Using the Theory of Planned Behaviour framework to understand Tasmanian farmer decision making and adoption of pasture management practices to inform future extension

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Abstract: *Improved pasture management and subsequent increase in pasture production are positively associated with dairy farm efficiency and profitability in temperate climates. Supporting dairy farmers in developing pasture management knowledge and skills has therefore been a key priority for research, development and public extension in the Tasmanian dairy industry, in southern Australia. The role of extension has been to increase farmer awareness and knowledge of best practice pasture management and to facilitate farmer learning, with a focus on training farmers to use pasture measurement tools. Despite focused extension efforts, there remains a large proportion of farmers who have either not engaged in extension activities, or do not implement the recommended approach of measuring and monitoring pastures. To further understand farmer decision making, this study obtained qualitative data through semi-structured interviews with thirty Tasmanian dairy farmers. The Theory of Planned Behaviour (TPB) framework was used to identify and explore the key factors influencing farmer intentions and behaviour around engagement and adoption. There was a strong negative effect of social influence around the use of pasture measurement tools by experienced farmers. This negative influence limited their intention to measure pasture and engage in the learning process required to overcome perceived control factors and change practices. Perceived control factors limiting behaviour change included tool data inaccuracy and challenging calculations associated with recommended management practices. This study provides valuable insights into the adoption behaviours of farmer sub-groups in the Tasmanian dairy industry, and demonstrates use of the TPB framework to guide future development of extension content and delivery.*

Keywords: *adoption, dairy farmers, decision making, engagement, extension, pasture management, Theory of Planned Behaviour*

Introduction

Tasmanian Context

The Tasmanian dairy industry in southern Australia is a primarily pasture-based system, with pastures typically composed of perennial ryegrasses or a perennial ryegrass and clover mix. Tasmania's temperate climate, relatively reliable rainfall and fertile soils support highly productive and persistent perennial ryegrass pastures, when they are well managed (French et al. 2015; Tasmanian Institute of Agriculture 2017). Pasture based systems form a key component in supporting the economically sustainable and competitive nature of dairy production in Tasmania. Pasture is invaluable as a farm resource, as it is the cheapest available feed source that is suitable for meeting the majority of a dairy cows nutritional requirements (Rawnsley et al. 2012; Chapman et al. 2009). However, dairy farmers are continually faced with the challenges of fluctuations in milk price, rising costs and seasonal conditions, which place a great emphasis on the importance of improving farm efficiencies. In order to address these challenges, Farina et al. (2013) suggested that increased production

and consumption of forages produced on-farm will be critical to future growth within the dairy industry. This emphasises the findings of Rawnsley et al. (2012), stating that in an economic environment where production costs increase faster than commodity prices, there is a need to enhance pasture consumption and production to maintain efficiencies within the Tasmanian dairy industry.

Improved pasture management and the subsequent increase in pasture production are positively associated with dairy farm efficiency and profitability in temperate climates (Dillon et al. 2005; Lane 2014). French et al. (2015) stated that, 'if profitability of grazing systems is driven by the degree of grass utilisation, which is in turn a function of both increased growth and optimum consumption of that growth, the accurate and timely measurement of pasture is integral to effecting grazing management practice'. Consequently, a key focus of research, development and extension (RD&E) within the Tasmanian dairy industry has been to increase the awareness, knowledge, and implementation of pasture management principles and practices in order to improve the consumption of home-grown pasture by dairy cows. The aim of extension has been to assist farmers in increasing their skills and ability in pasture management in order to achieve a higher level of pasture consumption (Mann 2006; Irvine 2013).

Using tools such as a rising plate meter or CDAX bike reader can assist in increasing farmer knowledge, skills and confidence by providing objective information about pasture quantity that is available to allocate to dairy cows, gives increased control and flexibility around pasture management decisions, subsequently increasing pasture consumption and productivity (Turner & Irvine 2017; O'Donovan et al. 2002). As farmers learn about the biological principles underlying recommended practices, using pasture measurement tools can train their eye to visually assess pasture growth and quantity with increased accuracy (Stockdale 1984; Scrivner et al. 1986). As these skills are developed and combined with experience and existing farm knowledge, the need to continue using the pasture measurement tool may decrease (Turner & Irvine 2017).

Despite focused RD&E efforts on pasture management practices, average pasture consumption on Australian and Tasmanian dairy farms is still well below potential (Dairy Australia 2015; Tasmanian Institute of Agriculture 2017). There remains an under-utilised, diverse range in on-farm pasture consumption, and adoption and implementation of pasture management principles. There exists large variation in the uptake of tools that have been developed to assist farmers in managing and improving pasture consumption, in addition to variation in farmer engagement with extension activities.

