MACQUARIE FRANKLIN
Consultants for business, agriculture and environment

MEAT & LIVESTOCK AUSTRALIA

final report

Project code: L.ADP.1702

Prepared by: Georgia McCarthy, Leanne Sherriff, Basil Doonan
Macquarie Franklin, Devonport, TAS

Date published: 10 September 2018

PUBLISHED BY
Meat and Livestock Australia Limited
Locked Bag 1961
NORTH SYDNEY NSW 2059

How agricultural extension leads to practice change.

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Executive summary

Practice change is the process of an innovation or practice being integrated into an existing farming system. Implementing a practice change is assumed to have beneficial effects on the farm business. While the adoption of new practices has historically been thought of as a simple process which assumed a link between knowledge and behaviour, current research suggests that the process is more complex and is directly related to the producers' internal and external motivations rather than simply being persuaded of a new practice's advantages and immediately adopting it. This review has been undertaken to improve the understanding of how Category C (practice change targeted) extension activities influence the adoption of practice change and how this relates to the design of Meat and Livestock Australia's new adoption program, Profitable Grazing Systems.

Practice change is a continuous process which occurs initially when producers identify the need for change and become motivated to make changes to their business and involves a decision to adopt or disadopt a technology or practice. Support from both technical experts and family or friends is crucial for producers to implement and sustain long-term practice change. A supported learning approach forms the basis of MLA's Profitable Grazing Systems program, and the evidence obtained from this literature review indicates that this approach is likely to be the most successful in achieving long term practice change which improves business profitability.

Recommendations based on this literature review include developing extension activities which aim to implement practice change (Category C) to be delivered over an appropriate period of time. There is evidence that follow up activities help to keep producers motivated to continue with the practice change process. There is also an important role for Category A and B activities in building awareness of the need to change and acting as feeder activities for Category C programs. The authors also suggest a 3-step process to maximise the successful outcomes of Category C extension activities:

1. Raise awareness of the practice and the beneficial impacts expected from its implementation into a farming system.
2. Generate interest in adopting the practice and/or participation in any associated extension program through feeder activities such as field days and workshops (Category A and B extension activities).
3. Follow up / support producers through the entire practice change process from awareness to adoption.

Table of Contents

1 Background

Research and development corporations (RDC) make a significant investment into activities which aim to improve industry productivity and profitability. The only way in which this objective can be achieved is if extension programs are effective at facilitating adoption of research and development outcomes and outputs, and to do this farm businesses must have the fundamentals of profitable grazing in place. Meat and Livestock Australia (MLA) have recently implemented a new extension program, Profitable Grazing Systems (PGS), with a key objective being to support red meat producers to upskill and implement new practices within their businesses that will lead to an increase in profitability.

Following on from the previous MLA extension programs, Making More from Sheep (MMFS) and More Beef from Pastures (MBFP), PGS has refined the definitions of these extension activities in one of three categories, relating to the core objective of the activity. Table 1 outlines the categories of extension delivery (Sherriff et al, 2016).

Table 1: Categories of agricultural extension activities (Sherriff et al, 2016)

Activity Category	Definition
Category A: **Awareness**	Initial stage of learning pathway by seeking to engage producers with MLA's E&A programs. The key purpose is to enable information sharing (increasing awareness) and networking. These activities must play a role as a feeder for either Category B or C activities. Examples are field days, forums / expos, seminars, and conferences.
Category B: **KASA change**	Building producer knowledge, skills, confidence, and some practice change may occur over time. KASA change is defined as a measurable increase in Knowledge, a positive change in Attitude, an increase in Skills or a change in producers' Aspirations. These events also feed producers into a Category C activity. An example of a Category B event is a workshop or comparative analysis session.
Category C: **Embedded practice Change**	Supporting adoption and increasing the uptake of practice change amongst producers to achieve quantifiable increases in on farm productivity and profitability. The focus is on skill development and supporting implementation of new skills and learnings within the farm business. These activities are delivered using a supported learning approach (e.g. coaching or benchmarking).

Category A activities aim to raise awareness of specific topics and to promote activities which enable participants to increase their knowledge. Category A activities are not designed to achieve practice

change or adoption. Category B activities are designed to improve knowledge, and skills and as a result influence the attitudes and aspirations (KASA) of participating producers. While category B activities may lead to practice change, to do so producers must already have the skills and knowledge in place and be confident in adopting new practices. Category C activities are more intensive and can take one of several forms, including producer demonstration sites and supported learning programs. While Category C programs are designed to be delivered in a more hands on format, in the context of PGS they will take the form of a supported learning approach with producers assisted by a trainer or coach who is a technical expert. They are designed to support producers through the practice change process and are delivered over a period of time.

