Rural Extension and Innovation Systems Journal

volume	17
number	2
year	2021
issn	2204-8758

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volume 17
number 2
year 2021

ISSN: print 2204–8758
ISSN: online 2204–8766

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Foreword

Volume 17, Number 1 of the *Rural Extension and Innovations Systems Journal* contains Research and Practice papers. The Research section is for publishing outcomes of research in extension. It contains papers which have been subject to a double-blind reviewing process by two independent reviewers. These papers include research into change management, extension, development and innovation systems issues for agricultural and natural resource management that follow a rigorous and recognised disciplinary research methodology and are double-blind reviewed by Editorial Board members and selected reviewers.

Practice papers are informal, accessible articles that document successes, failures and the lessons from extension professionals' experiences. They provide an opportunity for rural advisors and extension practitioners to publish stories and case studies about extension practice, which are relevant to other field operatives, but also show the application of extension theory to practice. They are assessed and edited to ensure coherency and suitability to these goals.

The journal is managed by the Australasia-Pacific Extension Network by an Editor, three Assistant Editors (Aysha Fleming, Denise Bewsell and Morag Anderson) and 14 Editorial Board members.

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Roy Murray-Prior

Editor

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The *Rural Extension and Innovation Systems Journal* is an innovative extension publication of APEN. The journal covers extension aspects of rural systems. It is for professional extension practitioners, researchers, educators, farmers, farmer groups, corporate agribusiness managers, professional farm business consultants, extension and development officers, and postgraduate students who want to help extend the available knowledge about efficient and effective agricultural extension and development activities. Extension has many definitions but to provide guidance we will adopt that found on the Australasia Pacific Extension Network website (http://www.apen.org.au). There are four types of papers published: Research, Literature reviews, Practice, and APEN conference keynote papers.

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Research papers contain research into agricultural and natural resource change management, extension, development and innovation systems issues that follow rigorous and recognised disciplinary research methodologies. Papers will be reviewed by the Editor and double-blind reviewed by two Editorial Board members or selected reviewers. Papers for this section target professional extension practitioners, researchers and educators. They should not exceed 7500 words.

Literature reviews

Literature reviews should be academic reviews in the fields of agricultural and natural resource change management, extension, development and innovation systems issues. The paper should follow a well-defined structure and will be reviewed by the Editor and double blind-reviewed by two Editorial Board members or selected reviewers. Maximum length is 5000 words.

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Practice paper provide a forum for practitioners and academics to share their experiences and practical innovations with others in the fields of agricultural extension, farm management and natural resource management. They are informal, accessible articles that document successes, failures and lessons from extension professionals' experiences. Papers will be reviewed by the Editor and an extension professional. Maximum length is 4000 words.

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The *REIS Journal* accepts articles submitted by rural advisory and extension researchers and practitioners worldwide. However, we encourage those of you resident in Australia, New Zealand or Pacific countries to become APEN members by contacting the APEN Secretariat at info@apen.org.au. To submit a paper for publication please send an electronic copy of your paper (edited as per Instructions to Authors, which is available on the *REIS* web site) to the Editor at reiseditor@apen.org.au. There is no charge for submission or publication.

The Editor will decide whether a paper meets the criteria for acceptance and then send it out for review under the relevant guidelines. Those articles accepted after the review process will be published.

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When submitting a manuscript corresponding author will be asked to submit an *Authorship, copyright and submission declaration*, which is available from the journal web site. It affirms that:

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- Individuals who have had a significant but not major role in the writing of the paper, the project or the research are acknowledged in the Acknowledgements section.
- The manuscript contains original work of the author(s) listed and where you have included the work of others this has been fully and appropriately acknowledged.
- The work has not been published previously in a peer-reviewed journal (except as part of an academic thesis, report to funding body or working paper).
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Refereeing process

When a paper is submitted, the Editor will organise the double-blind review process to involve two experts in the field of agricultural extension. In the event of strong disagreement between two referees a third referee may be appointed.

An investigation into the use of social media for knowledge exchange by farmers and advisors

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Abstract. As social media provides the opportunity for communication and knowledge exchange among rural actors and with better access to mobile devices and broadband, its popularity has grown in the rural sector. This paper explores rural actors' knowledge exchange from a preliminary investigation of advisors and farmers' social media use in a United Kingdom pasture-based dairy farmer Facebook group with 1208 members and the Twitter activity of 48 New Zealand farmers and advisors. Results suggest that rural actors are engaging in international social media networks for knowledge exchange that supports on-farm decision making. The analysis revealed that network hotspots and opinion leaders were key to this knowledge exchange. Although not an exhaustive investigation, the research suggests that social media provides a valuable tool for rural innovation by acting as a communication platform that stimulates individual and collective learning and promotes weak ties necessary for innovation.

Keywords: Social media, knowledge exchange, rural actors

Introduction

In recent years, there has been increasing interest in how Information Communication Technologies (ICT) and internet-based applications and tools may support decision making, learning and innovation in agriculture (Shanthy & Thiagarajan 2011; Sulaiman et al. 2012; Poppe et al. 2013). However, only recently have social media and software applications (apps) been explored as channels for information exchange between rural actors (Poppe et al. 2013; Jespersen et al. 2014; Materia et al. 2014; Munthali et al. 2018; Steinke et al. 2020). Many apps have been created specifically for agricultural purposes, but as Steinke et al. (2020) note, often these fail since they do not meet user requirements.

Social media provides a platform by which individuals and communities can engage in online networks to share, co-create, discuss and modify user-generated content, which is typically media rich (Kaplan & Haenlein 2010; Piller et al. 2012). In these communities, members can construct an identity within a bounded system - which may or may not be made public, engage with other users with whom they share a connection, make visible their own connections and view other members' connections (Boyd & Ellison 2007).

While the growth in personal use of social media has been extraordinary, there is a small but growing scholarship exploring its use among farmers and rural professionals such as advisors (Kaushik et al. 2018; Munthali et al. 2018; Nain et al. 2019). Research has explored farmers and other rural actors use of social media platforms for building networks (Kaushik et al. 2018), and for engaging in knowledge and information exchange (Materia et al. 2014; Mills et al. 2019).

However, there still remains a need to understand more about rural actors use of social media and specifically the roles social media play in farmer learning, as well as how advisory systems may connect to social media (Klerkx et al. 2019; Klerkx 2020). This article seeks to contribute to the growing scholarship about farmers and rural advisors use of online communities for knowledge exchange, by exploring two cases of rural actors' social media interactions to examine how these may contribute to knowledge exchange among farmers and advisors. In doing this the article asks: How does knowledge exchange occur in farmer learning networks on social media? To answer this, this article presents an analysis of conversations from two social media platforms used by farmers and rural professionals. The first case involves a Facebook conversation in a 'closed' pasture-based dairy farmer group coordinated from the United Kingdom, where the content is available only to members. The second case follows the Twitter activity of 48 New Zealand rural actors over five months.

The article begins with an exploration of the literature on farmer learning in real world and online networks. The methodology for investigating social media conversations is then explained, including a novel methodology for Facebook analysis to manage the complexity of these conversations. This is followed by the findings from the analyses of two cases of social media activity among rural actors. The discussion then explores how farmer knowledge exchange via social media might contribute to on-farm decision making. The paper concludes by recommending areas for further research.

Learning in farming networks in the real and virtual world

Farms exist in complex environmental, social, economic, political and cultural systems (Darnhofer et al. 2012). Farmers are not isolated individuals but are part of numerous social networks in which they build support networks to create their constructions of reality (Kelly 1955, Bannister & Fransella 1971) to operate and enact change on their farms. Farmers' perceptions of what is 'true', what they can aspire to, and what they are able to do, are influenced by their daily routines, past events and feedback they receive (Leeuwis 2004). Their strategic, tactical, and daily decisions are influenced by a body of knowledge that has evolved over time (Shadbolt & Martin 2005). Shadbolt et al. (2013) argue that farmers increase the resilience of their farm business by using 'buffer capacity' to make the existing systems stronger; 'adaptive capacity' to make small changes to existing systems; and 'transformability' to create completely new systems by making radical changes to cope with the volatility and uncertainties they increasingly face.

Social networks have long been recognised as influencing an individual farmer's decision making (Phillips 1985) and self-directed learning (Tough 1978). Prior to the Internet, farming networks were typically small and neighbours formed tight social ties and often worked collectively at seasonal peaks while also socialising together. These social networks provided social capital, which Bourdieu & Wacquant (1992, p. 14) define as 'the sum of the resources an individual "accrues" on the basis of belonging to durable networks … of mutual acquaintance and recognition'. Networks are recognised for creating bonding capital, which occurs from connections with like-minded people, and bridging capital, which occurs from association with others outside one's immediate social network (Bhandari & Yasunobu 2009). Social capital is importantly shown to support farmer learning (Tedjamulia et al. 2005; Tregear & Cooper 2016; Cofré-Bravo et al. 2019).

The principle of homophily says that people associate with other groups of people who are most like them (Bontcheva & Rout 2014). Unsurprisingly then, farmers bond with other farmers, who act as their main source of farm management information, despite the availability of agricultural research, extension services and media (Phillips 1985; Evans et al. 2017). Phillips (1985) found that farmers' peer acquaintances act both as a source of information and importantly as a validation for information that is received. Furthermore, he found that intimate peers, such as a farmer's partner or immediate family, play crucial support roles for the primary decision maker. Farmers trust in individuals in their network, influence the level of support they receive from those individuals. Information providers, including extension workers play other roles in the farmer's decision making (Phillips 1985; Gielen & Hoeve 2003; Sligo et al. 2005; Cofré-Bravo et al. 2019), for example enabling access to new sorts of information being derived from research. Peer networks therefore act as effective learning communities in agricultural settings (Klerkx & Leeuwis 2009; Morgan 2011). Networks have been shown to support the transformation of information to actionable knowledge and decision making on the farm (Phillips 1985).

The concepts of 'situated learning' and 'communities of practice' (Lave & Wenger 1990, Wenger 2000) show how knowledge is not purely attained from an individual's accumulation of information, but rather is socially constructed through social interaction and imitation. In communities of practice, members ask questions, request information, seek experience and problem solve within their domain (Wenger 2000). Collective learning and shared competence are an emergent property from these interactions. Collective knowledge is a critical asset of the community and relies heavily on the experience or tacit knowledge of members, while the exposure to tacit knowledge enables the construction of actionable knowledge (Evans et al. 2017). Tapsell and Woods (2008) describe the creative process of knowledge exchange and co-creation in collectives, as an entrepreneurial process of meaningful conversations between the experienced and the opportunist with new ideas. Jespersen et al. (2014, p. 1) recognise the creativity of knowledge exchange when they state, 'Innovation occurs as a result of the creativity and interplay between actors combining new and/or existing (tacit) knowledge'.

Knowledge exchange occurs from a process of social interaction often in transient networks which meet to address specific challenges and tasks, at particular points in time (Klerkx et al. 2009). These learning environments are known to enhance farmer self-efficacy (Bandura 1997) and validate collective learning (Drysdale et al. 2017), indeed in such networks there is a substantial move away from individual thinking to collective knowledge.

Materia et al. (2014) note that communities of practice also occur in the virtual world. Online communities, which can occur on a large scale and scope, expand a farmer's network and enable knowledge exchange between people who may be either unknown to each other or who may be connected to some extent in their offline world (Boyd & Ellison 2007). This knowledge exchange leads to a flow of resources in and out of the online community, which provides opportunities for collaboration (Faraj et al. 2011). Online conversations are recognised as key building blocks that

enhance interactive learning and the knowledge of members within the online community (Raaijmakers et al. 2008; Woolley et al. 2015). As in the offline world, conversations involve exchanges of opinion, or 'constructs' (Kelly 1955). The resulting learning that may occur from the exchange of 'personally relevant and viable meanings' (Thomas & Harri-Augstein 1976, p. 2) may well mean that members' constructs are changed. Since most online knowledge collaboration occurs among members who do not have established relationships, conventional conversation norms such as hierarchy or social conventions may be by-passed (Faraj et al. 2011).