Adoption is increasingly being viewed as a social process, in which adoption behaviour is influenced by social factors such as characteristics of the individual making the decisions, and their social networks (Pannell 2006; Fujisaka 1994). The adoption of new innovations and technology in agriculture has been an area of significant study (Marsh et al. 1995). These studies have focused on answering questions around what determined whether or not an innovation is adopted, characteristics of adopters versus non-adopters, and, if adoption occurs, what determines diffusion of the innovation through a population (Ghadim & Pannell 1999; Marsh et al. 1995). In this context, technology adoption is the implementation of knowledge into practice, and can involve a number of stages with a range of factors that can influence adoption and implementation of practices.

There are a number of models that have been used as a basis for predicting adoption, and typically outline the process or stages of decision making an individual goes through when it comes to adoption. A number of models, such as the technology transfer model, consumer behaviour theory, and diffusion of innovations, have been proposed to assist in explaining and predicting adoption behaviour, with shortfalls found in every approach. According to the well-known diffusion of innovations theory, once innovators and early adopters change practices, diffusion (involving naturally occurring knowledge transfer) will occur leading to widespread adoption by the remaining farmer segments. However, farmer to farmer diffusion and adoption is limited when the innovation involves knowledge intensive practices (as is the

case for pasture measurement tools and management practices), as they require more work, support and understanding in order to be adopted and used effectively (Ingram 2008).

Results of a previous study suggested that two factors limiting use of pasture measurement tools by Tasmanian dairy farmers were not having the time available, and a hesitation to trial new practices (Craigie 2013). Ghadim and Pannell (1999) also identified risk as a major factor reducing the rate of adoption of a new innovation or practice, with risk aversion generally having a negative influence on the rate of adoption of innovations and new technologies, given the usual uncertainty that comes with innovation before they have been trialled. However, many of the recommended pasture management tools and associated practices are not new to dairy farmers. The plate meter for example, is the pasture measurement tool owned by 59% of Tasmanian dairy farmers (Hall et al. 2017), and it was first available for purchase in Tasmania in 1980's. Despite its successful implementation by some dairy farmers, anecdotal evidence suggests that adoption and adaption remain low among a significant proportion of the Tasmanian dairy farmer population. Therefore, the decision making processes around technology and practice adoption is not as straightforward as simply reducing perceived risk through demonstration, and/or waiting for natural diffusion of knowledge and skills between farmers.

To understand why widespread adoption is not occurring, RD&E providers need a greater understanding of why many farmers are not implementing known and proven practices, and particularly the social factors that surround such decision making. This understanding is required to continue developing extension marketing, content and delivery to meet farmer needs and improve adoption and adaption of pasture management recommendations known to increase pasture productivity.

Theoretical Framework

This qualitative study draws on the Theory of Planned Behaviour (TPB) and its constructs to explore in greater depth why adoption and non-adoption are occurring and what factors are playing a role in influencing the process of adoption. The factors that impact farmer engagement with extension activities are also explored.

The TPB was designed to predict and explain human behaviour in specific contexts, and examines the relationship between an individual's attitudes (beliefs, intentions and behaviours) and their actions (Ajzen 1991). The TPB considers that intentions to behave in a particular way (in this case, the intention to implement recommended pasture management tools and practices) is guided through three main areas. The first is the degree to which the outcome of a behaviour is believed to be mainly positive or negative (attitude); the second is the negative or positive influence of the social pressure, and perceived role of significant others, associated with the new behaviour (subjective norms, or social influences); and the third is the perceived capability of an individual to perform the behaviour (perceived control) (Ajzen 1991). While attitudes, social influence and perceived control factors may interact to influence intentions positively, actual control factors that are outside the person's control also act to support or limit the subsequent behaviour change (Ajzen 1991).

This theory has been used extensively to understand the context of decision making and identify the motivational factors involved in a range of disciplines. These include health (Barberia et al. 2008; Bränström et al. 2004; Conner et al. 2003); marketing and consumer behaviour (Arvola et al. 2008; Lobb et al. 2007); and agriculture, natural resource management and conservation (Bond et al. 2009; Fielding et al. 2005; Trumbo et al. 2001; Beedell & Rehman 1999). There is increasing acknowledgement in agricultural literature that an individual's behaviour is connected to their attitudes and beliefs towards that behaviour (Blackwell et al. 2006; Guerin & Guerin 1994; Vanclay & Lawrence 1994). Bond et al. (2009) found that attitudes, in addition to social pressure and perceived control, were able to explain to an extent farmers' use of pesticides. Bond et al. (2009) went on to find that it was beliefs about the role of pesticides that accounted for the majority of the variation in behavioural intention. Improving knowledge about practices and how to perform a behaviour can alter

farmers attitude and subsequent behaviour, which is a key element in achieving adoption (Bond et al. 2009; Kaiser et al. 1999).

