

An investigation of social media's roles in knowledge exchange by farmers

Tom Phillips^a, Laurens Klerkx^b, Marie McEntee^c

^aRural Innovation Research Group, Faculty of Veterinary and Agricultural Science, University of Melbourne, (Australia), tom.phillips@unimelb.edu.au

^bKnowledge, Technology and Innovation Group, Wageningen University (Netherlands), Laurens.Klerkx@wur.nl

^cSchool of Environment, University of Auckland (New Zealand), m.mcentee@auckland.ac.nz

Abstract: *Social media (SM) such as Twitter and Facebook are new communication tools for rural communities, and SM has enabled the creation of rural social networks. Increased use by farmers of 'mobile digital devices' and better rural access to broadband services have enhanced so that SM is being used to support farming decisions.*

However, in depth studies on how SM is used for knowledge sharing amongst farmers and the role of rural professionals (e.g. advisors) in this space is an emergent field with limited literature. There is a need to understand more about the roles SM play in farmer decision-making and agricultural innovation more broadly. Is farmer participation oriented to strategic, tactical or operational farm decision making? Little is known about differences in participation between farmers and rural professionals or about learning processes and knowledge creation in these virtual spaces. Does SM create spaces where participants engage on an equitable, trust forming and self-directed basis? What is the composition and global reach of these media networks? How rapidly and flexibly do they form, disband and reconfigure?

To answer these questions, research methods used included 'Twitter Scraping software' and tools such as 'Twitonomy' to mine data off selected Twitter accounts and farmer forums. Also, online pasture based dairy farmer groups were examined in the Facebook study. Preliminary results suggest that Social Media platforms can play a significant role in agricultural knowledge exchange practices. Farmers are building new global networks through SM, willing to collaborate in social learning processes that are creating change and shared cognitive meanings. A concept of farmer initiated 'shared knowledge' is emerging from these online discussions. Posting questions sets the agenda, and farmers are sharing information, providing validation and support for decision making.

Keywords: *Social Media, Farmers, Rural Professionals, Opinion Leaders, Knowledge Exchanges, Engagement, Online Communities.*

Introduction

In recent years, there has been increasing attention to the role of ICTs, and related to that softwares and internet based applications, as tools to support decision making, learning and innovation in agriculture (Aker, 2011; Ballantyne, 2009; Poppe et al., 2013; Shanthy and Thiagarajan, 2011; Sulaiman V. et al., 2012). However, only recently studies in the field of learning and innovation in agriculture have started to include social media, a phenomenon which has emerged with the progress towards Web 2.0 technologies and the rise of internet enabled mobile phones (Cerkenková et al., 2011; Chowdhury and Hambly Odame, 2013; Jespersen et al., 2014; Materia et al., 2014; Poppe et al., 2013; Rhoades and Aue, 2010).

Social media are a broad term to comprising different forms, but most dominant are social networks like Facebook, LinkedIn, micro-blogging services like Twitter, and video and image sharing platforms such as YouTube and Vimeo (for an exhaustive overview, see (Chowdhury and Hambly Odame, 2013; Murthy, 2012).

Facebook was established in 2004 as a social networking site and Twitter began in 2006 as a 'micro-blogging' platform. It is estimated that 79% of Australians used Facebook and of that 49% use it daily (Sensis Report, 2017). There are now many social media sites on the internet that all connect people to a personalised community in some way e.g. on Twitter the use of a # (hashtag) allows members of a community to share in the conversation. The World Economic Forum (August 2017) estimated that in an 'internet minute', there would be 900,000 Facebook logins (cf. 701,389 in 2016) and 452,000 tweets sent (cf. 347,222 in 2016). In the past year Facebook logins grew by 28% and Twitter traffic by 30%. The growth in the personal use of social media has been extraordinary. Facebook now has more than two billion monthly users, SM is also being increasingly used for knowledge sharing amongst farmers and rural professionals (e.g. advisors).

While there is an increasingly growing body of literature on people's use in general of social media, there is very limited literature available about how farmers and rural professionals are using the numerous platforms (except Kaushik et al., 2018). There is, therefore, a need to understand more about the roles SM play in farmer decision-making and agricultural innovation more broadly.