Methodology

To investigate online knowledge exchange by farmers and rural professionals (e.g. farm advisors) using Facebook and Twitter to:

- Visualise what online rural actor knowledge exchange looks like across two different social media platforms e.g. Facebook that does not limit conversation length, compared with Twitter which limits length.
- Examine actors' knowledge exchange to give insight to the contribution social media exchanges make to farmer decision making.

The analyses are not intended to be exhaustive explorations, but rather are preliminary and illustrative investigations of advisors and farmer's social media use.

Facebook analysis

The first analysis examined a Facebook conversation about 'newly sown pastures', which took place during December 2017 and involved 94 'member' exchanges. The conversation was taken from an online group of 1208 pasture-based dairy farmers, farm staff and advisors. The group has no facilitator or chairperson to manage conversations.

Demographics at the time showed that group members came from 15 different countries although 68% of the members were from the United Kingdom, with 949 being male and 259 being female. Conversations are held in what could be called a 'gated' community as an administrator grants 'member' access. This Facebook group was selected because one of this article's authors had access to the group and gained permission from the participants to examine conversations. This online group largely formed to discuss pasture-based dairy farm management. While such groups are not unique, analysis of a conversation from this type of group has not been undertaken before.

Facebook conversations are complex to analyse and interpret, because they appear in threads and not in sequential order, making it a challenge to unravel the detail in these conversations. Furthermore, in general, they have numerous posts with many questions, comments, answers, likes and photos. To address both the complexity of the conversations and the challenge of analysing them, and to add rigour and substance to claims that can be made about Facebook conversations, a methodology was developed.

This involved developing what was termed a 'dialogue network analysis' to analyse the 'newly-sown pasture' conversation where 'conversation fragments' (questions, comments, answers and photos) were entered sequentially on a spreadsheet and a number of variables were recorded for each as follows.

- Date and time conversation fragment were posted.
- Participant who posted the fragment (labelled as P1, P2, P3, P4 etc. according to the order in which each participant entered the conversation). This label was retained for any subsequent posts the participant contributed to the conversation.
- Participant's country.
- Question number (numbered according to the order the question appeared in the conversation).
- Type of conversation 'fragment':
    - question
    - comment
    - answer
    - photo.
- Question reference (the question that each conversation fragment refers to).
- Receiver of conversation fragment (labelled according to the participant's number as noted above (P1, P2 etc.).
- Fragment 'likes': whether the post contained a 'like'.

The variables are not exhaustive and further variables could be added, including for example, 'fragment sentiment' (Positive, Neutral, Negative) as used by Raaijmakers et al. (2008) in face-to-face conversations.

Twitter analysis

The second analysis examined the Twitter accounts and activity of 48 New Zealand rural actors who separated into two distinct groupings of 24 dairy farmers and 24 rural professionals who were predominately farm consultants and industry extension staff. These actors were chosen because they were active, experienced Twitter users from New Zealand accounts with the highest number of tweets. The farmers posted a total of 60,428 tweets (average 2518 per account), while the rural professionals posted a total of 40,174 tweets (average 1674 per account). The farmers had an average of 550 followers each, while the rural professionals had an average of 484 followers per account. There is a potential bias of focussing on active and experienced Twitter users, as also recognised by others (Gaffney & Puschmann 2014). However, as the analysis is driven by research questions rather than simply the capture of large amounts of data to describe broad trends, the analysis still provides a much-needed contribution to the wider scholarship of Twitter investigations.

Twitter's metrics that code the tweets according to an array of variables was captured. A common way of measuring a tweeter's 'engagement' is to add up the number of replies, retweets and mentions (Gaffney & Puschmann 2014). This reveals what can be distinguished as the values for bridging capital (retweets) and bonding capital (replies and mentions). 'Twitonomy' was used to mine data from selected Twitter accounts to collect their scores. Twitter metrics were aggregated to create composite variables that measure online interaction. The analysis did not examine either Twitter forums or the use of hashtags.

Findings

Farmers' knowledge exchange in a Facebook conversation

Conversations in the investigated Facebook group were typically spontaneous and unpredictable, and, on a specific topic, ranged in time from 2-150 hours. Conversation threads typically started with a question that effectively set the agenda.

The Facebook conversation on newly sown pasture that was analysed for this investigation, began with a series of five questions being asked in one post by a United Kingdom participant (P1),

> I'd be interested to see photos & hear comments about newly sown permanent pasture. What was in the seed mix? Has it been grazed? When was it sown? Do you know the cost per hectare? Why are you doing it?

A number of members responded to the original question. To trace this, conversation fragments or posts were sequentially ordered for the complete conversation. This provided the foundation from which a visualisation of the conversation could be drawn by tracing the participants and their contributions to the conversation, as shown below in Figure 1.

This visualisation was created by numbering participants (P1-P13) in the order they joined the conversation. Questions (Q1-Q19) were numbered in the order they were asked and recorded against the participant who asked it. Questions drew responses classified as answers or comments. Answers to each question were recorded against the participant who provided it with some questions receiving multiple answers from multiple participants. In contrast, comments could be made on questions or answers so were recorded as arrows extending from the participant who made the comment to the participant to whom the comment was directed.

By tracking both the participants and their contributions, the complexity and non-linear nature of these conversations was revealed. Focussing only on participants and not their contributions may lead incorrectly to a simplistic linear progression being shown, which as the visualisation and analysis showed, is far from the reality of such conversations.

The visualisation was then summarised in a simple summary chart of participants' activity as shown below in Table 1.

A further analysis of the questions was undertaken to reveal the number of answers provided to participants' questions. Of the 19 questions, seven (37%) received no answers, 10 (53%) received one answer, one (5%) received five answers and one (5%) received two answers. The visualisation (Figure 1), and summarisation of participants (Table 1) and questions provided detail about:

- Who the opinion leaders were.
- Who asked questions; who provided comments; who answered.
- The level of redundancy in conversations (i.e. questions that were not answered).
- Fragments in the conversation that generated higher levels of interest among participants. These were called hotspots.

Figure 1. Visualisation of participants' contributions to the conversation

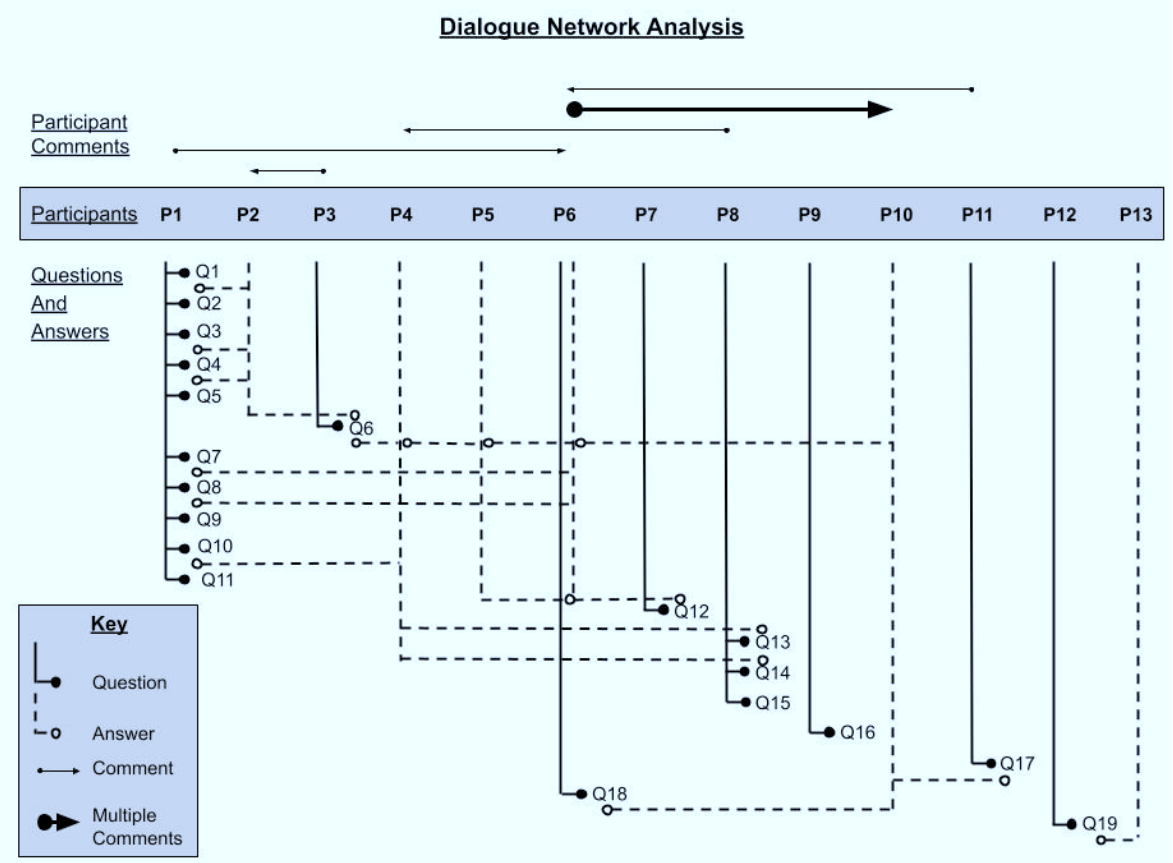


Table 1. Summary of participants' contributions to the conversation

Person	Country	Asked	Answer Gained	Answer Offered	Remark Offered	Remark Gained	Photos Used	Likes Gained	Total
P1	UK	10	6	0	1	0	0	1	18
P2	UK	0	0	4	0	1	6	5	16
P3	UK	1	5	0	1	0	0	0	7
P4	DE	0	0	4	0	1	4	3	12
P5	IE	0	0	2	0	0	0	2	4
P6	NZ	1	1	4	2	2	2	1	13
P7	FR	1	2	0	0	0	0	0	3
P8	UK	3	2	0	1	0	0	1	7
P9	UK	1	0	0	0	0	0	0	1
P10	NZ	0	0	3	0	2	0	1	6
P11	NZ	1	1	0	1	0	0	0	3
P12	UK	1	1	0	0	0	0	0	2
P13	UK	0	0	1	0	0	0	1	2

Abbreviations: UK - United Kingdom; DE – Germany; IE – Ireland; NZ - New Zealand; FR – France

In this conversation, P2, P4 and P6 emerged from the analysis as opinion leaders as they readily contributed answers, comments and photos but generally did not ask questions (only one in this conversation). These opinion leaders' detailed responses were largely drawn from their tacit knowledge. By answering questions, they acted as important knowledge providers with input likely shaped by their experience, status on the farm, and age. Their extensive use of tacit knowledge is seen in the following example from participant 2 (P2) from the United Kingdom:

> £408/ha, sown in the autumn, sprayed with glyphosate left 2 weeks then subsoiled with a sumo GLS, then left a further 4 weeks to avoid fruit fly, slurry applied over this period at 90m3/ha, ploughed with a 4-furrow plough with discs and furrow press, one pass with 3m power Harrow/ Cambridge roller

> combination, drilled with 6m corn drill with pipes removed and flat rolled. Usually go for a high sugar ley but thinking of changing due to cost. Reseed every 8 years as that is when we see performance in the pasture drop.

Opinion leaders' posts were typically media rich with photos, figures, videos and links. In the above conversation fragment, P2 attached six photos to illustrate and support the information they provided. The following example from an opinion leader (P4) from Germany (DE) included three photos:

> We under-seeded our barley/pea 'Whole crop' with 12kg/ha herbal ley this spring and the sward is great. As we're organic, we just incorporated it into our weed control. We go through our crops with a 6m Köckerling Striegel which has a pneumatic seed drill built on.