The majority of previous studies employ a quantitative approach using the TPB model (Bond et al. 2009; Arvola et al. 2008; Lobb et al. 2007; Fielding et al. 2005; Trumbo et al. 2001), with few published studies using qualitative research methods (Renzi & Klobas 2008). Studies using the TPB typically predict factors likely to affect behaviour associated with attitudes towards the behaviour, social influences, and perceived control over performing the behaviour. While such studies are concerned with identifying factors likely to influence behaviour, they do not explore in detail how and why these factors influence the decision making associated with intentions and practice change. In light of the complexity associated with adoption decision making, it is important to develop a more in-depth understanding of how these social factors interact to influence farmer behaviour. How and why these social factors interact to influence farmer behaviour, in terms of the decision making process and adoption of pasture management practices and recommendations in the Tasmanian dairy industry, was explored through in-depth interviews with farmers. The constructs of the TPB were used to identify how extension providers can address the attitudes, social influences and perceived control factors that limit farmers using pasture measurement tools and acquiring the knowledge and skills required to improve pasture consumption in the Tasmanian dairy industry.

Research Aims and Methods

The current qualitative study drew directly on findings of a recent survey that identified current use of pasture measurement tools by Tasmanian dairy farmers, and their engagement with extension activities. The paper based, quantitative survey was mailed to all 440 dairy farmers in Tasmania, with a return rate of 38%. The findings from this study are reported in Hall et al. (2017). The current study involved semi-structured interviews with a sub selection of survey participants, to further discuss pasture management (currently and in the past), sources of information and learning, factors influencing decision making around the adoption and implementation of pasture management practices, in addition to factors influencing engagement with extension activities.

Interview questions were further developed within the constructs of the TPB to explore the factors influencing intention to adopt pasture measurement and management practices, and subsequent changes in farmer behaviour. To explore farmer attitudes towards pasture management and extension, participants were asked about the advantages and disadvantages of using a tool to measure pasture, in addition to advantages and disadvantages of attending extension activities. Questions were aligned with perceived control factors by focusing on what made it more easy or difficult to implement recommendations, or encouraged or discouraged farmers from measuring pasture or attend extension activities. Social influences were identified by asking questions about the role of people and institutions (family, other farmers, industry bodies and experts) in their decision making around measuring pasture or attending extension activities.

Some participants in the preceding survey voluntarily provided their contact details, along with permission to be contacted by telephone and/or email about participating in follow-up interviews. These farmers were categorised into three sub-groups relating to their responses to key questions, with the aim to recruit equal numbers of farmers within each sub-group for interviews. The sub-groups were characterised by farmer engagement with extension activities and their extent of using measurement tools in pasture management (Table 1).

Table 1. Interview sub-groups and their characteristics

Sub-groups	No. farmers surveyed	No. farmers interviewed	Engaged in extension	Tool trialled	Tool used intensively	Tool used currently	Intention to adopt	Practice change observed

	providing contact details							
Unengaged	11	8	✗	✗(3) ✓(5)	✗	✗	✗	✗
Triallers	14	12	✓	✓	✗	✗	✓	✗
Adapters	38	10						
Temporary intensive users	*6*	*5*	✓	✓	✓	✗	✓	✓
Continued intensive users	*32*	*5*	✓	✓	✓	✓	✓	✓

Interview respondents for each sub-group were randomly ordered in Excel and contacted by the interviewer to confirm further participation and organise when and where to meet. Thirty one-on-one interviews took place face-to-face over a three-month period, conducted by one interviewer. Interviews were approximately 60-90 minutes in duration, and followed the same interview structure, including 'prompts' to elicit fuller responses from participants when required. The qualitative approach allowing for in depth discussion and freedom in exploring details brought up by the participant in relation to the questions asked. All interviews were digitally audio-recorded with the participants' permission, and transcribed verbatim into word documents.

Qualitative Data Analysis

Coding and analysis of the interviews was performed using NVivo 11, a Computer-Assisted Qualitative Data Analysis Software (CAQDAS). Two main activities were initially conducted in NVivo: set up of the node tree, and preparation of a coding framework, based on the literature reviewed for the study. A node in NVivo is an object that represents an idea, theory of characteristics association with data contained in a document. Nodes are linked in a hierarchical way to form a node tree. Initially, nodes were established that followed the structure of the interview guide, and then further broken into categories under each of the interview segments. The first four interviews were coded in this manner and discussed with the research team, before the remaining 26 interviews were coded. As the nodes reflected elements included in the interview schedule in addition to the TPB, most coding involved identification of sections of text that referred to these elements, and coding under the respective nodes. A response or section of text may refer to one or several elements or concepts. While the coder was alert for additional themes or codes that may have emerged from the data, none were apparent. Word frequency and search functions of NVivo were then used to identify common responses and themes within the participants' responses.

The focus of this paper is on the two groups of Triallers and Adapters, as these form the sub-groups who engage with extension activities, have measured pasture on a non-intensive or intensive basis in the past but have discontinued, and current users. These groups form the focus of this paper in order to understand in more depth what has driven the initial intention to measure pasture, and what factors have influenced subsequent decisions around practice change (adoption and non-adoption). The Unengaged sub-group, though important in the broader context of this study, are not focused on in this paper. The majority of the Unengaged sub-group have not embarked on the pasture management learning process, and have not performed the behaviour or undergone the decision making process that forms the key area of interest for this paper.