Investment into activities in each category differs, with Category C activities requiring the highest level of investment by the participant. Because the investment in training and upskilling is significant, it is important to be certain that a Category C activity is the most cost-effective way to achieve practice change. The purpose of this literature review is to provide a deeper understanding of how practice change occurs and how this relates to the design of PGS.

2 Types of practice change

Practice change is the process of an innovation or practice being integrated into an existing farming system (Prager and Creaney, 2017). By implementing practice change, farming systems are altered to improve the sustainability of the business (Ryan et al, 2004). The practice change process is dependent upon individual circumstances and is generally an ongoing process and may result in complete adoption, partial adoption or disadoption (Wilkinson, 2011).

Practice change can take many forms. It can be a simple technology adoption such as pregnancy scanning for twins in sheep enterprises or it could be a complex change implemented to a farming system, such as a change to the management systems or a change of enterprise. However, all practice change starts with the adoption of an innovation, technology, or management practice.

Adoption is not a one-off event but instead a complex process (Wilkinson, 2011), regardless of whether it is a simple technology adoption or a more complex change. Early behaviourists assumed a link between knowledge and behaviour and this assumption carried through to an adoption model based on diffusion. This assumed than once a person had heard about an innovation or technology and been persuaded of its value they would then adopt the innovation and implement a practice change into their business (Hooks et al, 1983; cited in Wilkinson, 2011). However, later research has demonstrated that if there is not a clear value proposition for the promoted technology and if the process of implementation is not explained clearly enough or presented in the right context by the

extension deliverer, the adoption process can be much more complex than first thought. While the diffusion model is still relevant in some cases, it is recognised that it is not the only way practice change is achieved (van den Ban and Hawkins, 1996).

Wilkinson (2011) outlined seven dimensions of adoption of new technologies or practices:

1. *Partial adoption:* Producers may not adopt a new technology or practice completely if there are not an overwhelming number of benefits to be received by adopting it.
2. *Gradual adoption:* Adoption can be gradual, by which the area allocated to or the intensity of use of a technology or practice can be increased over time. Gradual adoption can also lead to partial adoption as the gradual process can be terminated at any time. Gradual adoption can occur as it allows the producer to determine the suitability of the technology within their farming system or, alternatively, because the producer experiences a barrier to further adoption at that point in time (e.g. financial constraints).
3. *Stepwise adoption:* Stepwise adoption can occur when related technologies are promoted as a package but where producers adopt only one or two components at a time, or where they only adopt some components and not others, depending on what components are perceived to be the best fit for their business. The Green Revolution is a classic example of a technology package which combined several elements such as high-yielding crop varieties, chemical fertilisers and weed control and new planting methods. The elements were able to be adopted separately or in combination.
4. *Flexibility in use*: Some technologies are flexible and can be used in a range of different ways. This can increase the likelihood of adoption because it gives producers' choices. If sufficiently flexible, it is possible for the technology to be adopted by the producer without it being fully integrated into the farm system. An example of a flexible technology is the practice of plate metering for pasture growth rate measurements. Plate metering, a relatively simple practice, can be implemented in a whole farm approach or intermittently (e.g. on the highest and lowest performing paddocks).
5. *Technological evolution:* Technologies are not constant, they change and evolve as improved versions are developed and feedback is given from early adopters. Producers who implemented an early version of the technology may choose to upgrade or stay with the earlier version as they are still observing the benefits associated with its use.
6. *Adaptation:* Technologies and practices are often likely to be adopted in different versions by different producers. The more difficult a technology is to implement, the less likely it is to be adopted unchanged. Without adaptation, adoption is likely to be slow and in many cases,

inappropriate. The adaptation and adoption of a technology is positively aided by its flexibility.

7. *Disadoption*: Adoption is not the end of the process. Disadoption of a technology is not uncommon and can occur due to a variety of reasons. Technologies may be disadopted due to high maintenance requirements, incompatibility with other technologies or practices, economic circumstances or when the technology is superseded by a superior product.