An opinion leader (P6) from New Zealand (NZ) supported their post with two photos:

> We have just sown 2 paddocks here in NZ. 2 paddocks apart. 1. Full cultivation- Sprayed with glyphosate-ploughed-heavy rolled-cultivated twice then roller drilled with 22kg/ha Base-tetraploid ryegrass + 3 kg white clover/ha. 2. Sprayed with glyphosate- direct drilled. 21kg/ha trojan ryegrass + 4kg white clover. Our goal is to use all direct drilling on our property for re-grassing and just go through full cultivation if post fodder beet or the paddock is rough, and we want to smooth it out. Photos are from yesterday day 13 since drilling. Since sowing we have had no rain though both are fully irrigated with a centre pivot. For us the big advantages of direct drilling are the limited impact on the soils, it doesn't pull up all the stones!! It's considerably cheaper and the paddock is returned to the rotation a lot quicker for grazing.

While P1 provided the framing questions for the conversation and was a very active participant contributing 18 conversation fragments, this participant only asked questions and so was not an opinion leader in this conversation. A number of participants contributed very little, lying low and observing the conversation or contributing only occasionally.

A summary of the questions and answers within the conversation (Table 2), interestingly demonstrated a significant level of redundancy. Nineteen questions received a total of 18 answers. Six questions (32%) received no answers. A further 11 questions (58%) only received one answer each. One question (5%) received two answers and the remaining question received five answers (28%).

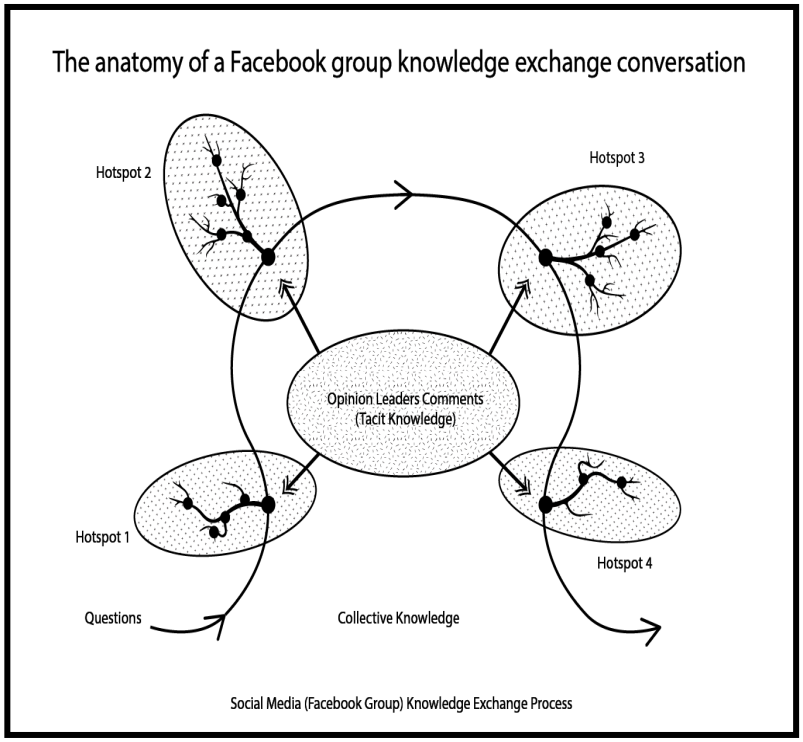
While questions 1-5 (see Figure 1) framed the conversation and set the initial agenda for participants to engage, it was question 6 asked by P3 that generated a significant flurry of activity. Opinion leaders' posts, which are driven by these questions, then generated a further burst of activity. The question and the subsequent opinion leader's input, which is rich with media, created a hotspot of activity. In this conversation opinion leaders P2, P4 and P6 stimulated heightened levels of activity.

The dialogue network analysis reveals deeper understanding of these hotspots of heightened activity, which is visualised in a simplified diagram (see Figure 2). This shows that a question stimulates online interest, which results in a small flurry of activity. An opinion leader assists with answering the question by drawing largely on their tacit knowledge. Qualitative analysis of opinion leaders' comments suggests that their tacit knowledge is informed by a collective pool of knowledge (both tacit and explicit knowledge). The heightened online activity stimulated by the question and the subsequent input from the opinion leader, creates a flurry of activity or hotspot. The intensity of the hotspot is based on the number of posts per day and the degree of media richness from the opinion leader, which encourages more posts. Conversations in these hotspots do not follow a linear progression, as unlike face-to-face meetings, participants are not in the same room at the same time. These online hotspots appear to be the site for intense knowledge exchange - development and co-creation.

Conversations were international, drawing participants with knowledge and experiences from a variety of contexts across a broad range of countries. The small segment of dialogue from the newly sown pasture conversation, drew participants from the United Kingdom (UK), Germany (DE), France (FR), Ireland (IE) and New Zealand (NZ). The opinion leaders were also international, contributing their knowledge from the United Kingdom, Germany and New Zealand.

Conversations end abruptly either because the conversation has run its course, or the members move to a new topic. Rarely is a conclusion drawn or a summary of the conversation provided. However, the archiving of the conversation on Facebook ensures that there is a 'permanent' record of the knowledge exchange and collective learning in the group.

Figure 2. Simplified visual conceptualisation of the social media knowledge exchange among Facebook users



Twitter Activity by New Zealand dairy farmers and rural professionals

Twitter activity among the selected group of farmers and rural professionals in New Zealand shows an active community of practice. This is most evident in the high proportion of replies and suggests Twitter use among rural professionals and farmers is well evolved with open participation, collaboration (retweeting) and full engagement (asking questions, providing answers/replies) compared with lower levels of one-way messaging (new/ original tweets) as shown in Figure 3.

However, the analysis revealed key differences in Twitter use between rural professionals and farmers. Rural professionals made greater use of retweeting, links, and being retweeted themselves, all forms of bridging capital. Farmers were engaged more in bonding capital activities such as being active 'repliers', likely to include 'mentions' in their replies, being favourited, and were frequent followers as well as being followed themselves. Initial findings suggest farmers used Twitter more conversationally by engaging in questions and answers. The questions also acted to set the agenda. Conversations were fast and could rapidly engage multiple players worldwide.

Rural professionals used Twitter to disseminate information rather than as a platform for actively engaging personal responses. Distinctions were evident among rural professionals and farmers in terms of impact as indicated by the incidence of tweets being retweeted (see Figure 4) and content as indicated by the inclusion of externally created content.

A low level of content being retweeted by other users may suggest a small, well-defined community with content being narrowly targeted at specific users (see Figure 5). A low inclusion of links has some correlation with the high proportion of activity generated through 'replies', rather than new or retweeted material.

Twitter enabled rural actors to stay connected according to their daily routine. Twitter's accessibility via a smartphone enabled tweets to be posted throughout the day. Dairy farmers who were active users would tweet from 4am till 10pm, seven days a week with peak tweeting occurring after morning milking. Farmers sent 5-11 tweets per day, whereas rural professionals only sent 1-3 tweets per day. Farmer Twitter users ask questions and offer tacit knowledge in replies, to assist other farmers to problem-solve.

Figure 3. Twitter activity among selected farmers and rural professionals in New Zealand

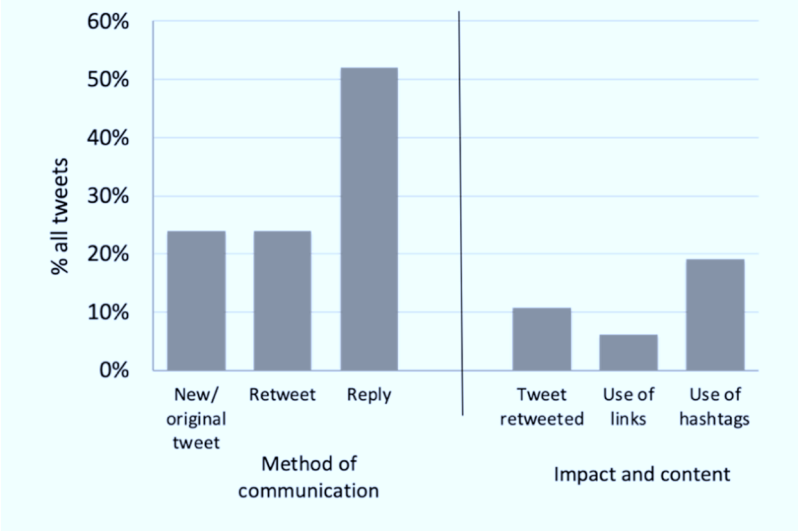


Figure 4. Comparison of tweets retweeted by farmers and rural professionals

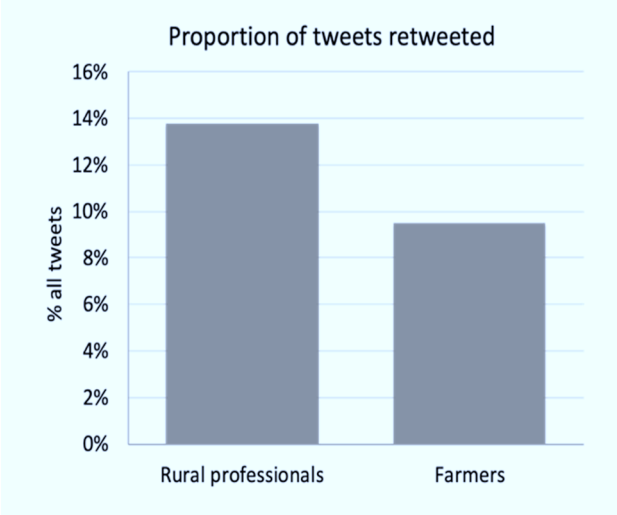
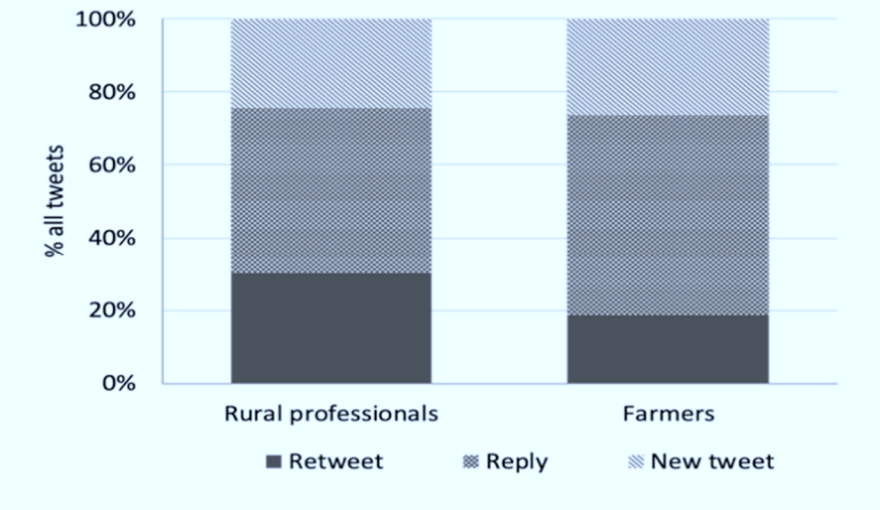


Figure 5. Comparison of farmers' and rural professionals' tweet types



Users gauge audience reception and acceptance of their Twitter streams by the number of followers they have, the level of re-tweets their messages receive and how often tweets are 'favourited' by followers. This suggests that users are aware of their audience even if there is little direct feedback from them.

Users' intensity of engagement was assessed using the following scale (Pang et al. 2018).