Results and Discussion

Theory of Planned Behaviour

Farmers in this study were categorised based on their past use of a tool, which identified the extent of previous use. Trialling was classed as only testing or trying out a tool on a once-off or very short term basis, and non-intensive use was use by farmers who had used a tool to measure on a regular basis (weekly to fortnightly) for a period of six months or less, or only at certain times of the year. Intensive use was use by farmers who had measured on a regular basis for an extended period, being six months or longer. The Triallers included farmers who have trialled a tool, or used a tool non-intensively, indicating an intention to adopt but not the continued use required to signify practice change. In comparison, Adapters have used a tool on an intensive basis, and some have continued using a pasture measurement tool. Using a tool to measure pasture for an extended period of time indicates the Adapters have changed their behaviour so that pasture management now involves a more quantitative decision making approach, whether they currently measure (continued intensive users) or not (temporary intensive users).

Some of the Adapters sub-group have discontinued using a pasture measurement tool, having been through an intensive period of measuring and monitoring previously. With many farming recommendations, there exists opportunity for farmers to adapt technology and practices to their own needs (Flor et al. 2016; Byerlee 1987). This requires a high level of understanding of the technology and/or practice, a wide range of additional information, and an improvement of farmers' technical and managerial skills (Byerlee 1987). Such a level of understanding of pasture measurement tools and associated practices is only likely to come from farmers who have been through an intensive period of using a tool to measure pasture, learning about how the tool works, what information it can provide, and how this can be implemented in practice on-farm. For the Adapters who have discontinued using a pasture measurement tool, they have been through a sufficient period of measuring that they have been able to adapt the principles learnt to their situation, through merging existing knowledge and experience with new knowledge (Flor et al. 2016) that has been learnt through an intensive period of measuring.

Attitudes towards pasture management

A large proportion of farmers identified that there are definite advantages and benefits of using a tool to measure pasture. There were a number of farmers in the Triallers sub-group who noted that measuring pasture is the best way to learn how to visually assess the quantity of pasture available in a paddock, or learning how to 'get your eye in'. In addition, using a tool to measure pasture was noted as a good way to build confidence in decision making around pasture management. The belief that behaviour, in this case using a tool to measure pasture, has positive benefits for farmers is important in influencing and motivating behaviour change and adoption (Fielding et al. 2005). Farmers in both the Triallers and Adapters sub-groups identified the benefits of using a tool to measure pasture, indicating that this is a factor likely to influence initial tool use. Farmers in the Triallers sub-group have not continued using a tool to measure pasture for an extended period of time, suggesting that though they believe and recognise there is benefit in measuring pasture, additional factors have played a role in influencing this intention not progressing into changed behaviour.

Case study research by Turner and Irvine (2017) suggest that farmer confidence increases through the use of pasture measurement tools for an extended period of time, in part due to the role of tools in the pasture management learning process. Using a tool to measure pasture is a quick and effective way of providing farmers with objective, quantitative data from which they can make decisions on pasture management, that has a greater level of accuracy than visual assessment (O'Donovan et al. 2002; Scrivner et al. 1986; Stockdale 1984). Dairy farmers have been shown to alternate between using such quantitative

approaches, and more informal, experienced based approaches (Gray 2001; Öhlmér et al. 1998). Often, farmers may use a quantitative approach such as measuring with a tool, as a means of self-validation (Eastwood & Kenny 2009). Extended use of pasture measurement tools through such a learning process provides the opportunity for farmers to make connections between evidence based ideas and their own experiences, which is key to supporting farmer learning and adoption (Sewell et al. 2014).

Farmers in the Adapters sub-group, have developed their knowledge and ability to visually assess pasture with increased accuracy, which has been developed through an intensive period of measuring. Farmers in the Triallers sub-group are also largely relying on visual assessment of pasture, with many feeling they have validated this through a short period of measuring. However, these farmers have not continued through the pasture management learning process, with an intensive period of measuring pasture using a tool. They are therefore unlikely to have developed their skills to visually assess pasture with a greater level of accuracy as what could possibly be achieved, and are therefore not aware of the additional benefits of increased accuracy in pasture assessment.

The Adapters who continue to measure report that they see value in doing so as they are able to plan ahead and budget, such as forward planning feed surpluses and deficits and making management decisions earlier. While this positive attitude towards measuring pasture was also noted responses from farmers in the Triallers sub-group who have discontinued measuring, those who continue to measure for an extended period of time received additional value compared with those who have only measured for a short period. These farmers are not aware they are missing out on the added value and could be referred to as being 'unconsciously incompetent' (Howell 1982). When individuals are unconsciously incompetent, they are unaware they are not performing, or are unable to perform, an activity (in this case, pasture management); do not recognise there is a deficit in their management, or see the usefulness or value in improving that skill (measuring pasture for improved management) (Howell 1982).