3 How practice change occurs

From the existing literature it can be concluded that adoption is a process and not a single event (Wilkinson, 2011; Pannell et al, 2006;). According to van den Ban and Hawkins (1996), research studies have demonstrated that there can be extensive delays between when a producer first hears about an innovation and when they adopt it. The rate of the adoption tends to be heavily influenced by the strength of the producers' motivation to adopt and is therefore highly variable (Wright 2011; cited in Kaine et al, 2013).

According to the Sustainable Grazing Systems Practice Change Model developed by Nicholson et al (2003), and further supported by Turner et al (2017) the desire to implement practice change can occur in two ways. It commonly arises as a proactive process which stems from a producer's strategic desire to continually improve on-farm productivity and efficiency and achieve goals, or by being exposed to a situation where they are made aware of the benefits they can receive by changing practice (most commonly through observation of local examples yielding financial, social or environmental benefits to another producer). The desire to change can also occur as a reactive process by which producers become increasingly dissatisfied with a current practice or when change is deemed necessary in reaction to a problem or issue that needs resolving. Findings from a study undertaken by Turner et al (2017) suggest that the extent of change is likely to be greater when producers make changes based on new knowledge or evidence they have proactively sought or gained through record keeping and benchmarking activities as opposed to being forced to make a change to resolve an issue. Practice change can generally be explained as the following process (adapted from van den Ban & Hawkins, 1996, Manjala, 2009 and Rogers, 2003):

1. Awareness; Producer first hears about the innovation or becomes aware that they need to implement practice change and are motivated to achieve goals.

2. Interest; Producers seek further information about potential innovation while extension deliverers create an appetite for change by identifying the potential benefits of achieving

goals or highlighting the consequences that will result from inaction. Pannell (2006) notes that the more serious the consequences that result from inaction, the stronger is the need for information and increased knowledge on the issue. An increase in knowledge on the issue is critical to improving the producer's confidence about the outcomes of practice change. In addition, farmers who are more open to adopting new innovations are more likely to seek advice and information from multiple sources before making practice changes (Kilpatrick and Johns, 2003). Turner et al (2017) suggested that to capitalise on this, extension programs seeking to promote practice change should be more than a single information session. Successful ongoing programs promote practice change because producers are continuously motivated from session to session to achieve results.

3. Evaluation; The extension deliverer may propose a range of options for on-farm implementation while the producer weighs up the advantages, disadvantages and potential barriers to adoption of each and decides on whether to research an option further or to discount entirely.
4. Trial/Follow Up; To ensure that practice change occurs, producers need continued support as they make changes. This support can take many forms, it could be referrals to specialist professionals, regular calls or visits by an extension deliverer or support from fellow producers and/or family (Manjala, 2009). The decision to adopt may also be reliant on a trial period where producers are able to test the innovation on a small scale and compare it with existing methods.
5. Adoption/disadoption; Producers confirm their decision to adopt by applying the innovation on a large scale and dis-adopting the old methods in preference for the new practice.

Both Pannell et al (2006) and Sewell et al (2017) identify two important characteristics of technologies or practices which drive their adoption (or non-adoption); relative advantage and triability. If the perceived advantages of the new technology do not exceed the existing technology it will supersede, then this may dissuade producers from implementing change. The triability of a new technology or practice greatly increases the attractiveness of implementing practice change. If a producer can test a new practice out on an area of their business without fully implementing it across the business, the risks associated with it are greatly reduced.

It is argued that adoption and consequently practice change is implemented in an often continuous, cyclical process due to the constant evolution of technologies and producer circumstances (Wilkinson, 2011). Therefore, the practice change process outlined above could be repeated each

time an innovation or adaptation to a business practice is considered provided the delivery and project are appropriate for the producer and their farm system.

Sewell et al (2017) explains that producers often adopt evolutionary practice change into their businesses. This process generally involves a series of incremental changes and associated learnings over time which could eventually result in larger scale or more complex changes to farming systems. This process can reduce the risk involved with complex practice change as it allows producers to plan and pave the way to greater practice change through earlier changes implemented.

If a producer is highly motivated, supported and has some level of prior skills and knowledge, practice change can occur after a single extension activity. As an example, Lachlan and Dugald Campbell run a 7,300-hectare property focussing on trade cattle and breeding Merino ewes. In 2012, Lachlan attended a one day 'Bred Well Fed Well' workshop, not expecting it to be the catalyst for a major management change to their business. However, through participation in the workshop, Lachlan and Dugald began to identify weaknesses in their business and became motivated to find ways to improve them. The Campbells began to focus on improving efficiency by increasing body condition scores in their ewes and the availability of feed at joining, prior to lambing and during lactation, and through tightening the joining period.