1. Just observation (users who mainly read, but rarely post).
2. Low engagement (one-way messaging).
3. Open participation to collaboration (retweeting).
4. Full engagement (creating two-way conversations).

This broad assessment enabled a comparison to be made between farmers and rural professionals. Farmers used all four levels of engagement, especially engaging in two-way conversations whereas rural professionals mainly used one-way messaging with little evidence of higher levels of engagement.

Tweets were frequently written as informal comments about life on the farm. Sometimes tweets included links to interesting media stories and websites and pictures were used to share with others about 'life at the office', as the following tweet, which was accompanied by three photos illustrates:

> #MangaRa Station looking good yesterday. Weaned lambs get lost in the grass and cows are putting on weight and condition.

Discussion

This work reveals that social media enables rural actors to share knowledge in online conversations or posts. Users post text, photos, videos, links and icons to make their knowledge publicly visible or within gated or restricted networks. The posting of knowledge is effectively for the collective good of the social network, where recipients are free to interpret, modify and use the knowledge. From here people can comment, reply, like, or share. Social media appears to connect farmers and rural professionals to inform and advance on-farm decisions. The following key findings have emerged from this research.

Rural actors use social media to engage in knowledge exchange

Virtual problem-solving discussions in the virtual world, such as the one analysed in the Facebook conversation in this research, like real world on-farm discussions, illustrate the constructed nature of knowledge production. This work illustrates that in both the real and virtual world, knowledge that is not readily available is developed and adapted 'on the spot' through interactions between rural actors (Leeuwis 2004). Knowledge exchange in the virtual world like in the real world is therefore likely to be valuable for innovation as Kaushik et al. (2018) has similarly shown. Farmers using Twitter have in a relatively short time moved from simple observation where they largely read but did not actively participate through posting, to using Twitter for two-way engagement in online communities.

Both Twitter and Facebook conversations in this research facilitated knowledge exchange. However, they achieved this in different ways. Farmers in this research used Facebook to solve problems, gather information and converse with virtual networks on topical and relevant issues. Problem solving discussions were largely designed to enhance on-farm decisions. Facebook provides more scope than Twitter for conversations, with an expectation from users that posts will be answered, though surprisingly the analysis showed many questions remained unanswered. Twitter, on the other hand is an open and loosely connected network of like-minded communities brought together for discussions and problem-solving.

The analysis however, revealed differences between farmers' and rural professionals' knowledge construction and exchange on Twitter. The Twitter analysis suggests rural professionals' social media engagement favours linear and more traditional 'top down' approaches to 'extension'. This suggests rural professionals, unlike farmers, may not be maximising and optimising the collaborative potential of social media as a platform for knowledge exchange, a finding which Kamruzzaman et al. (2019) have also observed in advisors in developing countries.

Social media network hotspots are key places for exchange and opinion leaders are key providers of knowledge

The research shows the key importance of hotspots in the knowledge exchange Facebook conversations. Hotspots are a space for knowledge exchange, where opinion leaders hold an important knowledge provider role whose input stimulates the development of the hotspot. They become influencers in these social media networks, a finding which others have also recently observed (Phillipov & Goodman 2017; Rust et al. 2020). Opinion leaders' exchanges display self-

efficacy which likely underpins their confidence in knowledge sharing. Their recording of on-farm activities with photos and video and sharing these in the online exchanges, indicates their willingness to engage in knowledge diffusion. Hotspots are therefore rich collaborative spaces for knowledge exchange which it could be suggested are likely to play a role in fostering change.

Social media acts as stimulus for individual and collective learning

The importance of real-world social networks for fostering change in the agricultural sector is widely recognised (Phillips 1985; Ridley 2005; Kroma 2006; Sligo & Massey 2007). The Facebook conversation in this research which centred around a problem-solving discussion, appears to provide a useful channel for fostering important weak ties. Weak ties are deemed necessary for innovation (Gielen & Hoeve 2003).

Social media appears to support and encourage farmer learning. Farmers are using social media in online networks mostly with other farmers to advance their self-directed learning strategies. The nature of these knowledge exchanges therefore suggests a strengthening of both buffer and adaptive capacity although the preliminary nature of investigation limited the ability to see transformability (Shadbolt et al. 2013). There is also evidence in the conversations of the creative processes of 'acknowledge, adopt and advance', as described by Woods (2018), which are deemed necessary for learning and innovation. These problem-solving networks on social media highlight a move away from individual thinking to collective knowledge, where assumptions are being challenged by the tacit knowledge of others (Drysdale et al. 2017).

The online Facebook communities of practice in this research can be described as self-organising networks as described by Morgan (2011). While group administrators may act as gatekeepers to membership and set the tone for discussion, the research reveals that social media provides a place for self-directed learning in an online community. Knowledge exchange does not reflect a 'top down' model and as the Facebook conversation analysis shows, it can bypass traditional extension models and extension professionals. This has profound implications for rural advisors and agricultural extension agencies.

The conversations and the growth of these online farmer groups that exhibit high levels of activity, suggest the farmer members see a perceived value in asking questions and contributing in the knowledge exchange either as active participants and/or as observers. Tedjamulia et al. (2005) suggest a participation and response ratio in a conversation of 1% lead initiators, 9% highly active responders, and 90% least active or silent observers.

Social media allows knowledge exchange on a global scale

Farming is noted for its social isolation caused by its geographical remoteness and long working hours (Alston 2012). The analysis in this research suggests that social connections enabled by social media platforms are likely to provide channels for breaking down farmers' social isolation, by acting as a space for sharing and knowledge exchange, while they work in remote locations. Social media does not require real time audiences with conversations typically starting in the evening once work on the farm had ceased for the day.

Farmer knowledge networks and advisory systems are now international (Klerkx et al. 2017). This research shows that social media enables global communities of practice as it makes it easy to engage with international counterparts. The participants analysed in this research engaged internationally. Local discussions become global discussions in the virtual world and this occurred both in Facebook groups and on Twitter. Facebook 'closed' communities in particular, act as a conduit for problem solving interactions that are likely to contribute to participants' pool of knowledge that may be used for instigating on-farm action and change.

Conclusion and further research

This investigation into rural actors use of social media shows farmers use social media for knowledge exchange to address and support on-farm decisions. Knowledge that is not readily available to rural actors is discussed, questioned and validated within online communities, which suggests that social media can provide a valuable tool for rural innovation. While social media provides a conduit for knowledge exchange, more research needs to be undertaken to show the effect these exchanges have for farmer learning and on-farm management practices.

This research contributes to understanding about farmers' knowledge exchange in the online world. Farmers using both Facebook and Twitter have mastered the skills of social media engagement and have embraced the concept of collective knowledge-making. The research suggests, however, that rural professionals while using social media platforms, may not yet have fully embraced the collaborative opportunities offered by social media, preferring instead to use it for the dissemination of information. The comparison in this research between farmers and rural

professionals use of Twitter, suggests that further investigations need to consider comparisons between different rural actors.

The role of Facebook opinion leaders has emerged as being important in online conversations. Opinion leaders share media-rich tacit knowledge and can generate high-intensity discussion in hotspots of activity which appear as ripe sites of potential innovation. Opinion leaders are the influencers, demonstrating high levels of farmer self-efficacy and a willingness to share their learning.

More focussed research needs to explore the social capital potential of social media. Trust is one of the distinguishing features of face-to-face farmer problem solving. Since social media knowledge exchange appears to take place in the absence of existing social relationships, there needs to be more research into the role trust plays in these networks, as well as the effect these networks have on trust-building. There is also tentative evidence of both bridging and bonding capital. However, further analysis with much larger samples would be required to more deeply understand the contribution of social media to social capital in agricultural contexts. Doing this will give further insights to how social media activity and communities contribute to agricultural innovation.

The dialogue network analysis developed for this research provided a simple and effective tool for analysing Facebook conversations within a network of participants that initially appeared chaotic due to its non-linear nature. However, the methodology's use in larger conversations, and with other social media platforms, needs further investigation to provide more empirical evidence of its effectiveness at revealing network characteristics and aiding analysis of the nuances and group dynamics of dialogue within a network. Further research is also required to understand the on-farm application of knowledge gained from social media conversations.

Acknowledgements

The authors acknowledge the inputs of P. Edmond, B.A. Wood, Lyndon Phillips and Grant Dumbell. This article is a revised version of an oral paper presented by the authors at the 13th European IFSA Symposium, 1-5 July 2018, Chania (Greece) and the authors thank those who provided feedback on this earlier version.

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Identifying factors that support sustainable farming practice change: Application of Theory of Planned Behaviour in project evaluation

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Abstract. To achieve water quality targets needed to support the ecological restoration of the Great Barrier Reef, increased uptake of programs aiming to change farming practices is needed. However, notwithstanding extensive research and progress in this area, knowledge gaps may be limiting the potential effectiveness of initiatives. Of particular significance is the relative paucity of reliable evidence on social and psychological factors that are theoretically known to influence the performance of a person's behaviour. This paper reports an application of the Theory of Planned Behaviour to evaluate intentions, perceived behavioural control, attitudes and social norms in changing farming practices following participation in a project aiming to enhance water quality. Overall, 23.5 % of the variance in self-reported framing practices were explained by the Theory of Planned Behaviour. The results are consistent with previous research on the influence of social norms in the adoption of behaviours, supporting a role for including social and psychological variables in farming practice change research, while simultaneously acknowledging the need for further research to draw definitive conclusions.

Keywords: farming practices, theory, social norms, social factors, Great Barrier Reef

Background

Since 2015 the Reef 2050 Long Term Sustainability Plan (Australian Government & Queensland Government 2015), a joint plan between the Australian and Queensland Governments that was endorsed by the World Heritage Committee, has served as a shared blueprint for managing the Reef and improving its health and resilience. The Reef 2050 Plan outlines a partnership approach implemented with governments, Traditional Landowners, the community, industry and scientists. In 2017 concern was expressed about progress made to date towards achieving water quality targets (Waterhouse et al. 2017). Calls were made for acceleration in approaches to ensure that the intermediate and long-term targets outlined in the Plan could be met.

Sediment and chemical run-off from farms into waterways can be reduced and a co-ordinated response across stakeholder groups is needed to realise the outcomes sought. Over past decades a considerable number of programs and projects have been implemented with the aim of improving the ecological health of the Great Barrier Reef (GBR). Many of these programs and projects have focused on changing farming practice to reduce loads of catchment-sourced stressors, principally nutrients, fine sediment and pesticides which act to reduce Reef resilience (State of Queensland 2018). Programs have also sought to incentivise land use changes – such as wetland conversion and wetland restoration – which can actively reduce nutrient, sediment and pesticide loads delivered to the GBR Lagoon.

Considerable quantities of data have been collected on these programs, tracking expenditures, detailing voluntary uptake of programs across the agricultural sector and, to a lesser extent, recording outcomes in the Reef Lagoon. The Reef 2050 Water Quality Improvement Plan 2017-2022 (State of Queensland 2018) identified that **c**hanges in on-ground management, improvements to program design, delivery and evaluation systems were an urgent need, along with greater incorporation of social and economic factors, and better targeting in program delivery. Therefore, in this context, work to identify social and individual factors that enable, and support practice change represents an important undertaking. The identification and understanding of relevant social and individual factors can be advanced through the application of theory.