Although the Triallers have a positive attitude towards measuring pasture, it is not enough to motivate them to return to this practice as they believe that they have sufficient knowledge and practice in this area and so do not need the extra information. Other common themes among participants were the importance of understanding how pasture grows, the importance of pasture in the farming system and understanding how to allocate pasture and feed to cows. This indicates that the importance of measuring and monitoring pasture in the pasture management learning process, and the benefits of doing so, are recognised, but this has not necessarily led to adoption to the fullest extent to maximise benefits. This suggests that though farmers in the Triallers and Adapters sub-groups believe there to be benefits of measuring pasture, which has likely played a role in initial use of pasture measurement tools, additional factors have played a role in influencing the decision to continue measuring. For those farmers in the Triallers sub-group that have started but not continued measuring pasture, it is likely that additional factors such as beliefs about social influences and norms, and control beliefs about whether they can perform the behaviour, are influencing their decision making and adoption behaviour.

Social Influences

A common theme emerging from the interviews was the belief, particularly in the Triallers sub-group, that younger and less experienced farmers require pasture management training, but not older or more experienced farmers. This negative social pressure discourages more experienced farmers from participating in pasture management training, even if farmers do not openly recognise this. This is supported by the Triallers consistently noting the advantages and benefits of using a tool to measure pasture for young farmers or those new to the industry. The Triallers see the value this offers to less experienced, new or young farmers, but do not see that measuring offers further value to them personally. The Triallers

see themselves as experienced farmers, who have 'been there and done that', and therefore the current pasture management training and courses are applicable to young farmers or those new to the industry rather than skills that could benefit all levels and abilities. This was further emphasised by a number of farmers who do not currently measure pasture, noting it was an activity they would revisit only if they were training a new or young person on the farm. This negative social influence on intentions to measure pasture is reflected in the findings of Craigie (2013), who found in a previous study of Tasmanian dairy farmers that younger farmers were more likely to use a tool to measure pasture and implement best practice management recommendations.

The theme of age and experience was also mentioned in relation to engagement with extension activities. Several farmers indicated that they do not value attending extension activities, but participate to help young or less experienced farmers. This indicates that there is the perception that extension activities, particularly those with a focus on pasture management, are targeted and designed for younger and less experienced farmers, and not designed for those who consider themselves to be more experienced. Variation in adoption and the use of new technologies on farms has been attributed in part to a lack of support structures and programs (Eastwood et al. 2017; Eastwood et al. 2012; Douthwaite et al. 2001). Extension has the ability to play a role in supporting and facilitating the process of adoption of knowledge intensive processes, but requires a focus on the social influences impacting farmer decision making to engage with extension, and the creation of social acceptance of behaviour (Klerkx et al. 2010).

Other farmers and consultants play a role in influencing adoption of tools to measure pasture, through social status and reputation, and being deemed knowledgeable or an expert. The intention of the majority of Triallers to measure pasture was initially influenced by other farmers or consultants, and from attending farmer discussion groups. Despite being encouraged initially to measure pasture and not continuing, many also mentioned that they are no longer influenced by what other farmers do in terms of their pasture management. This is an attitude that is likely to increase with farmer age and experience, and is consistent with the thought pattern that measuring pasture quantitatively with a tool is an activity for young farmers or those new to the industry. Encouraging farmers in the Triallers sub-group to return to measuring pasture through demonstration of what others are doing, is therefore likely to have limited impact.

Perceived Control

Focus groups conducted previously within the Tasmanian dairy industry to determine farmer attitudes towards pasture management led to the suggestion that one of the factors limiting use of pasture measurement tools by dairy farmers was not having the time available (Craigie 2013). In comparison, the majority of farmers in this study did not discuss time as a major factor limiting the use of pasture measurement tools. Of the Triallers and Adapters, only three farmers discussed limited time as a factor contributing to not measuring pasture, in combination with the physical effort required to do so. A further two farmers, one each from the Triallers and Adapters, noted the effort required as a factor that could impact on measuring pasture, but both had adapted best practice recommendations. Their adaptations involved dividing the number of paddocks to measure between two people, or measuring a smaller number of paddocks to give a more general approximation of pasture quantity.

Six Triallers identified a lack of accuracy of tools to measure pasture as a reason they discontinued measuring pasture. These farmers intended to change practices (as evidenced by their acquisition of a tool and initial use) but encountered difficulties when the tool did not perform as expected. While plate meters are not completely accurate, the additional operational difficulties they encountered may have been overcome with continued support from ongoing extension sessions or consultancy advice, until they could use the tool confidently and effectively. It is likely that the Triallers initially believed that they could use

pasture measurement tools successfully after engaging briefly in extension activities (e.g. a 2-day course), but the challenges associated with using the pasture measurement tool acted to reduce their perceived control, and therefore constrained practice change. Singular or one-off extension sessions can create awareness about improving pasture management, and influence intentions to change practices, but are unlikely to support farmers developing the sufficient knowledge and skills needed to measure and manage pasture well. In contrast, ongoing support and training allow farmers to increase their perceived control, as questions are asked and problems solved together over time (Turner & Irvine 2017).