Hunecke et al (2017) suggests that the adoption of technology is the tip of the iceberg and after an initial adoption there will be further changes to management practices as well as the adoption of additional technologies. This suggestion is seen in the Campbell example, above. In the first year of implementing practice change the Campbells realised some significant improvement to their business, and as a result engaged a technical expert to assist them to better understand the energy requirements of their breeding stock. The Campbells are now working on making further changes to their business by significantly increasing their Merino breeding flock and improving productivity by producing Merino lambs to meet market weights earlier (Meat and Livestock Australia, 2015).

In a study undertaken by Sewell et al (2017) it was found that after engaging in an innovative agricultural extension program (on par with a Category C activity) delivered over a period of eighteen months to three years which focussed on establishing and maintaining herb pastures, the eighteen producers involved made a variety of changes to their farming systems relevant to this topic. Interviews and group discussions were used to determine what factors supported and or hindered their learning (outlined in Table 2) and to what extent the extension program had an impact on practice change. Participating producers were asked about any future changes they intended to make over the next two years. The results indicated that most participants planned to

capitalise on their recent practice change by making further changes to their system as a direct result of their participation in the program.

3.1 Boundaries to practice change

A study undertaken by Turner et al (2017) proposes the idea that the existence of 'barriers' to practice change is perception, rather than reality. Turner et al (2017) propose that the concept of a barrier to adoption assumes that if the barrier is overcome adoption will immediately follow. This is often not the case and the concept is too simplistic a view of producers' decision-making processes. Turner et al (2017) introduces a new concept – 'boundaries to change' to supersede the idea of barriers. The term 'boundaries' refers to factors within the business (e.g. management, infrastructure, land, enterprises, labour or debt) which may constrain change rather than restricting it from taking place completely. The boundaries to change approach suggests that producers are likely to have differing boundaries to change around different aspects of their business.

These boundaries may change over time as producer attitudes and circumstances change. It should be accepted by extension deliverers that producers are likely to have boundaries to change around different aspects of their business (and that these boundaries will vary between producers) instead of viewing a producer's reasons for non-adoption as barriers that must be overcome. The flexibility of the producer's boundaries (and consequently the extent of practice change undertaken) is directly related to the individual's values (which motivate change), participation in group extension activities, their benchmarking activities and patterns of information seeking (Turner et al, 2017).

3.2 Drivers of practice change

An essential component driving practice change in any environment is the desire to change and this desire is the key factor in determining the urgency that is placed on a potential adoption opportunity by the producer. The desire to change is influenced by financial, environmental and personal motivations (Ecker et al, 2011; Kaine et al, 2013). Ecker et al (2012) found that internal and external motivations influenced producers' decision to change practice more than the availability of support. This suggests that the action to change is driven by motivations and that most producers only seek support once they have decided to act. It was found that in cases where the presence of support did influence the decision to implement practice change, the type of support that was most valued depended directly on the type of practice change being implemented. In cases of practice change being made to cropping, horticulture and grazing management systems, private consultants are considered to play an important role (Ecker et al, 2012).

It is recognised that the likelihood of producers engaging in extension activities and the extent of their adoption of new technologies or practices is directly influenced by internal drivers - their personal values, social capital, motivations and attitudes towards risk (Pannell et al, 2006; Ecker et al, 2011; Hunecke et al, 2017; Turner et al, 2017). External drivers such as production issues or market changes are also motivators for producers to implement practice change.

Table 2 lists common internal and external drivers and boundaries of practice change to improve production.

Table 2: Internal and external drivers and constraints of practice change to improve production