To address this limited scholarship around farmers and rural professionals use of social media, this paper analyses Facebook conversations from two pasture based dairy farmer Facebook groups, and one series of twitter activity and then explores how these contribute to farmers, decision-making, and knowledge sharing and (co)creation. The paper begins with an exploration of the literature on farmer learning in networks including online networks. The paper then moves to the results section which is divided into two parts. Part A contains analysis of three Facebook groups. The first two took place in May 2014 with two separate 'closed' dairy farmer pasture groups, while the third took place in one of these groups in 2017. Part B compares farmer and rural professionals use of twitter by examining the Twitter activity of 48 New Zealand 'experienced' agricultural Twitter account holders who posted 23765 tweets over a 5-month period. The paper presents a discussion that explores how social media contributes to farmer knowledge sharing and the potential this offers for agricultural innovation

Learning in farming networks - a literature review

The term 'social media' denotes highly interactive internet platforms via which individuals and communities share, co-create, discuss and modify user-generated content which is media rich (Kaplan and Haenlein, 2010; Piller, Vossen and Ihl, 2012). These online communities (OCs) are open collectives of dispersed individuals and members with weak ties, who are not necessarily known or identifiable but who share common interests (Sproull and Arriaga, 2007). Furthermore, social network sites are "web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system. The nature and nomenclature of these connections may vary from site to site." (Boyd and Ellison, 2007:211).

Farms are part of a complex social, cultural and environmental ecosystem. Farmers are not isolated individuals they are part of many social networks. Farmers are not passive receivers of information, rather they build support networks for their constructs of reality (Kelly 1955, Bannister and Fransella, 1971) in a world of rapidly increasing uncertainty and variability. Farmers increase their farm business resilience (Shadbolt et al., 2013) by using 'buffer capacity' (make the existing systems stronger), 'adaptive capacity' (make small changes to

existing systems), and ‘transformability’ (create completely new systems by making radical changes) to cope with this volatility.

Their perceptions of what is ‘true’, what they can aspire to and what they are able to do, are influenced by their daily routines, what has happened in the past and the feedback they receive (Leeuwis, 2004). The nature of the strategic, tactical and daily decision-making (Shadbolt and Martin, 2005) is heavily influenced by a historically grown farming system and the body of knowledge that has evolved over time, plus their role on the farm. Prior to 1989 and the internet, farmers lived in small sometimes isolated rural communities. Most neighbours were farmers often farming in a very similar manner. Farmers and their families were regarded as mostly self-sufficient, working with neighbours at seasonal peaks and socialising with the same families. These rural communities had and still have tight social network ties.

So why do farmers join these networks. In theoretical terms, value creation can be conceptualised as the formation of social capital. Bourdieu and Wacquant (1992: 14) define social capital as “the sum of the resources an individual ‘accrues’ on the basis of belonging to ‘durable networks ... of mutual acquaintance and recognition.’” The concept has a varied and influential history, including in online analysis. Putnam (2002) made an influential distinction between the two types of social capital. Bonding capital is the value associated with networking between homogeneous groups of people held together by strong ties. Bridging capital on the other hand is the value associated with networking between heterogeneous people who are weakly tied together. Bonding occurs when people socialize with like-minded people, bridging capital occurs when people socialize with people not like them.

The principle of homophily (Bontcheva and Rout, 2014) says that people associate with other groups of people who are most like themselves. Farmers bond with other farmers, who are their main source of farm management information, despite the availability of agricultural research, extension services and agricultural media (Phillips, 1985; Parnell et al., 2006; Barr, 2011, Evans et al., 2017). Social networks have been recognised as influencing an individual farmer’s decision-making (Phillips, 1982; Phillips, 1985) and self-directed learning projects (Tough, 1978).

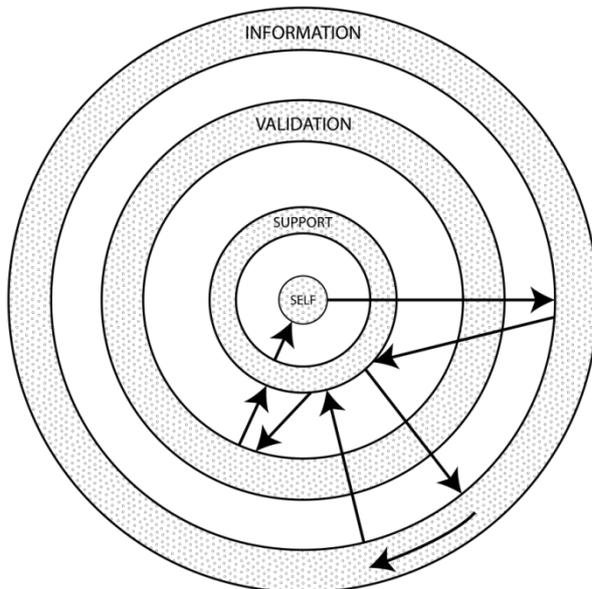


Figure 1. A model – The learner’s social environment and learning pathway (Phillips, 1985).