Some Adapters who currently measure pasture also discussed plate meter inaccuracy, particularly as a negative factor influencing others' intentions to measure pastures, but had continued to measure themselves. Farmers in the Adapters sub-group have been through an intensive learning period involving measuring, with ongoing support from a consultant or coach. Unlike the Triallers, the extended use and ongoing support experience by the Adapters developed their knowledge, skills and ability to use pasture measurement tools, and address and overcome any challenges or difficulties experienced. The Adapters were then able to experience to a greater extent the benefits and value of using pasture measurement tools. These results further support the idea of a supported pasture management learning process requiring an extended period of measuring to receive the greatest benefit and value.

A study by Eastwood and Kenny (2009) highlighted the importance of perception of accuracy in pasture measurement data in decision making, highlighting the importance of certainty and consistency in farmer trust concerning data. Eastwood and Kenny (2009) went on to find that a low level of trust results in a preference of farmers to use their own visual assessments over data gathered using a more objective method. Consistent support and training over time assists farmers in using a tool to measure pasture with increased accuracy, with support provided to apply new knowledge and learning on an individual farm basis in order for farmers to continue through the process from intention to practice change. Further education may be necessary in how tools for measuring pasture and the subsequent information can be used to reduce error, particularly for those who have not continued along the pasture management learning process or who discontinued due to inaccuracies or uncertainty.

Three farmers in the Triallers group stated that the work associated with applying pasture measurement information negatively affected their intention to measure pasture. Their inability or disinterest in the range of calculations required to apply pasture measurement data was therefore a negative perceived control factor influencing their behaviour. Ronan and Cleary (2000) report that data alone is not sufficient to achieve practice change; data must be combined with knowledge and skill in order to draw meaning from the information so that can be applied in practical management. For farmers with lower levels of literacy, undertaking the calculations associated with pasture management recommendations is particularly challenging, regardless of their positive attitude or intention to measure pasture. This finding indicates the potential for future extension content to be developed to meet the needs of farmers who may not have the ability or desire to conduct calculations and use figures within the current pasture management recommendations.

Actual Control

Actual control factors are those factors outside an individual's control that can impact the ability to perform a behaviour, for example if they are not in charge of decision making. There was no indication from the farmers interviewed that there were actual control factors playing a role in the use of pasture measurement tools and implementation of pasture management practices. Using a tool to measure pasture involves little financial input or infrastructure development, but focuses on improving existing practices and efficiency through knowledge, skill development and implementation. As those who were interviewed were predominantly in roles where they were responsible for pasture management, they had the ability to make

changes and implement new, recommended practices. Regardless of the intention to implement pasture management practices, practice change may be limited for those farmers who were not in a management role on farm, if the support to do so did not exist, or they were not in charge of the pasture management decision making.

Conclusions and Recommendations

Using TPB constructs, this study has highlighted factors influencing the intentions of Tasmanian dairy farmers to implement pasture measuring and management recommendations, as well as the factors supporting or limiting subsequent practice change.

Attitudes towards pasture measurement were consistently positive across the farmer sub-groups. Whether farmers were measuring pasture and implementing the associated recommended pasture management practices or not, they discussed the wide-ranging benefits of measuring pasture. These include the ability to forward plan feed surpluses and deficits, increased confidence in pasture management and decision making, being able to make management decisions earlier, learning how to visually assess pasture quantity, assisting farmers new to the industry when initially learning about pasture management, and for training staff. However, only farmers who had been supported through an intensive period of using a pasture measurement tool and learning the underlying pasture management principles, had progressed from a positive intention to improve pasture management, to practice change (the Adapters).

The Triallers initially intended to measure pasture, but many discontinued when they experienced negative perceived control factors. These factors included perceived inaccuracies in plate meter measurements, and challenging calculations and interpretation of measurement data that form an important part of recommended practices. In addition, there was a strong perception that there is a reduced need for measuring pasture and attending extension activities for experienced farmers. This negative social norm limited the use of pasture measurement tools by experienced Triallers farmers, and the re-engagement of Triallers with extension activities that could support them in continuing the pasture management learning process.

Specific targeting and marketing of extension activities to more experienced farmers, such as those in the Triallers group, is required if they are to experience the additional benefits and value from re-engaging in an extended pasture management learning process involving additional measuring, ongoing support and training. There is a need for these benefits, such as feed planning, budgeting and improved accuracy in the ability to visually assess pasture, to be demonstrated and communicated in a practical way that builds on existing farmer knowledge and experience. This would require ongoing support and training on farm, and may require removing some of the focus on calculations for those who are discouraged by the effort or literacy required.