Internal drivers (motivations and values) (Turner et al, 2017; Manjala, 2009; Hameed and Samwicka, 2017)	**External drivers (Ecker et al, 2011; Sewell et al, 2017)**
• Solving problems (e.g. production issues or market changes). • Fulfilling non-financial desires (e.g. keeping animals content or maintaining optimal soil health). • Achieving production goals (changes to stocking rate or introducing new enterprises to the farm system). • Gaining greater management efficiencies (e.g. pasture management improvements or increases). • Continually improving business profitability (changing enterprises, herd expansion). • A sense of belonging: If producers are unhappy with performance in one area of their business, they may benefit from listening and modelling practice change off producers who are achieving success with best practice management in that area.	• Farm finances, profitability and income (it is important to note that while increasing profit may be a driver associated with practice adoption, in most cases the business also needs to be in a financially secure position to be able to afford to implement the practice change and manage any risks). • Groups and networks: being involved in producer groups and networks with a diverse range of producers and industry professionals encourages change. • Information sources and provision of resources: Access to credible and practical information and resources through extension programs is a key driver of practice change. • Incentives and external pressures: Incentives including subsidies, co-funding arrangements; tax deductions, rebates, credits, awards and external pressures such as regulations, changing policies, animal health and welfare issues, societal/consumer expectations all influence practice change. • Market drivers: market access based on sustainability credentials or environmental certifications such as Meat Standards Australia (MSA) or Livestock Production Assurance program (LPA) accredited or RSPCA approved.
Internal boundaries (Cowan et al, 2015; Vanclay, 2004; Sewell et al, 2017; Micheels and Nolan 2016, in Hunecke et al, 2016)	**External boundaries (Hogg and Davis, 2009; Vanclay, 2004; Ecker et al, 2011; Sewell et al, 2017; Pannell, 2006; Batz, 1999 in Sarker et al, 2009)**

• Family/personal circumstances. • Lack of support (as identified at the beginning of this section) or social capital: Social capital refers to the networks and relationships producers are a part of. There is a direct correlation between adopted technologies and producer social capital. • Not compatible with farm or personal goals or values • Too much additional learning is required: Producers may not have the skills or knowledge required to adopt a new practice and therefore additional learning would be required for successful practice change.	• Unreliable/unpredictable seasons. • Cost of establishment. • Lack of funds. • Risk and uncertainty: The risk associated with change is too great. Producers with a higher income are more likely to adopt technologies with higher associated risks than producers with a low income. • The practice is too complex for the farm business: The more complex the practice, the higher understanding and management skills it requires. • The practice is not easily divisible into manageable parts: Divisibility allows for partial adoption to occur. • Delay in return on investment/little relative advantage: Producers may not be able to wait for a delayed return on investment and may instead choose not to adopt or to adopt a different practice in which financial results will be achieved earlier. Alternatively, the proposed practice change may not present producers with any relative advantage for business improvement over existing on-farm practices. • Reduced triability: If a practice is not easy to trial on a small scale it may be a constraint against its adoption.

It is important to note that while media and marketing has an important role in raising awareness of innovations and generating interest it has little direct influence on the producer's decision-making process. Media and marketing can accelerate existing change processes but will rarely initiate a change in practice or behaviour by itself (van den Ban and Hawkins, 1996).

A study conducted by Howard et al interviewed 554 producers over a two-year period to determine what percentage of practice change had occurred after attending a Making More from Sheep or More Beef from Pastures event. All the producers interviewed had previously stated on event evaluation forms that they intended to make a practice change. Of these producers, 65% made the specified change, 10% had made a different change than initially specified and 25% had made no changes. It was observed that simpler changes were adopted much more quickly and easily than complex changes (Howard et al, 2014). Of the 65% of producers who made the specified changes, 70% had fully implemented the change and 30% had partially implemented their change.

Results found that the majority of simpler practice changes made were directly attributed to a single workshop attended by the producer, while more complex practice changes were made over much longer periods of time with many more influences contributing to the change. The major influences on these complex practice changes were identified as being a member of a current discussion group, discussions with other industry professionals and attending other courses, field days or workshops. Additionally, these results confirmed that Category C participants had a higher rate of having made or intending to make a practice change to their business (Howard et al, 2014). These findings support literature from Sherriff and Doonan (2017) which demonstrated that supported learning extension programs (Category C) are considered more successful than awareness raising or knowledge building activities because they focus on improving the skills of producers. Participating in extension programs and interacting with a diverse group of producers and accessing information over time may increase producers' motivation to adopt a given practice (Ecker et al, 2011, Sewell et al, 2017).

4 Measuring practice change

In reviewing the varying adoption processes, and the fact that adoption is complex and often continuously evolving, it has become apparent that information on how practice change is measured is scarce. The references that are available on measurement of adoption and practice change concur that it is difficult to measure. There is some evidence that the measurement of adoption by focusing on change in profitability of an individual business over time is confounded by other variables influencing profit which are outside the producers' control (e.g. price, weather, etc).

To some degree practice change can be measured by the extent of continual on-farm practice change observed as a result of a producers' participation in an extension program, with the implementation of appropriate monitoring and evaluation of the program (McCarthy et al, 2018).