Phillips (1985) developed a model to describe the farmer’s social network and how networks were used to transform information to actionable knowledge and decision--making on farm.

Farmers' trust in individuals in their network influenced the level of support they received from those individuals. Phillips found acquaintances were used not only as a source of information but importantly to validate information received, while intimates played a crucial support role for the primary decision-maker. Many 'information providers' including extension workers had only minor roles in the farmer's decision making and learning. Fisher (2013) described the role of social capital and trust in transforming information into usable knowledge.

The term 'situated learning' and the concept of 'communities of practice' (Lave and Wenger, 1990, Wenger 2000,) evolved to see knowledge being attained not purely from the individual accumulation of information but as an act of social participation (Bandura, 1989). Collective learning and a shared competence emerged from groups who met and connected regularly. Communities of practice ask questions, request information, seek experience and problem solve within their domain. The collective knowledge is a critical asset of the network and relies heavily on the experience or tacit knowledge of members. Exposure to tacit knowledge, which "maybe "harvested through storytelling, interviews, communities of practice and social networks" (Evans et al., 2017:3) enables the construction of actionable knowledge.

A number of research papers about the nature of agricultural knowledge exchanges and farmer learning have emerged from a major 'learning project' (Managing perennial summer forages) conducted by a multi-disciplinary team at Massey University in New Zealand (Sewell et al., 2014a, Sewell et al., 2014b, Wood et al., 2014, Drysdale et al., 2017, Henwood et al., 2017, Sewell et al., 2017). Collectively these highlight the failure of the traditional linear extension model. Their work focuses on the processes of interactive learning, the importance of belonging to a learning network, validation of learning and farmers' self-efficacy. Self-efficacy (Bandura, 1997) is a self-belief and confidence in one's own ability and has been suggested as a factor in decision-making (Drysdale et al., 2017), change management and social networking and learning. This sociocultural approach to farmer learning (Sewell et al., 2017) requires consideration of the networks, interpersonal skills and personal factors. One might judge the effectiveness of a group, network or online community Woolley et al., (2015) by the structures, processes and norms (Group up processes) or the group composition e.g. gender and diversity (Bottom up processes).

Social media is now enabling people to participate in knowledge networks online. "Online Communities (OC) are a virtual organisational form in which knowledge collaboration can occur (often among people not known to each other) in unparalleled scale and scope. The fluidity engenders a dynamic flow of resources in and out of the community and affords collaboration. Online communities have a world-view that the collective intelligence is very important. This is not dissimilar to peoples of 'First Nations' (Durie, 2005, Tapsell and Woods, 2008, Nicolson et al., 2012; Phillips, 2016) where traditional indigenous communities hold collectivist principles and social values that value the wellbeing of the community above that of the individual. "The fluctuation in tensions creates opportunities of working together" (Faraj et al., 2011:1224). Much of the knowledge collaboration appears to take place in the absence of existing social relationships. A growing 'sense of belonging' to a learning or problem-solving community (Sewell et al., 2017) might override the importance of trust in face to face engagement. Building collective knowledge capacity becomes 'embedded' (Sewell et al., 2014) in participants' social interaction. Furthermore, there is a substantial move away from individual information centric thinking to community centric and 'collective knowledge'.

People use social networking sites 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. These vary according to the social media platform. 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. Majchrzak et al. (2013:39) describes four ways people engage in online media: metavoicing, triggered attending,

network-informed associating and generative role-taking. While people’s comments and replies are reasonably straightforward, ‘likes’, ‘shares’, acronyms, abbreviations and neologisms (Reed, 2014) are more complex to interpret and often have multiple meanings. Conversations are recognised as key building blocks that enhance interactive learning and the knowledge of the members within the online community (Raaijmakers et al., 2008, Woolley et al., 2010, Woolley et al., 2015). Conversations involve exchanges of opinion, or ‘constructs’ held by participants (Kelly, 1955) that they believe to be true. The resulting learning that may occur from the exchange of “personally relevant and viable meanings” (Thomas and Harri-Augstein, 1976:2) may well mean that individual’s constructs are changed.