Theory is a set of interrelated concepts, definitions, and propositions that explain or predict events or situations by specifying relationships among variables (Glanz et al. 2008; Glanz & Bishop 2010). When applied, theory offers an organising framework for conducting research. Moreover, the methods and results of theoretically based studies are open to critical analysis and evaluation relative to predefined parameters or constructs. It is through such critical analysis and evaluation advances in any scientific field are achieved (Rothman 2004). Importantly, in the context of initiatives for behaviour change, theoretically-based research can assist in understanding why (or why not) programs and interventions are more, or less, successful. However, evidence reviews of behaviour change research have found that theory is predominantly used 'to inform' research, meaning that the explanatory or predictive power of one or more specific theories may be discussed as part of the background of the study; and at times theoretical constructs may be

selectively utilised (Pang et al. 2017; Willmott et al. 2019; Kim et al. 2020). Comparatively fewer studies are found to empirically 'apply' or 'test' whole theories in the explanation or prediction of behaviour and behaviour change. While it is acknowledged that the under-utilisation of theory may reflect incomplete reporting and inconsistent selection and definition of constructs, considerable room for improvement exists to increase the role of theory in monitoring and evaluating programs that aim to change behaviours (Rundle-Thiele et al. 2019).

Traditional and environmentally sustainable agricultural systems and practices have been extensively researched across disciplines, including economics, sociology, psychology, marketing, agricultural extension, and anthropology, producing an extensive and diverse body of literature (Pannell et al. 2006). The adoption of sustainable farming practices has been examined as a decision-making process in which a multitude of personal, social, cultural and economic factors exert influence on people's behaviours (e.g. Rogers 2003; Pannell et al. 2006; Ranjan et al. 2019). In addition, social and behavioural theories have informed conceptual explanations of agricultural decision making, most notably Diffusion of Innovations (Rogers 2003), and to some extent the Theory of Planned Behaviour (TPB) (Ajzen 1991), or its predecessor the Theory of Reasoned Action. However, until recently, the relationship between behavioural theory and the empirical evidence on adoption of sustainable farming practices has received limited scholarly attention (Small et al. 2016).

Literature reviews has been primarily focussed on the identification of factors associated with agricultural decision making, particularly those that positively influence or enable the uptake of sustainable farming practices (e.g. Pannell et al. 2006; Knowler & Bradshaw 2007; Prokopy et al. 2008; Baumgart-Getz et al. 2012; Prokopy et al. 2019; Ranjan et al. 2019). For example, in an early narrative review, Pannell et al. (2006) sought to integrate the multi-disciplinary literature and concluded that the main theme underlying landholder decision making about the adoption of conservation practices was the extent to which the practice was perceived to support the achievement of individual goals. Pannell et al. (2006) identified three sets of issues as significant in individual decisions: the process of learning and experience; the characteristics and circumstances of the landholder within their social environment; and the characteristics of the practice (Pannell et al. 2006). In contrast, based on their meta-analysis of quantitative studies across the world, Knowler and Bradshaw (2007) found that, with the exception of some support for the role of social capital, no specific factor could be said to consistently explain practice change at farm and farmer level, leading them to suggest that the context of change should be the prime consideration in conservation agriculture policy and practice. Focusing on quantitative studies undertaken in the United States on the adoption of Best Management Practices (BMP), Prokopy et al. (2008; 2019) found that as a whole the evidence reviewed was inconclusive about factors that consistently determined adoption of BMP. However, some factors were more likely to have a role than others, including social networks, access to information, increased environmental awareness, positive environmental attitudes, self-identity, some farm (land size) and farmer characteristics (age). Ranjan et al. (2019) sought to deepen understanding of motivators and barriers to adoption of BMPs in the United States through an examination of qualitative studies. Corroborating some of the findings of earlier reviews, the evidence suggested that farmer characteristics, environmental awareness, and trust in information sources were more likely to motivate adoption; whereas, farm management, negative perceptions of a conservation practice, and land tenure represented primary barriers. Reflecting the complexity of decision making, Ranjan et al. (2019) noted that the influence of economic factors, social norms, perceptions of programs, and farm characteristics, could be positive or negative depending on interactions between individual and contextual characteristics.

Common to quantitative and qualitative reviews, was the observation that use of theory in studies on the adoption of conservation practices was highly variable in terms of both frequency and precision (e.g. Prokopy et al. 2008, 2019; Ranjan et al. 2019). Notwithstanding the correspondence of likely influencing factors with focal constructs in social and behavioural theories, quantitative studies often lacked an explicit theoretical base, or applied theory selectively or imprecisely (Prokopy et al. 2008; 2019). For example, following a further analysis of data in the Prokopy et al. (2008) review, Baumgart-Getz et al. (2012) suggested that theoretically imprecise measures of behavioural constructs contributed to limited or mixed evidence for the role of some factors, including attitudes and awareness. Furthermore, research gaps were observed for some factors that are prominent in theories of behaviour and behaviour change, most notably social norms – a central construct in the Theory of Planned Behaviour (Prokopy et al. 2008; 2019). Similar issues were identified by Ranjay et al. (2019) in the qualitative evidence for BMPs in the US. While welcoming the trend for a greater role of qualitative research in exploring the complexity of farmer decision making and farming practice change, Ranjay et al. (2019) lamented the under-utilisation of established behavioural and behavioural

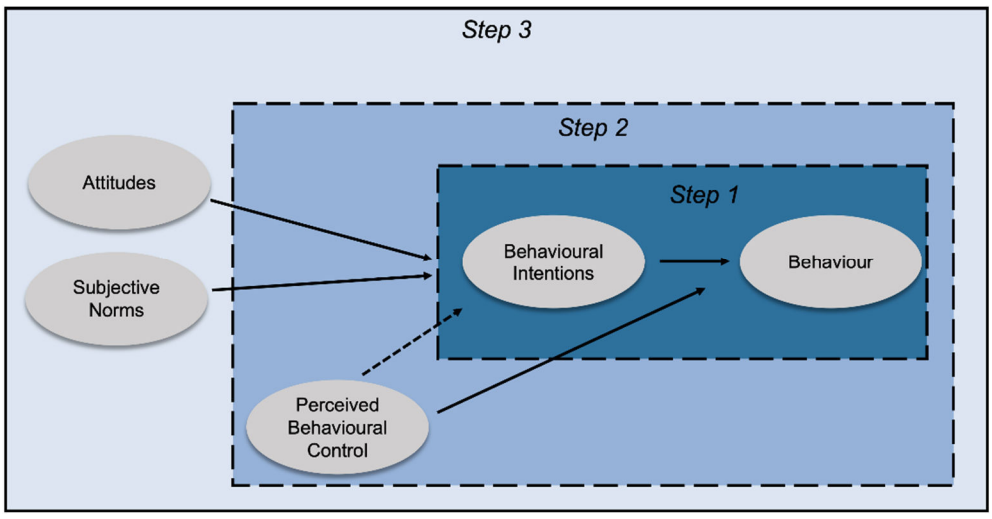
change theories that include many of the very factors that are empirically found to contribute to such complexity.

As has been found in behaviour change research generally, the most recent reviews of the literature suggest that gaps in the evidence as well as under-utilisation and incomplete reporting of behavioural theories, represent likely limitations for bringing greater clarity and extending the knowledge base on the adoption, or intention to adopt, environmentally sustainable farming practices (Small et al. 2016; Prokopy et al. 2019; Ranjan et al. 2019). The establishment of sustainable farming practices has a fundamental role in the urgent task of restoring the ecological balance of the Great Barrier Reef. The potential effectiveness of initiatives in this area will be maximised by knowing not only what factors are likely to influence practice change, but also by accessing plausible explanations of their interactions. It is through the application of theory and its evaluation across different contexts that researchers can formulate and refine plausible explanations (Prokopy et al. 2019).

Against this background, this paper contributes a case of theory applied in the evaluation of a project that aimed to achieve a reduction in nitrogen application on farms, which if achieved would contribute to improved water quality benefitting the Great Barrier Reef. The Theory of Planned Behaviour (TPB) was applied to examine the role key psycho-social variables, including intentions, perceived behavioural control, attitudes and social norms, may have on sustainable farming practices following participation in a water quality project. In assessing behavioural outcomes relative to focal constructs of the Theory of Planned Behaviour, this research sought to contribute insights on gains in effectiveness that might be expected (or not) of initiatives that specifically address TPB constructs.

The Theory of Planned Behaviour pioneered by Fishbein and Ajzen (2011) suggests that a person's performance of a specific behaviour depends on their behavioural intentions, their attitude toward the behaviour, subjective norms, and perceived behavioural control (see Figure 1). Behavioural intentions are an indication of effort and dedication towards performing the behaviour (David & Rundle-Thiele 2019). Attitude towards a behaviour is based an individual's belief about the likely outcomes of a particular behaviour. Subjective norms refer to a person's beliefs about how other people they care about would judge them if they carried out a specific behaviour. Subjective norms are closely related to social norms defined as unwritten rules about how to behave within a specific setting (Stern 2018), and have been distinguished into two types: injunctive and descriptive (Cialdini & Goldstein 2004). Injunctive social norms are generally agreed upon moral standards and beliefs shared by members of a social group, whereas descriptive social norms refer to an individual's perceptions of the behaviour of the majority in a specific situation (Berkowitz 2010; Stern 2018). Subjective norms can be influenced by a tendency to want to conform to descriptive social norms, or by social pressure associated with injunctive social norms (Stern 2018). Finally, perceived behavioural control (PBC) refers to individual beliefs of the existence or absence of resources and opportunities to execute a behaviour, and how easy or difficult the behaviour is to perform. Perceived behavioural control acts as a motivational influence on behaviour through intentions (Fishbein & Ajzen 2011).

Figure 1: The Theory of Planned Behaviour



Source: David & Rundle-Thiele (2018, p. 194)

There is a wealth of research suggesting that social norms, attitudes, and perceived behavioural control are significant socio-psychological factors across a range of human intentions and behaviours (Pickering et al. 2017; Stern 2018). It is acknowledged that there are conceptual and functional overlaps between Theory of Planned Behaviour focal constructs of intentions, attitudes, social norms and perceived behavioural control and constructs included in other established behavioural theories, including Diffusion of Innovation (Rogers 2003), the Trans-theoretical model (Prochaska & Velicer 1997) and the Health Belief Model (Rosenstock et al. 1988). More recent research emerging in behavioural economics draw from this earlier work. The Theory of Planned Behaviour was selected as a parsimonious and pragmatic choice for the purposes of this research.

Theory of Planned Behaviour constructs have been included in research on sustainable practices in agriculture (e.g. Grover & Gruver 2017; Zeweld et al. 2017; Pandey & Diwan 2018). However, to our knowledge, this has seldom been in the context of approaches or methods based entirely on the predictions of the Theory of Planned Behaviour. When the Theory of Planned Behaviour has been applied as a conceptual framework in research on the adoption of sustainable farming practices, the results have mostly supported the explanatory power of its socio-psychological constructs in different contexts. For example, Marquez-Garcia et al. (2019) compared corporate conservation behaviours in vineyards participating in a sustainability wine-farming program and non-participating vineyards. They found that participation in the sustainable winery program was positively associated with the adoption of conservation practices. Although attitudes to conservation practices were similar among the participants and non-participants, participants in the program reported positive social pressure from 20 stakeholders, which was higher than the control group that reported pressure from 11 stakeholders. Similarly, Zeweld et al. (2017) applied Theory of Planned Behaviour as a theoretical framework to analyse intentions of crop farmers to adopt conservation practices of row planting and minimum tillage[1]. Their study identified that attitudes and normative issues explained farmers' intentions to adopt both practices. However, perceived behavioural control did not have a significant effect on intention to practice row planting or to apply minimum tillage. On the other hand, perceived efficacy and perceived resources significantly influenced perceived control for minimal tillage, while only perceived efficacy significantly contributed to perceived control for row planting.

In summary, this study had multiple overlapping aims: to assess the role of Theory of Planned Behaviour specific socio-psychological factors in behavioural outcomes following participation in a practice change project; to contribute to the broader evidence base about the explanatory power of the Theory of Planned Behaviour; and, respond to recent calls for more consistent applications of theory in empirical research as a means of building reliable and valid knowledge to inform initiatives in sustainable farming.