The recently completed Profitable Grazing Systems Pilot Project assessed ten independently developed supported learning projects delivered by consultants around Australia, utilising KASA skills audits and questions to assess confidence and use of specific practices to measure the success of each project (Sherriff and Doonan 2017). and This project concluded that there were two elements critical to assessing the impacts of supported learning projects on practice change of participating producers:

1. Questions in both the pre and post KASA skills audits regarding the frequency of use of different practices which are considered best practice by deliverers in achieving improvements in business productivity and performance.
2. A question in the post KASA audit regarding the intention to implement practice change and providing an opportunity for participants to list the practices they intend changing or adopting.

These steps can be taken to measure the intent of producers to implement practice change on-farm after participating in a supported learning project but cannot assess whether that practice change was actually implemented or sustained in the farm system.

Some authors have also noted that measuring practice change a short time after the project concludes would be inaccurate because it cannot be assumed that an extension activity will result in immediate practice change (La Grange et al, 2010).

An important observation made by Howard *et al* (2014), throughout their study was that producers do not measure the benefits of their practice change in terms which are easily measurable. For example, most producers commented in terms such as 'the stock looked better' or that 'the pastures seemed to produce more grass' (Howard et al, 2014). This observation supports the idea that the measurement of the extent of practice change is difficult to determine.

5 Sustaining long term practice change

The goal of extension programs is to encourage producers to adopt different methods or technologies in their business to improve business performance. Once a change is implemented, the extension goal must then adapt to ensure that the practice change is sustained long term until it is superseded or no longer providing value to the business (La Grange et al, 2010). While the objective is that practice change will be sustained long term, because there are many drivers and boundaries this is not always possible or realistic. The circumstances of businesses and people change, and this can cause practices to be discontinued or a reversion to old methods. It has been suggested that once a producer implements practice change, continued commitment will be guaranteed if the new techniques meet the producer's expectations (Barr and Cary, 2000). Pannell et al (2006) notes that when practice change is not sustained long term is it often because producers are not convinced that it is contributing to meeting their goals sufficiently to outweigh the economic costs associated with it. There are also other factors which affect the long-term status of certain practice changes. For example, market driven economics may present producers with uncertain financial returns, or

alternatively, environmental regulations may result in additional financial burdens and this may affect whether a practice is sustained or abandoned, particularly if there are high costs associated with its implementation (La Grange et al, 2010). Traditionally, extension programs have focussed on providing support during the motivation and trialling stages of the practice change process but there is a recognised need for ongoing support right through the practice change process from awareness to adoption. This could be in the form of an extension program delivered over an appropriate period of time and which is paid for by the participants under a 'fee-for-service' arrangement to ensure that the increase in knowledge and skills and the resources invested are translated into long-term action (Nicholson et al, 2003).

6 The link between practice change and increased knowledge/skills

Monitoring and evaluation can determine how effective an extension program has been at increasing a participant's skills and knowledge. A well designed and delivered program which provides effective support will not only increase the likelihood of producers increasing their knowledge and skills but will also ensure that they are better equipped to make practice changes when they are motivated to do so (La Grange et al, 2010).

The Profitable Grazing Systems pilot project (Sherriff and Doonan, 2017) demonstrated a link between improvement in KASA score and extent of practice change across the ten pilot project groups.

A review of other literature has indicated that there is a direct link between practice change and knowledge and skills, and that this link may take one of three forms:

1. Skills and knowledge are a prerequisite to implementing change. In most cases it is necessary for producers to have some level of skill or knowledge prior to making a practice change to their business. Using the Campbell case study described in section 3.0 (Meat and Livestock Australia, 2015), it is evident that to make the practice change of achieving ewe condition score target at key times, the producers already needed to be able to correctly condition score sheep.
2. Skills and knowledge are increased through the practice change process: While it is recognised that most technologies require a certain level of skill and knowledge for them to be applied in practice, there are also further opportunities to upskill during the practice change process (Abadi Ghadim and Pannell, 1999 in Pannell et al, 2006). Additionally, through the practice change process producers may realise there are skills which they do not

have or gaps in their knowledge. As a result, providing support for continued learning is crucial until the producer is adequately skilled and knowledgeable to sustain the practice change successfully. This support may come in the form of technical advice or information from individuals who are considered leaders by the producer (Pannell et al, 2006).