Results: Part A - Analysis of Dairy Farmers’ use of Facebook Groups

The way in which 2100 dairy farmers, including farm staff and rural professionals were using Facebook was investigated during May 2014 by analysing two different ‘closed secret’ Facebook groups (see Table 1), where participation required request and then administrator acceptance into the group and conversations were held among ‘members’ only in what could be termed a ‘gated’ community. The two groups were selected as the authors had unique access. These online communities of pasture based dairy farmers have formed for the purposes of discussing ‘Farm Management’ decision making (referred to as ‘conversations’). The groups are not unique but data on similar groups has not been recorded.

Group A had 1400 members (established 2011) and was administered by a dairy farmer. Group B (2008), had 700 international members from 12 countries and was established by a pasture based dairy farm consultant.

The role of the group administrator is integral to the membership, group rules of engagement and the social nature of the group. Both group administrators initiated 16% of the Facebook conversations during the 2014 research. Group A’s administrator was a very active participant in most conversations.

Facebook ‘knowledge exchanges’ were categorised into either ‘Conversations’, ‘Notices (curated material) or advertisements’ (typically no comment responses to a post but possibly ‘likes’). Group A’s administrator actively discouraged ‘Job and Livestock sale’ notices whereas they were encouraged in Group B.

Table 1. Comparison of Group A and B’s use of Facebook.

	Group A		Group B	
	Totals	Averages	Totals	Averages
Total number of Farm Management conversations (only)	47		31	(Social not included)
Total number of posts	1354	28	191	6
Number of posts asking questions	138	3	30	1
Number of posts replying to questions	991	20	134	4
Validation of comments	225	5	27	1
Likes	1456	31	222	7
Photos	2		3	
Links	4		10	
Research days of Facebook activity	5		70	

New conversations per day per group	10		>1	
Total conversation time (average time per discussion in hours)	549	12	2195	71

100 Facebook ‘knowledge exchanges’ were analysed, 50 for each group. Group A conducted 50 conversations in 5 days (10 new engagements per day) whereas Group B took 70 days to complete 50 conversations. The average duration of a conversation was 35 hours (Group A nearly 12 hours average, Group B 70+ hours). 100 ‘knowledge exchanges’ was judged to be representative of the farmer Facebook group activity. Group A was more active than Group B.

Table 2. Analysis of the main conversations according to conversation topics for Group A and B

Conversations Scores	Conversation Topics				
	Animal Health	Employment	Farm Business	Nutrition	Pastures
Group A					
Total number of conversations	2	14	7	2	2
Percentage of topics	4.3	29.8	14.9	4.3	4.3
Total number of posts	45	704	195	20	38
Percentage of posts	3.3	52.0	14.4	1.5	2.8
Group B					
Total number of conversations	1	5	5	5	3
Percentage of topics	3.2	16.1	16.1	16.1	9.7
Total number of posts	7	14	29	35	36
Percentage of topics	3.7	7.3	15.2	18.3	18.8
Combined Group					
Total number of conversations	3	19	12	7	5
Percentage of topics	3.8	24.4	15.4	9	6.4
Total Number of posts	52	718	224	55	74
Percentage of posts	3.4	46.5	14.5	3.6	4.8

All conversations were categorised into 16 different subject groupings (Table 2). The topics discussed were seasonally relevant to the initiator of the ‘conversation’. In Group A, conversations were dominated by employment related topics (30%), social (21%) and farm business management 15%.

In Group B the nature of the conversation topics was different. There were very few social conversation topics and a greater spread of farm topics, employment (16%), farm business management (16%), dairy cow nutrition (16%), milking 13% and pastures (10%). Advertisements were predominantly job and livestock sales related. Notices (curated material) covered a wide range of websites/links of interest to farmer group members.

‘Farm Management conversations’ that were analysed contained 1545 comment responses and 1724 ‘likes’ i.e. 42 responses per conversation. The average conversation had 20 comment responses (Table 3). The groups had different levels of engagement activity. Group A (28 comments plus 31 likes per conversation) compared to Group B (6 comments plus 7 likes per conversation). There was a range of engagement from a large employment related

conversation (112 comments plus 141 likes) to the smallest being (2 comments of clarification in a livestock for sale conversation).

Table 3. Summary of both groups 2014 Farm Management conversations.

Conversations	Total
Total no. conversations	100
Total no... of responses	1545
No. Posts asking questions	168
No. of posts replying	1125
Validation	252
Likes	1724
Research time days	6
New conversations/ day / group	21
Total conversation time hours	2743

The 1545 comment responses were analysed as ‘Asking further Questions’ (11%), ‘replying and providing additional information’ often tacit knowledge (73%) and 16% were ‘Validation responses of either the original post or to subsequent responses’. The ‘likes’ are also a form of validation. So, if the ‘likes’ are added to the ‘validation comments’ the total forms of validation responses (1976) becomes very significant.