Method

Context and rationale

The project that was evaluated featured provision of a nutrient management plan and one year of on-farm agronomic advice. The aim of this project was to provide farmers with support necessary to confidently adopt recommended best practices - including reduced fertiliser rates to align with regulation standards.

The practice change project, delivered across a government and industry partnership, worked with farmers assisting them to lower nitrogen application rates. A key focus within the project was ensuring that farmers did not compromise their productivity and profitability. The project aimed to be delivered across 90 farms over a two-year period. On-farm help valued at AU$ 5,000 worth of agronomy services including personalised one-on-one extension was a feature of this project. Agronomists visited farms to provide services including farm decision support, planning and equipment calibrations. Expected outcomes were improved nitrogen efficiencies, reduced nitrogen application, and reduced runoff into local waterways. Additional project outcomes were increased profitability and sustainability for the growers' businesses. At the time of data collection 58 growers were signed up to participate in the project.

A survey was designed to evaluate the program. Specifically, the aims of the social research survey applied to evaluate the agronomy support program were:

1. Identify why growers chose to participate in the project.
2. Understand why they have/have not changed practices.
3. Determine the likelihood of this change continuing in the future.

[1] Row planting refers to crop sequences and associations that increase species diversification. Minimum tillage involves minimal mechanical soil disturbance by direct seed and/or fertilizer placement (FAO, n.d.).

Surveys were implemented after one or two years of participation within the project. The survey incorporated one or more measures for each Theory of Planned Behaviour construct.

Sample

Following ethical clearance from the university (2018/370) surveys were administered to growers who had varying levels of experience participating in the farming practice change project. The survey was administered in 2018 to 9 growers (representing 11 farms) who commenced participation in the project in its first year. The survey was also administered to 15 growers (representing 21 farms) who commenced participation in the practice change project in its second year. Grower and farm representation were high. A total of 40% growers representing 36% of farms involved in the project were included in this study. In total, self-report data for a total of 24 growers was included in this analysis.

Design and Procedure

Informed by the Theory of Planned Behaviour the survey was designed to understand participants' experience in the three-year program that delivered extension support to enable farming practice change. Farmer beliefs and behaviours regarding participation in the extension support program are given in Table 1. Farming behaviour was measured with four self-reported behaviours including 'I have changed my farming practices'; 'I have used my technology effectively'; 'I have changed irrigation scheduling'; 'My weed management timing has changed'. All items were measured on scales ranging from "Strongly disagree" (1) to "Strongly agree" (7). Surveys were collected by extension service staff on behalf of the project team. Key Theory of Planned Behaviour measures were included in the survey, namely attitudes (4 items), perceived behavioural control (3 items), group norms (1 item), intentions (1 item) and self-reported farming practice behaviours. See Table 2 for examples of TPB constructs and measures.

Data Analysis

Following procedures reported in David and Rundle-Thiele (2018) stepwise hierarchical multiple regression (see Figure 1 and Table 3 for stepped approach) was applied to examine the explanatory potential of the Theory of Planned Behaviour to explain farming practices.

Stepwise hierarchical regression was applied because it aligns to TPB's theoretical underpinnings, namely that attitudes, social norms and perceived behavioural control interact together to influence intentions. In turn, intentions and perceived behavioural control interact together to influence behaviour.

Step 1 tested the influence that behavioural intentions had on self-reported framing practice changes behaviour. Step 2 included perceived behavioural control (perceptions of my own ability to undertake the recommended farming practices) in the model and tested the explanatory potential of intention and perceived behavioural control on behaviour. Finally, Step 3 tested all Theory of Planned Behaviour constructs, to ascertain whether the variance in behaviour explained was increased by including all Theory of Planned Behaviour constructs into the explanatory model. A hierarchical approach permitted the additive contribution of each construct to be partitioned and considered separately.

Results

Prior to statistical analyses, reliability was estimated for relevant Theory of Planned Behaviour constructs. Attitudes towards the farming practice (α = 0.85) and perceived behavioural control (α=0.86) demonstrated high internal consistency exceeding the recommended Cronbach's alpha level (α=0.70). Intentions, social norms and farming practice behaviour were measured as single items so reliability estimates were not calculated for these measures. Descriptive statistics are outlined in Table 1.

Examination of descriptive statistics indicated that growers were positive about their experiences with the farming practice change project. Of note growers agreed their profitability will improve (M=5.2) as a result of participation in the project, growers agreed that their farming practices have changed (M=5.3) and their networks have increased as a result of participating in the farming practice change project (M=5.5).

Table 1. Grower perceptions of project participation

As a result of participation in this project	Mean
I think my profitability will improve	5.2
I have changed my farming practices	5.3
My network has increased	5.5
I am happy with the progress I have made	5.9
I believe that time I've spent on the project is good use of my time	6.0
I think my soil health will improve	5.0
I have implemented a whole farm management plan	6.2
I have used my technology effectively	5.4
I have changed irrigation scheduling	5.4

Growers participating in the project were asked to report on Theory of Planned Behaviour constructs (see Table 2). Attitudes towards the farming practice were measured with two items (see Table 2). For example, the first question asked *respondents' attitudes toward the farming practice before the program*, and results showed a neutral attitude (M=4.4). Taken together results demonstrated that although growers' attitudes towards the farming practice were neutral, their intentions to continue to use the farming practice (M=6.0) were high. Moreover, growers agreed they would know how to continue the farming practice after the project (M=5.1) as measured by perceived behavioural control.

Table 2. Grower perceptions of project participation

As a result of participation in this project	Mean (Standard Deviation)
(Intentions) How likely are you to continue to use the farming practice after the project finishes?	6.0 (1.5)
(Perceived behavioural control) I am confident I can continue; I am able to continue; I can overcome obstacles faced.	5.1 (1.3)
(Attitudes toward the farming practice) I think my profitability will improve; I think my soil health will improve.	4.4 (1.7)
(Social norms) Growers in my local area who implement the farming practice are positively recognised.	5.0 (1.2)

Half (54%) of the participants (n=13) also agreed that growers implementing the recommended practices are positively recognised. Results demonstrate that 95% of respondents felt their profitability would improve.

A model of farming practice change

Results of hierarchical regressions are presented next (see Table 3). Only intention was entered in the first step, which did not explain the variance in farming practice behaviour. Step 2 accounted for 8% of variance in farming practice behaviour, with the addition of perceived behavioural control. Both models were not statistically significant. After entry of all Theory of Planned Behaviour constructs in Step 3 of the hierarchical regression, the total variance explained by the model was 23.5 % ($F(3, 19)=3.256$, $p<0.05$). The final model was statistically significant at the 5% level. The inclusion of attitude and social norms explained an additional 15.5 % of the variance in farming practice behaviour, after controlling for intention and PBC ($(1, 21)=2.910$ and $p=0.10$). Unstandardised (B) and standardised (b) regression coefficients and squared semi-partial (or "part") correlations (sr^2) for each predictor on each step of the hierarchical multiple regression are reported in Table 3. In the final step, one measure was statistically significant, social norms (p = 0.026), which had the strongest effect on intentions to continue the farming practice behaviour. The results of the adjusted R^2 for the final model show that Theory of Planned Behaviour explained 23.5% of the variance to continue the farming practice behaviour.

Table 3. Theory of Planned Behaviour Hierarchical Regression Results

Dependent Variable: Farming behaviour	***B***	**Beta**	**sr^2**	**Step 1 significance**	***B***	**Beta**	**sr^2**	**Step 2 significance**	***B***	**Beta**	**sr^2**	**Step 3 significance**
Constant	5.4				3.5			0.018	1.8			0.322
Intentions	-0.037	-0.042	-0.0	0.848	-0.2	-0.2	-0.2	0.319			-0.2	5.300
Perceived behavioural control					0.4	0.3	0.4	0.062	0.2	0.2	-0.1	0.303
Attitudes towards the farming practice									-0.2	-0.2	-0.1	0.312
Social norms									**0.6**	**0.5**	**0.5**	**0.026**
Sig.	0.848				0.103				**0.044**			
R2	0.042				0.349				0.583			
Adj. R2	-0.046				0.080				0.235			
F value	0.038				2.910				3.256			

Practical implications

The aims of this study were twofold:

1. Apply Theory of Planned Behaviour within one agronomist delivered practice change project.
2. Respond to recent calls for more consistent applications of theory in empirical research as a means of building reliable and valid knowledge to inform initiatives in sustainable farming.

Understanding the drivers of intentions to continue recommended farming practices

Theory offers a roadmap that when followed should achieve the intended outcomes (Rundle-Thiele et al. 2019). By understanding more about how people think and feel, psychosocial theories deliver explanations about why people behave the way they do. This paper demonstrates how psychological and social factors can be incorporated into evaluations to monitor and measure intentions to continue farming practices. A survey was administered by an extension service provider on behalf of the research team. The research team analysed data and provided a report to the project funder and the extension service team. This paper modelled the data to understand which Theory of Planned Behaviour constructs were influencing self-reported farming practice changes. Results demonstrate that social norms were the only factor within the broader Theory of Planned Behaviour explaining 23.5% of the variance in behaviour. In simple terms, this means that improving social norm perceptions will lead to continued application of the farming practice behaviour.

The path forward - Increasing farming practices to benefit the environment

The current study demonstrates the role social norms have on the adoption of agronomist recommended farming practices. In this study the desired farming practice behaviours were performed by growers when they felt other growers viewed the performance of this practice positively (see the social norm measure in Table 2). This statistically significant finding demonstrates that farmers can be influenced through social norms and approaches that emphasise others' perceptions will support farmers to continue the recommended farming practice. Norms messages can be developed from survey data insights. Examples would be '*XX% of sugar cane farmers apply the regulated amount of nitrogen to their farms'* or '*4 out of 5 sugar cane farmers have implemented a farm management plan*.'

The social norms item used in this study was singular and our understanding of social norms is more advanced. Social norms capture perceptions of what people think others are doing (descriptive norms) and perceptions of what people think others think they should do (injunctive norms). Inclusion of measures capturing the different types of social norms can further assist development of the farming practice change project. Further examples of the types of measures that can be used to capture the different types of social norms are identified in Table 4.

Table 4. Social norms measures

Measure	Scale Anchor
Injunctive norm measures	
People who are important to me think I should/should not [insert farming practice here].	Should not–should
People who are important to me would disapprove/approve of the [insert farming practice here].	Disapprove–approve
People who are important to me want me to [insert farming practice here].	Strongly disagree–Strongly agree
Descriptive norm measures	
Most growers I know [insert farming practice here].	Strongly disagree–Strongly agree
Most growers in {insert region here] [insert farming practice here].	Strongly disagree–Strongly agree

Source: Pang et al. (2017)

By understanding the influence of particular types of social norms (e.g. injunctive and descriptive) further guidance on communication actions can be gained. Measuring and monitoring descriptive and injunctive norms can provide insights to guide project management. For example, when perceptions of descriptive norms are lower than the proportions of people performing the practice, clear communication about the percentage of growers performing a behaviour will demonstrate what other growers are doing, potentially influencing individual growers' social norms. For lower perceptions of injunctive norms, communication demonstrating approval of other growers will also further increase social norms and in turn increase the desired farming practice behaviour. Supporting actions that increase social norms will support farming practice change ensuring outcomes such as improved water quality are realised benefitting the GBR.