3. Continuous improvement of skills and knowledge promotes practice change: One such example is that of Victorian producers, Tim and Georgie Leeming. Tim and Georgie run their prime lamb and cattle trading business on 1,330 hectares. They have made several changes to their business including building stock numbers from 3,000 to 6,500 ewes and drought proofing along with several smaller changes to improve efficiency. Tim credits much of the knowledge and confidence underpinning their decisions to a variety of training he has participated in over the last 21 years. Through extensive participation in extension activities over a long period of time, Tim gained sufficient skills and knowledge to be confident to implement major practice change into his business (Meat and Livestock Australia, 2014).

A producer's confidence in their own abilities and those of their advisors is an important driver of whether practice change occurs or not. Sewell et al (2017) note that an important influence of producers' learning and implementing practice change is their belief in their individual capabilities to successfully understand, manage systems and perform tasks related to the practice change. As producers recognise that their knowledge and understanding of the practice is increasing, their confidence in trialling it in their business also grows. Having trust in the extension deliverer, advisor or scientist is also an important factor in adoption and practice change. Sewell et al (2006) suggests that sustained participatory extension activities which encourage produce's confidence and belief in their abilities will best support practice change.

7 Conclusion

Agricultural extension aims to improve producer's capability, capacity, adaptability and attitude so they can farm sustainably, productively and profitability in a continuously changing and challenging world. Extension is the sharing of new technologies, information and practices with producers and helping them to understand the fit for these new practices or technologies within their businesses (La Grange et al, 2010). Practice change is a continuous process that occurs initially when producers identify the need for change and become motivated to make changes to their business and involves a decision to adopt or disadopt a technology or practice. There are many drivers and boundaries which influence a producer's decision to implement practice change. The time taken to implement practice change can vary due to individual producers' values and circumstances. In order to sustain long-term practice change and capitalise on historical practice change, it is important that producers

have support from technical experts as well substantial social capital, including support from fellow producers and family. To maximise the number of participants implementing practice change, extension programs should be designed and delivered over an appropriate period. This supported learning environment ensures producers remain motivated to achieve results and are supported during and after the practice change process. A supported learning approach forms the basis of MLA's Profitable Grazing Systems program, and the evidence obtained from this literature review indicates that this approach is likely to be the most successful in achieving long term practice change which improves business profitability.

8 Recommendations

- Extension activities which aim to implement practice change (Category C), rather than raise awareness (Category A) or increase knowledge (Category B), should be developed and delivered over a period of time. There is evidence that follow up activities help to keep producers motivated to continue with the practice change process. This confirms the approach of PGS in applying a supported learning methodology to increase the uptake of practice change resulting in improved business performance. However, there is still an important role for Category A and B type activities in building awareness, and for some producers who already possess the basic skills an extension activity such as this can be sufficient to trigger them to change practice. A process to deliver successful outcomes from Category C activities would be;

  1. Raise awareness of the practice and the beneficial impacts expected from its implementation into a farming system.

  2. Generate interest in the practice/associated extension program through feeder activities such as field days and workshops (Category A and B extension activities).

  3. Follow up / support producers through the entire practice change process from awareness to adoption.

- Extension deliverers should be made more aware of the benefits of, and trained in delivering programs, that follow a Category C approach. Building the capacity of extension deliverers is important to maximise the support given to producers such that practice change is more likely to occur as a result. While it is essential that extension deliverers are experienced in the technical practices being promoted, they should also be experienced in explaining these principles and practices in a practical context and supporting producers as they undertake the adoption process.

- The articles on barriers to adoption and practice change focus on those inherent within the producer participants. There is limited research on the delivery approach (e.g. deliverer skills and experience, delivery methods, etc) and the influence of these on the end result of an extension program in achieving practice change (i.e. a lack of practice change from an extension program could be a direct result of the quality of delivery rather than any barriers experienced by producers).

9 References

Barr N. and Cary J. (2000). Influencing Improved Natural Resource Management on Farms: A guide to understanding factors influencing the adoption of sustainable resource practices. Canberra.

Cowan L., Wright V., Kaine G. and Cooksey R. (2015). The influence of family and personal domains on change decisions on irrigated dairy farms *Rural Extension and Innovation Systems Journal,* **11**, 11-22.

