government to fund training of consultants, agronomists and extension agents in extension methodology and adult learning styles.
8. Increase Rural Research and Development Corporation (RDC) investment to employ extension specialists to ensure effective communication of research outcomes.

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Plain English Compendium Summary

Project Title:	How Farmers Learn Getting better value for research and developm dollars through better extension
Nuffield Australia Project No Scholar: Organisation: Phone: Fax: Email:	1405 Chris Reichstein Mount Burdett PO Box 526 Esperance 6450 WA 08 90767049 0429 101 970 08 9076 7049 creichstein@bigpond.com
Objectives	• Gain perspective on the impact of research, development and extension on grains sector productivity and profitability; • Understand what drives and impedes practice change on-farm; • Assess the effectiveness of different extension methods; • Discover ways to bring researchers and farmers closer together for mutual benefit; and • Use case studies from different countries to demonstrate the value of different extension approaches
Background	Declining public sector investment in research, development and extension has coincided with a decrease in the rate of total factor productivity growth in agriculture resulting in a shift to greater utilisation of private consultants and weaker linkages between researcher and farmers.
Research	Examination of different research and extension models being utilised around the world along with gaining an understanding of the science of extension and adult learning styles. This involved looking at different models in New Zealand South and North America the UK and Europe.
Outcomes	Facilitated peer learning is powerful extension tool and undervalued in Australia. When combined, peer learning and benchmarking can drive practice change at range of levels. Adult learning styles need to be taken into account when seeking to influence farmer decision making. Grower Groups play a vital role in providing linkages between researchers and farmers and in research itself along with the dissemination of information between farmers
Implications	Research and adoption of innovation is essential in order for Australian agriculture to remain competitive and profitable, as such investment in research extension needs to be well targeted with investment in extension training and an understanding of the role peer learning, benchmarking and grower groups play in the research and adoption pipeline.
Publications	Findings from the report were delivered at the 2015 Nuffield Conference along with presentations to 2016 Australian Pacific Extension Network Conference, 2017 Ag Ex Alliance Conference, 2015 Western Australian Crop Updates, 2017 National Grower Group Summit- Growing Expectations and various state and regional seminars.