Identification of theoretically derived mechanisms of action enables researchers to determine why some programs succeed and others fail. By applying theory, a roadmap can be identified delivering a fine-grained understanding of how the intervention is (or is not) supporting people to make the desired behavioural changes (Michie & Abraham 2004; Rothman 2004; 2009). By applying theories, such as the Theory of Planned Behaviour, primary industries and natural resource management practitioners can gain some understanding of the human dimension. In this study 23.5% of the variance in the adoption of recommended farming practices was explained by social norms. Other factors outlined in the Theory of Planned Behaviour did not explain adopted farming practices. The study sample size may have limited the explained variance and more research is recommended using larger sample sizes before definitive conclusions are drawn. Larger sample sizes will permit confidence in analytical methods applied in this paper and it will permit further analyses requiring much larger samples to be undertaken including mediation analysis and structural equation modelling. However, the findings in the present study are in line with meta-analytic studies identifying that on average TPB explains 27% of the behaviour studied (Armitage & Conner 2001).

A further limitation of the present study centres on the implementation approach applied. The research team prepared the survey and data was collected by stakeholders involved in the farming practice change project. This may have led to a biased outcome. Administration of the survey by the research team, who had no direct involvement in day-to-day program implementation, direct to growers that permitted anonymity would have minimised any bias in data. Further, implementation of longitudinal research designs would have permitted change to be modelled, extending understanding beyond self-reported current behavioural practices. The data collected in this study was limited to a survey. An ability to apply mixed methods would have extended understanding, providing insights into the failure of attitudes and perceived behavioural control to predict the farming practices that were self-reported in this study. Implementation of observational methods would permit farming practice behaviour to be monitored, extending data assessments beyond self-reports which are prone to social-desirability responding.

Understanding how people think and what people plan to do may help identify how to influence behaviour. The Theory of Planned Behaviour, is one of many theories outlining factors that can be included in evaluation studies to identify the influence that social and psychological factors may (or may not) exert a person's behaviour. When scientific enquiry is supplemented with social science approaches, we can understand more about how and why people act. Moving forward extension services, agronomy support services and natural resource management practitioners should monitor social and psychological factors to build then evidence base to understand more about how desired outcomes are realised. By monitoring social and psychological factors (intentions, perceived behavioural control, attitudes and social norms) and understanding the influence of these factors on farming practice behaviours (e.g. reduction of nitrogen application) practitioners can make program changes that are aimed at increasing the desired behaviour. Improvements in uptake of farming practice behaviours will contribute towards achieving the desired environmental outcomes (e.g. improved water quality).

Theory of Planned Behaviour has its critics (see David & Rundle-Thiele 2018, p. 184) and a considerable body of work has been undertaken on the theory. Applying theories that move focus beyond how an individual thinks and feels will further extend understanding. Calls have been made to challenge the research community to apply and test theories as reported in this paper and to commence work to build understanding of how behaviours can be maintained or changed. Models that consider whether people have the ability and social and environmental support to change do exist in the literature and future work applying other theories clearly and transparently is recommended to further inform practice. The more we can apply roadmaps that are known to work, the more success in program delivery can be guaranteed.

Summary and Conclusion

Psychological and social theories have been built describing why people perform (or not) focal behaviours. Application of theory is recommended but remains rare in practice. This study applied the Theory of Planned Behaviour to understand farming practices, specifically reductions in nitrogen application. The study identified that 23.5% of the variance in farming behaviours was explained by the Theory of Planned Behaviour. Hierarchical regression identified the influence of social norms on the adoption of the desired farming practice. One indicator was used in the current study to capture social norms. Further precision can be gained, and additional measures of social norms are provided for practitioner consideration. In future, measurement of psychological and social factors is recommended to extend understanding beyond what people are doing. Monitoring the factors known to influence behaviour will better enable and support practice change further supporting progress towards achieving water quality targets. By understanding what growers

think support service providers can fine tune communications to change grower perceptions in turn influencing farming behaviour.

Acknowledgements

Data collection was funded by Queensland Government. The preparation of this scientific paper was supported with funding from the Australian Government's National Environmental Science Program. The team thank staff at Department of Environment and Science and Department of Environment and Energy who provided feedback on the survey at the time it was prepared for the evaluation study. Our team wish to thank the Department of Environment and Science staff, the agronomy service provider team and the growers who assisted the data collection and granted us permission to use the data for this work. We wish to thank the growers who completed the survey. The funding bodies were not involved in the data preparation, data analysis, interpretation of data reported in this manuscript.

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Training needs of rural youth for agricultural development: evidence from district Sargodha, Pakistan

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Abstract. The Government of Pakistan is trying to make youth productive in the light of the goals for sustainable development. This study explored the needs of rural youth in Sargodha district of Punjab, Pakistan. A sample of 450 rural youth was interviewed using an interview schedule and a multistage sampling technique. Above 40% of rural youth possess 10 years of schooling and 75% of rural youth is directly associated with agriculture. Rural youth regarded services and campaigns of the private sector more valuable than the public sector. Rural youth public extension offices were rated inefficient in comparison to 'fellow farmers' (94%) and 'marketing agents' (80%). Their participation in agricultural related societies is also ignorable. A kind of thrust was found among the rural youth for training about 'crop protection' and 'capacity building'. Therefore, it is suggested that there should be a holistic training plan for rural youth to make the agriculture sector sustainable.

Keywords: Rural youth, information, awareness, training needs, participation.

Introduction

Socioeconomic development and prosperity of rural areas are dependent on the type of young people living in rural areas because rural youth can have skills to assist the development process. Teenagers as 'change agents' can assist the process for distribution and adoption of modern techniques in agriculture. If the skills and abilities of rural youth are streamlined, then agriculture can achieve growth and prosperity. Information can improve rural livelihoods and empower farmers in developing countries by improving their connectivity (McLaren et al. 2009; Sylvester 2013) and increasing access to agricultural and market information (infoDev 2009). Information also contributes to social justice and equality by empowering marginalized groups (e.g. women, the elderly, and youth) in rural communities in the Global South (IDEV 2016). Information and awareness empower farmers as innovators by accumulating access to innovative information (UNCTAD 2008; Uphoff 2012). Agricultural innovation is about timely access to and use of available information to respond to opportunities and risks (Baulcombe et al. 2009). In developing countries, ICTs are widely used by extension services and advisory services to provide farmers with information and advice (i.e. weather forecasts, plant and livestock diseases, market information prices), via Short Message Service (SMS), web portals, and call centres (McNamara 2008).

Many think young people pose challenges, but some supporters claim that they could be seen as an opportunity to advance rural development. The performance of young and well-educated farmers can lead to greater use of highly advanced farm technology, commercial agricultural practices, and the expansion of non-farm businesses in rural areas (Mueller & Thurlow 2019). These could be important steps to accelerate the transformation of agriculture, and young men and women can become 'transformers' in a region that is in dire need. Aside from developing informed youth, there is a need to understand the information needs of rural youth and focus on the priority areas of rural youth, which is imperative for the growth of the agricultural sector. There is a need to break the stigma of disappointment prevailing in rural youth about agriculture as a profession.

It is evident from different studies that almost one-fifth of the population of the developing world is youth; this youth population will continue to rise in coming decades (Proctor & Lucchesi 2012). Due to this rising population of youth, migration of youth from rural areas to urban areas will become alarming and this migration will be for the sake of employment (UN 2013). Because youth are less interested in the agriculture sector for their livelihoods (Bezu & Holden 2014), it is beneficial to launch capacity development programs for youth to motivate and engage them in the agriculture and allied sectors for sustainable development, poverty reduction, and food security (Hunt et al. 2011). Moreover, rural development also relies on youth participation for sustainable improvement in livelihood and living standards. Thus the government should initiate rural youth supportive policies to activate youth in agro-based income generation activities and to generate self-employment and improve household income (Butt et al. 2011). With the help of training programs, rural youth could be engaged in a better way for agricultural development by providing them agro-based livelihoods (Yaseen et al. 2015).

The rural youth experience variety of hurdles while accessing livelihood opportunities. This includes the unavailability of proper services and networks. There is a broad need to implement strategies for rural youth to engage them in agricultural activities (Porter et al. 2008). The youth is experiencing many challenges and hindrances in adopting the profession of agriculture. One of the main constraints in Pakistan is the economical or financial condition of the country. Due to economic issues, youth prefers migration towards cities (Ghanem 2015). Empowering youth will enhance the quality of the living conditions that can be gained through different programs in this regard (Ledford et al. 2013; Zimmerman et al. 2018). It is a huge challenge for the field of agriculture to keep youngsters involved in agriculture to improve the production and profitability of the country. For agriculture to grow in a country, rural youth is important. The main reasons are that rural youth are brave, motivated, determined, and energetic and can bring new ideas that will help in agriculture (Ahmad et al. 2005). Training programs can help enhance the capability of the rural youth and improve their knowledge regarding the field of agriculture. Training helps in transferring innovative knowledge, skills, and technology to youth that help in enhancing the efficacy and productivity of agriculture (Ogundele et al. 2012). Training needs assessment is a way to find out the rural youth's interests and needs according to their situation and to provide them with a curriculum that is best suited to their situation (Lynton & Pareek 2011).

Therefore, it is imperative to assess various needs of rural youth to improve their vibrant role in the development of economic, social, and cultural conditions of rural youth in Pakistan. As the training programs for rural youth could help to cope with advanced skills and competencies in generating agro-based income sources and other income generation activities on a sustainable basis. After ensuring this, the income of rural families will increase, living conditions will become better, the societal status will flourish and food security will be accomplished. As a result, unemployment, poverty, and food insecurity risks will be reduced.

Methodology

Rural Youth aged 15-24 years living in the Sargodha district were considered as the population for this study. District Sargodha has 7 tehsils (administrative unit/sub-district) including Sargodha, Silanwali, Sahiwal, Kotmomin, Bhalwal, and Shahpur. Purposive sampling technique was adopted for the selection of four tehsils having maximum Union Councils (UCs): Sargodha, Kotmomin, Silanwali, and Bhalwal. Out of 62 UCs in tehsil Sargodha 19 were selected. Tehsil Bhalwal has 53 UCs and 16 were selected. From tehsil Kotmomin six UCs were selected out of 30 UCs. In the case of Silanwali four UCs were selected from 16 UCs. All the union councils were selected through simple random sampling. The percentage of selected UCs from each tehsil is given in Figure 1. Following Bell et al. (2020), 10 respondents were selected from each Union Council using an equal distribution technique. Thus, a total of 450 respondents were finally selected for data collection from 4 tehsils of the Sargodha district. Figure 1 represents the sample selection procedure.

An interview schedule was developed as the instrument of the study for collecting data from rural youth. Both close and open-ended questions were part of the interview schedule, which was designed keeping in view the objectives of the research study. Five-point Likert-type scales were also used in the instrument to record the opinions of the respondents. Content validity of the interview schedule was checked by subject experts and a preliminary survey of 50 young farmers living in Sargodha was also carried out. The respondents who participated in the preliminary survey were excluded from the final data collection procedure. The collected data were analysed using SPSS and descriptive statistics (frequency, percentage, SD and mean) were employed for data analysis and interpretation of the results.

Results and discussion

Figure 2 reveals the demographic attributes of the rural youth living in the rural settings of the Sargodha district. It shows that the maximum number of youth were in the age category of 20-22 years. As for as the educational level of rural youth is concerned, slightly less than half of the rural youth respondents possess education of 10 years of schooling, while only 3% of respondents were illiterate. The findings of Ahmad (2015) also correlate with these findings from the rural youth of Sargodha. Three-quarters of respondents owns more than 5.1 acres (2.1hectares) of farming land. The trend in the income generated by the rural youth of Sargodha is similar to the ownership of arable land (maximum) are earning medium to high income. In Figure 2 it could be seen that PKR1.01 million (AUD 8,400) to 1.5 million (AUD 12,400) and above PKR1.5 million per year is earned by 37% and 36% of respondents. As for as sources of income are concerned (agriculture based, non-agriculture based and both) the highest number of respondents (42%) have both; agriculture and non-agriculture-based income sources, while one-third of respondents rely solely on agricultural income.