Successful adoption and practice change will require a change in the way we approach and think about extension, requiring a greater understanding of farmer sub-groups and the social factors that impact on farmer decision making within these groups. Understanding the factors that impact or limit the use of pasture measurement tools on farm is needed to design extension programs targeted towards particular sub-groups of farmers who are motivated by different sets of beliefs and social influences. Specific design and targeting of extension activities to address these social influences, combined with the provision of ongoing support and training, are likely to have a great impact in leading to practice change and an improvement with pasture management and productivity on farm.

References

Ajzen, I. (1991) The theory of planned behavior. *Organizational behavior and human decision processes* 50(2): 179-211.

Arvola, A., Vassallo, M., Dean, M., Lampila, P., Saba, A., Lähteenmäki, L. & Shepherd, R. (2008) Predicting intentions to purchase organic food: The role of affective and moral attitudes in the Theory of Planned Behaviour. *Appetite* 50(2): 443-454.

Barberia, A.M., Attree, M. & Todd, C. (2008) Understanding eating behaviours in Spanish women enrolled in a weight-loss treatment. *Journal of Clinical Nursing* 17(7): 957-966.

Beedell, J. & Rehman, T. (1999) Explaining farmers' conservation behaviour: Why do farmers behave the way they do? *Journal of Environmental management* 57(3): 165-176.

Blackwell, R.D., Paul, W. & James, F.E. (2006) Attributes of Attitudes. *Consumer Behavior* 235-243.

Bond, J., Kriesemer, S., Emborg, J. & Chadha, M. (2009) Understanding farmers' pesticide use in Jharkhand India. *Extension Farming Systems Journal* 5(1): 53.

Bränström, R., Ullen, H. & Brandberg, Y. (2004) Attitudes, subjective norms and perception of behavioural control as predictors of sun-related behaviour in Swedish adults. *Preventive medicine* 39(5): 992-999.

Byerlee, D. (1987) From adaptive research to farmer recommendations and extension advice. *Agricultural administration and extension* 27(4): 231-244.

Chapman, D.F., Cullen, B.R., Johnson, I.R. & Beca, D. (2009) Interannual variation in pasture growth rate in Australian and New Zealand dairy regions and its consequences for system management. *Animal Production Science* 49(12): 1071-1079.

Conner, M., Smith, N. & McMillan, B. (2003) Examining normative pressure in the theory of planned behaviour: Impact of gender and passengers on intentions to break the speed limit. *Current Psychology* 22(3): 252-263.

Craigie, A. 2013, *Dairy Pasture Management in Tasmania*, Honours thesis, University of Tasmania.

Dairy Australia 2015, *Dairy Moving Forward*, Dairy Australia

Available from: <http://www.dairyaustralia.com.au/~/media/Documents/Levy%20investment/Dairy%20Moving%20Forward/DMF%20Strategy%20Refresh%20Final.pdf>.

Dillon, P., Roche, J., Shalloo, L. & Horan, B. (2005) Optimising financial return from grazing in temperate pastures. *Utilisation of grazed grass in temperate animal systems (ed. JJ Murphy)* 131-147.

Douthwaite, B., Keatinge, J.D.H. & Park, J.R. (2001) Why promising technologies fail: the neglected role of user innovation during adoption. *Research Policy* 30(5): 819-836.

Eastwood, C. & Kenny, S. (2009) Art or science? Heuristic versus data driven grazing management on dairy farms. *Extension farming systems journal* 5(1): 95-102.

Eastwood, C., Klerkx, L. & Nettle, R. (2017) Dynamics and distribution of public and private research and extension roles for technological innovation and diffusion: Case studies of the implementation and adaptation of precision farming technologies. *Journal of Rural Studies* 49(1-12.

Eastwood, C.R., Chapman, D.F. & Paine, M.S. (2012) Networks of practice for co-construction of agricultural decision support systems: Case studies of precision dairy farms in Australia. *Agricultural Systems* 108(10-18.

Farina, S.R., Alford, A., Garcia, S.C. & Fulkerson, W.J. (2013) An integrated assessment of business risk for pasture-based dairy farm systems intensification. *Agricultural Systems* 115(10-20.

Fielding, K.S., Terry, D.J., Masser, B.M., Bordia, P. & Hogg, M.A. (2005) Explaining landholders' decisions about riparian zone management: The role of behavioural, normative, and control beliefs. *Journal of environmental management* 77(1): 12-21.

Flor, R.J., Singleton, G., Casimero, M., Abidin, Z., Razak, N., Maat, H. & Leeuwis, C. (2016) Farmers, institutions and technology in agricultural change processes: outcomes from Adaptive Research on rice production in Sulawesi, Indonesia. *International journal of agricultural sustainability* 14(2): 166-186.

French, P., O'Brien, B. & Shalloo, L. (2015) Development and adoption of new technologies to increase the efficiency and sustainability of pasture-based systems. *Animal Production Science* 55(7): 931-935.