Doonan B. and Goodwin, T. (2012). Tasmanian Dairy Industry Skills Audit – supplementary case studies. Macquarie Franklin, Devonport, Tasmania

Ecker S., Thompson L., Kancans R., Stenekes N. and Mallawaarachichi T. (2012). Drivers of practice change in land management in Australian agriculture *ABARES report to client prepared for Sustainable Resource Management Division.* Canberra.

Hameed T.S and Sawicka B. (2017). The importance of opinion leaders in agricultural extension. *The Scientific World Journal, **76**, 35-41.*

Hogg N. and Davis J. (2011). What is hindering the adoption of new annual pasture legumes? Extension requirements to overcome these barriers *Extension Farming Systems Journal,* **5**.

Howard K., Beattie L. and Graham C. (2014). Assessing the impacts of MLA's Southern Majority Market Program, Sydney Australia: Meat and Livestock Australia

Hunecke C., Engler A., Jara-Rojas, R. and Poortvliet P. M. (2016). Understanding the role of social capital in adoption decisions: An application to irrigation technology. *Agricultural Systems,* **153,** 221-231.

Kaine G., Longley S., Seymour E. and Wright V. (2013). The desire to adopt: Enhancing the psychological plausibility of adoption models *Extension Farming Systems Journal,* **9**, 10-19**.**

Kilpatrick S. and Johns S. (2003). How Farmers Learn: Different Approaches to Change. *The Journal of Agricultural Education and Extension,* **9,** 151-164.

La Grange R. F., Titterton M., Mann E. M. and Haynes C. M. (2010). Agricultural extension: a review and case study in the Tasmanian dairy farming sector. *Proceedings of the 4th Australasian Dairy Science Symposium.*

Manjala T. (2009). An extension officer's perspective on practice change. *Extension Farming Systems Journal* **5**, 119-122**.**

Meat and Livestock Australia. (2015). (March/April Edition). Focusing on performance *Feedback Magazine.* Sydney, Australia: Meat and Livestock Australia.

Meat and Livestock Australia. (2014). *Putting learning into practice* [Online]. Sydney, Australia: Meat and Livestock Australia. Available: https://www.mla.com.au/extension-training-and-tools/producer-case-studies/putting-learning-into-practice/ [Accessed 13/10 2017].

Nicholson C., Barr N., Kentish A., Dowling P., McCormick L., Palmer M., Simpson I., Simpson K. and Wash J. (2003). A research-extension model for encouraging the adoption of productive and sustainable practice in high-rainfall grazing areas. *Australian Journal of Experimental Agriculture* **43,** 685-694.

Pannell D. J., Marshall G. R., Barr N., Curtis A., Vanclay F. and Wilkinson R. (2006). Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture,* **46,** 1407-1424.

Rogers E. M. (2003). *Diffusion of Innovations,* New York, The Free Press.

Ryan E. W., Day L., Evans M. and Gartmann A. (2004). Evaluation and practice change: a private and public-sector collaboration.

Sarker M. A., Itohara Y. and Hoque M. (2009). Determinants of adoption decisions: The case of organic farming (OF) in Bangladesh. *Extension Farming Systems Journal,* **5**, 39-46.

Sewell A. M., Hartnett M. K., Gray D. I., Blair H. T., Kemp P. D., Kenyon P. R., Morris S. T. and Wood B. A. (2017). Using educational theory and research to refine agricultural extension: affordances and barriers for farmers' learning and practice change *Journal of Agricultural Education and Extension*.

Sherriff L., Doonan B. and Davey L. (2016). Profitable Grazing Systems - MLA's Extension and Adoption Pilot Project Final Report. Meat and Livestock Australia, Sydney, Australia.

Sherriff L. and Doonan B. (2017). Profitable Grazing Systems – review of pilot supported learning projects. Meat and Livestock Australia, Sydney, Australia.

Turner L., Wilkinson R. and Kilpatrick S. (2017). Boundaries to change: insights into the change process of beef and sheep farmers. *Rural Extension and Innovation Systems Journal,* **13**, 9-18.

Vanclay F. (2004). Social principles for agricultural extension to assist in the promotion of natural resource management. *Australian Journal of Experimental Agriculture,* **44,** 213-222.

van den Ban A. W. and Hawkins H. S. (1996). *Agricultural Extension,* Victoria, Australia Blackwell Science.

Wilkinson R. (2011). The Many Meanings of Adoption. *In:* Pannell D. and Vanclay F. (eds.) *Changing Land Management: Adoption of New Practices by Rural Landholders.* Victoria, Australia: CSIRO Publishing.