Figure 1. Multistage sampling technique of for sample determination

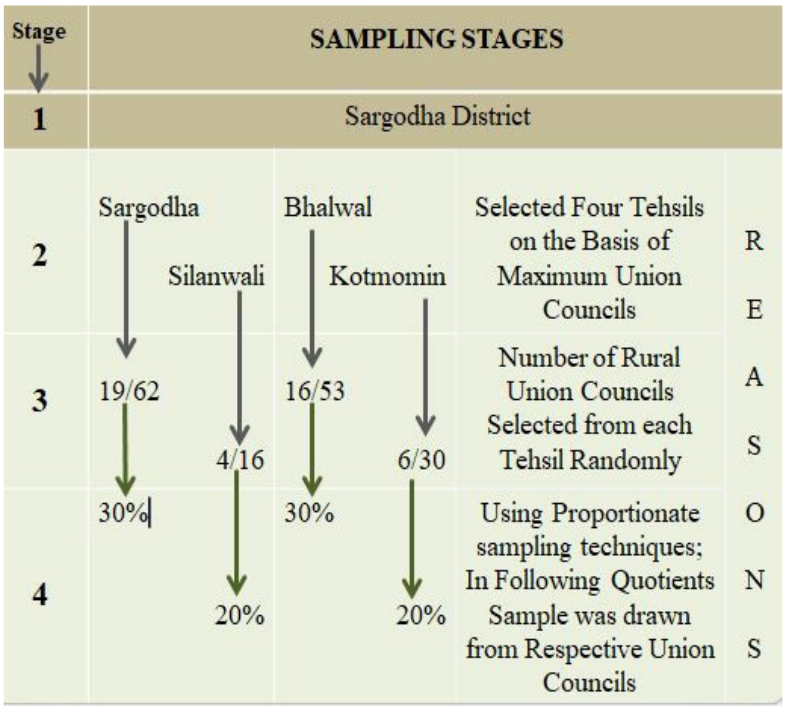
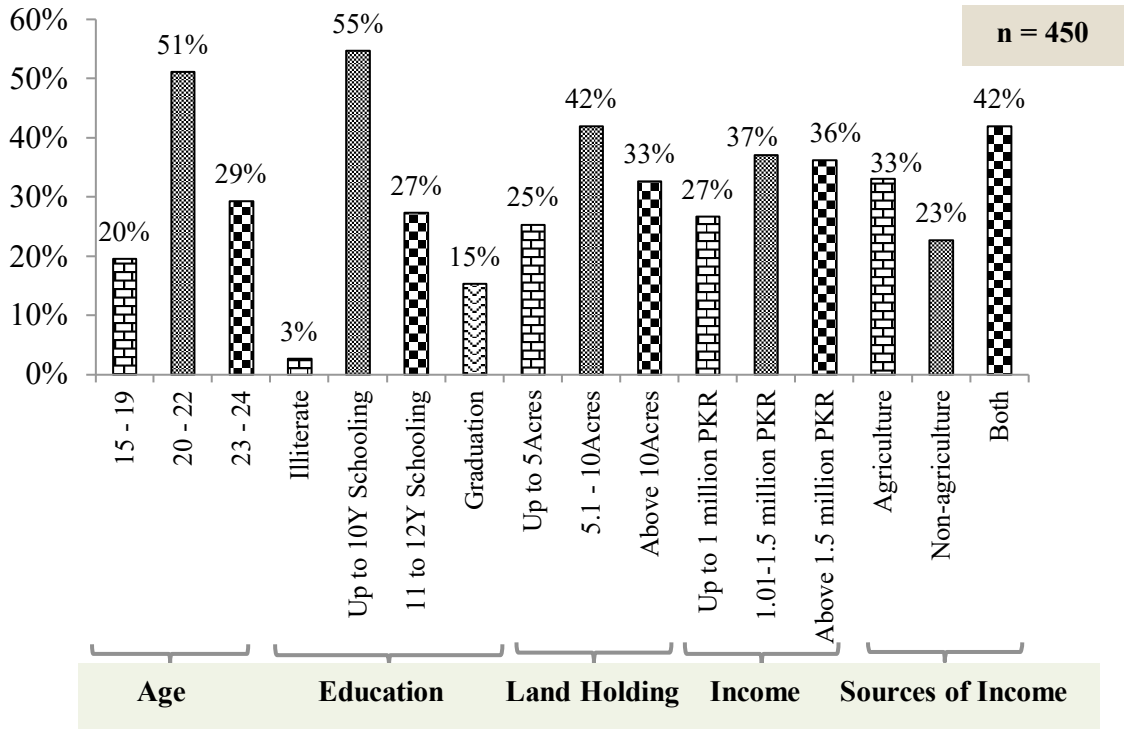


Figure2: Demographic attributes of the respondents



Access to the latest advancements and the internet makes it convenient for rural youth of this era to receive information. The use of mobile phones has revolutionized the field and provided different outlets that help in creating awareness. According to Table 1, these sources are private extension services, public awareness campaigns, public extension and advisory services, electronic and print media, social media, workshops on agriculture and training sessions. The private sector is more accessed by the respondents as compared to the government sector, as 66.4% of rural youth get information and knowledge for farming activities from private extension

services, whereas, 40.7% of respondents were involved in the public awareness campaigns. From public sources (Government Extension Offices) Almost 40% of rural youth get knowledge. Electronic and print media is a very easy and fast method to get knowledge about agriculture but unfortunately, only 37.3% of rural youth get knowledge from electronic and print media, whereas 34.2% receive information from social media. Rural youth have a lack of interest in agriculture and they don't get the benefit of these sources as they should be. Almost 11.6% attended workshops related to agriculture and 0.7% of rural youth attended training sessions for agricultural information. This suggests that rural youth are not receiving sufficient information related to agricultural practices.

Table 1: Sources of agricultural information & knowledge for rural youth

Information sources	%	Freq.
Private extension services	66.4	299
Public awareness campaigns	40.7	183
Public extension & advisory services	39.6	178
Electronic & print media	37.3	168
Social media (Facebook, Twitter, WhatsApp, LinkedIn, etc.)	34.2	54
Workshops on agriculture	11.6	52
Training sessions	0.7	3

Table 2 highlights that most rural youth use local information sources (fellow farmers, marketing agents, and extension agents), although some youth also use cosmopolite information sources (government and private organizations) for agricultural information. Alexopoulos et al. (2009) also stated that rural youth depend on the information sources from where they could obtain face-to-face information. Aside from the fellow farmers and marketing agents as the main sources of information, other sources are less able to meet the needs of rural youth; the needs which have the driving force to advance participation in agriculture.

Table 2: Typology of sources of information

Typology		%	Freq.
Localite information sources	Fellow farmers	93.8	422
	Marketing agent	80.0	360
	Extension agent	20.2	91
Cosmopolite information sources	Private organization	48.7	219
	Government organization	35.3	159
	Research institutions	17.6	79
	NGO's	11.6	52
Mass media information sources	Electronic media	37.8	170
	Print media	34.0	153

Rural youth was asked about their membership of agriculture societies or organizations. Figure 3 illustrates that majority of the respondents (94.2%) were not members of any agricultural society or organization. Only 5.8% of the respondents were active members of different agricultural organizations or societies. Sometimes we only need a push to kick start or adopt anything. That is the role of these societies or organizations. Making youth aware of the importance of sustainable agricultural practices is a fundamental of its kind. The farming communities with appropriate and functional agricultural societies create more managed, informed, skilled, and organized farming communities (Shinde et al. 2020).

Table 3 depicts the data about the training needs of rural youth regarding agriculture activities. All the training needs gain a mean value above 4 (out of 5), so rural youth agree and strongly agree to gain various agricultural training. The training need regarding 'crop protection' was ranked at first with the mean value of 4.67 and SD of 0.536, which indicates that rural youth is eager to participate in 'crop protection training'. 'Vocational agricultural training' (mean value of 4.65 with SD of 0.529) and 'capacity building of rural youth' (mean value of 4.62 and SD of 0.529) were ranked as second and third by the rural youth. The least rated training needs are 'fisheries and aquaculture, 'marketing transportation' and 'handling of agricultural machinery', ranked as 18th, 17th, and 16th respectively.

Figure 3: Membership of agricultural societies/organizations

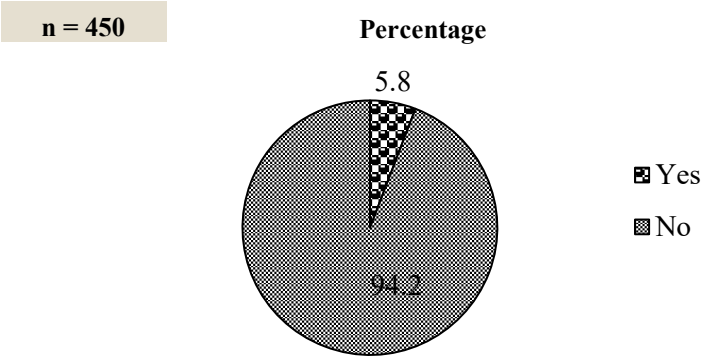


Table 3: Training needs of rural youth

Training needs regarding	Mean	S.D	Ranking
Crop protection	4.67	0.536	1
Vocational agricultural training	4.65	0.529	2
Capacity building of rural youth	4.62	0.549	3
High income generation by agricultural activities	4.54	0.562	4
Vegetable farming	4.52	0.608	5
Crop production	4.51	0.609	6
Kitchen gardening	4.49	0.575	7
Fruit crops	4.41	0.545	8
Decision making	4.37	0.538	9
Pre and post harvesting techniques	4.36	0.678	10
Sericulture	4.30	0.634	11
Cottage industries	4.30	0.662	12
Sustainable agricultural practices	4.29	0.562	13
Apiculture	4.26	0.631	14
Livestock	4.24	0.622	15
Handling of agricultural machinery	4.24	0.721	16
Marketing Transportation	4.20	0.743	17
Fisheries and aquaculture	4.18	0.797	18

Scale: Strongly disagree=1, Disagree=2, Neutral=3, Agree= 4 and strongly agree=5

Managing a small-scale fisheries operation could prove an addition to the income of young farmers. Only motivated young farmers could carry out innovative farming. Rural youth could also be motivated for apiculture, sericulture, fruit crops, kitchen gardening, and livestock as these ago-based activities could help rural youth to generate their livelihoods. Young farmers are lacking in the handling of overpriced agricultural machinery, this costs them thousands for maintenance every year. For minimizing that cost, training in this regard would be a plus. It is clear from Table 3 that each of the aspects related to agricultural activities of rural youth needs training to make them more efficient young farmers.

Conclusion and recommendations

The major sources of agricultural information and knowledge for rural youth are 'private extension services', 'public awareness campaigns' and 'public extension & advisory services'. Similarly, the typology of information sources for rural youth includes local information sources (fellow farmers), cosmopolite information sources (a private organization), and mass media information sources (electronic media). Moreover, the majority of rural youth don't have any affiliation to agricultural societies and organizations. As for as the training needs are concerned, 'crop protection', 'vocational agricultural training' and 'capacity building of rural youth' were the most emerging needs of the rural youth in the research area.

Below are few recommendations to streamline rural youth participation in agricultural activities:

- The rural youth should be motivated and encouraged to use multiple information sources and typology to have diversified information related to agriculture.

- There should be agricultural societies and associations to encourage memberships for rural youth for improving their participation in agricultural activities.
- Rural youth should be provided different need-based training (particularly in crop protection, vocational agricultural training, and capacity building of rural youth) to equip them with advanced techniques and skills for improving their farming activities.

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