Fujisaka, S. (1994) Learning from six reasons why farmers do not adopt innovations intended to improve sustainability of upland agriculture. *Agricultural Systems* 46(4): 409-425.

Ghadim, A.K., A. & Pannell, D.J. (1999) A conceptual framework of adoption of an agricultural innovation. *Agricultural Economics* 21(145-154.

Gray, D.I. (2001) The tactical management processes used by pastoral-based dairy farmers: a multiple-case study of experts: a thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Farm Management at Massey University.

Guerin, L. & Guerin, T. (1994) Constraints to the adoption of innovations in agricultural research and environmental management: a review. *Animal Production Science* 34(4): 549-571.

Hall, A., Turner, L., Irvine, L. & Kilpatrick, S. (2017) Pasture management and extension on Tasmanian dairy farms-who measures up? *Rural Extension and Innovation Systems Journal* 13(2): 32.

Howell, W.S. 1982, *The empathic communicator*, Wadsworth Pub Co.

Ingram, J. (2008) Agronomist–farmer knowledge encounters: an analysis of knowledge exchange in the context of best management practices in England. *Agriculture and Human Values* 25(3): 405-418.

Irvine, L. (2013) Dairy smart-profitable, resilient and sustainable dairy farmers who possess the skills and information to grow the Tasmanian dairy industry.

Kaiser, F.G., Ranney, M., Hartig, T. & Bowler, P.A. (1999) Ecological behavior, environmental attitude, and feelings of responsibility for the environment. *European psychologist* 4(2): 59.

Klerkx, L., Aarts, N. & Leeuwis, C. (2010) Adaptive management in agricultural innovation systems: The interactions between innovation networks and their environment. *Agricultural systems* 103(6): 390-400.

Lane, N. (2014) '*Pathways to successful farm businesses*', in Australian Dairy Farm Investment Forum

Lobb, A., Mazzocchi, M. & Traill, W. (2007) Modelling risk perception and trust in food safety information within the theory of planned behaviour. *Food Quality and Preference* 18(2): 384-395.

Mann, E. 2006, *20/12 Pasture Business Project Final Report*, Department Primary Industries and Water.

Marsh, S.P., Pannell, D.J. & Lindner, R.K. (1995) '*The adoption of lupins in Western Australia: did extension make a difference*', in 39th Annual Conference of the Australian Agricultural Economics Society, University of Western Australia, February.

O'Donovan, M., Connolly, I., Dillon, P., Rath, M. & Stakelum, G. (2002) Visual assessment of herbage mass. *Irish Journal of Agricultural and Food Research* 41(2): 201-211.

Öhlmér, B., Olson, K. & Brehmer, B. (1998) Understanding farmers' decision making processes and improving managerial assistance. *Agricultural economics* 18(3): 273-290.

Pannell, D. (2006) Adoption of conservation practices by rural landholders: Implications for research and extension. *Pannell Discussions* 86(

Rawnsley, R.P., Chapman, D.F., Jacobs, J.L., Garcia, S.C., Callow, M.N., Edwards, G.R. & Pembleton, K.P. 2012, *Complementary Forages - integration at a whole farm level*, Australasian Dairy Science Symposium, Tallygaroopna, Australia.

Renzi, S. & Klobas, J. (2008) Using the theory of planned behavior with qualitative research. *Dondena Working Paper* 12).

Ronan, G. & Cleary, G. (2000) Best practice benchmarking in Australian agriculture: issues and challenges. *Agribusiness Perspectives–Paper* 39(

Scrivner, J.H., Center, D.M. & Jones, M.B. (1986) A rising plate meter for estimating production and utilization. *Journal of Range Management* 39(5): 475-477.

Sewell, A.M., Gray, D.I., Blair, H.T., Kemp, P.D., Kenyon, P.R., Morris, S.T. & Wood, B.A. (2014) Hatching new ideas about herb pastures: Learning together in a community of New Zealand farmers and agricultural scientists. *Agricultural Systems* 125(63-73.

Stockdale, C. (1984) Evaluation of techniques for estimating the yield of irrigated pastures intensively grazed by dairy cows. 2. The rising plate meter. *Australian Journal of Experimental Agriculture* 24(126): 305-311.

Tasmanian Institute of Agriculture 2017, *Tasmanian Dairy Business of the Year Awards*, Burnie, Tasmania.

Trumbo, W., Garrett, J. & O'Keefe, C. (2001) Intention to conserve water: Environmental values, planned behavior, and information effects. A comparison of three communities sharing a watershed. *Society &Natural Resources* 14(10): 889-899.

Turner, L. & Irvine, L. (2017) Tasmanian dairy farmers and the pasture management process: Case study findings on the role of coaching in achieving practice change. *Rural Extension & Innovations Systems Journal* 13(1): 31-40.

Vanclay, F. & Lawrence, G. (1994) Farmer rationality and the adoption of environmentally sound practices; a critique of the assumptions of traditional agricultural extension. *European Journal of Agricultural Education and Extension* 1(1): 59-90.