Table 4. Differences between the two (closed) dairy Facebook groups

	Group A	Group B
Group members	1400	700
Age of group	3 years	6 years
Location	Mainly NZ	International
Time to record 50 engagements	5 days	70 days
Average New Conversations per day	9+	<1 per day
Average engagement per conversation	28 comments plus 31 likes	6 comments plus 7 likes
Number of different people initiating conversations	38	29
Facilitation / Administrator started conversations	8	8

Part A, 2017 analysis of Group B

In 2017, a further analysis of Group B’s Facebook group was undertaken as this international pasture based dairy farmer group has evolved into a larger more active online community group. What had changed to the group engagement and the knowledge exchanges?

Membership in December 2017 was 1208 compared to 700 in 2014 (+508) with 949 males and 259 females (78% male). The group members come from 15 different countries with most living in the UK (68%). Of the non-UK members there are participants from New Zealand (13.2%), Ireland (9.2%), Australia (4.6%) and France (3.4%) with small numbers from Indonesia, Netherlands, Belgium, Argentina, Norway, Saudi Arabia, Switzerland, Italy

and Latvia. Rural Professionals were 7% of the membership. This pasture based dairy group now has a diverse membership.

During the 6 months to December 2017, there were 211 posts that initiated a conversation of which 116 were advertisements placed by the members, 87 were Farm Management conversations/questions (divided into Strategic, tactical and operational decision-making topics). The remainder were an assortment of Administrator posts, photos of farm operations or links (curated material) to other websites of possible interest to group member.

Table 5. Summary of Engagement Analysis 2017

	Posts	Engagements	Engagements per post
Advertisements	116	793	6.8
- Staff employment	40	397	10.0
- Livestock for sale	45	258	5
- Livestock wanted	13	67	5
Farm Management	87	2436	28
Strategic	47	1644	35
Tactical	28	445	15.9
Operational	12	151	12.6
Admin, Photos, Links	9	196	21.8
Average engagement per post	212	3229	15.2

The number of new Farm Management questions (agenda setting posts) rose from less than one per day (2014) to nearly 2 per day over the research period in 2017. In the Farm Management ‘conversations’ the total engagement (comments/replies plus likes) increased from 13 (in 2014) to 28 per post in 2017.

Table 6. Participation response of the group 2017

	% of posts	% of engagement
Advertisements	54.7	24.6
Farm Management	45.3	75.4
Type of Decision	% of Farm Management	% of engagement
Strategic	54	75.4
Tactical	32.2	19.9
Operational	13.8	6.7

Total Agenda Posts = 212

Although farmer advertisements for livestock and staff were 54.7% of the number of posts during the 6 months in 2017 they only represented 24.6% of the engagement. Most of the engagement and activity of the group discussions centred on Farm Management decision making and knowledge exchanges. The dominance of strategic farm management decisions reflects the membership being predominantly farm owners.

Table 7. People and Posts from Group B in 2017.

Post information

Total no. of different people posting agenda questions 121

No. of agenda posts	212
Members making 3+ agenda questions	18
The 18 members made	81
No. of members at 16.1.17	1208
No. of people posting agenda	121
Representing % of membership	10

Eighteen individual members asked 81 of the agenda questions which represents nearly 35% of all Farm Management conversations during this research period. These 18 people (both genders) appear to be younger members. Farm Management conversations were not initiated by 1087 members (nearly 90% of the total group). This is not unusual in Social Media knowledge exchanges. The rule of thumb is 10% engagement and 90% silent or passive observers. The passive observers will include people who are keenly watching the discussion but not being actively involved in that conversation, to those who are not regular users of Facebook. It is difficult to assess their involvement nor should assumptions be made.

Table 8. Social Media Response Ratios.

Category	Number
Creator	1
Engagements	9
Silent Observers	90

Interpreting Farmers' use of Facebook

Dairy farmers utilised Facebook 'closed/secret' groups for discussion to assist in farm management decision-making. Only a small number of rural professionals joined the groups largely as observers. The online groups act and behave in a very similar way to on-farm discussion groups or groups of 'like-minded' farmers meeting to discuss on-farm business issues. Online networks encourage self-managed groups, reducing barriers of time and distance.

It is likely that belonging to a Facebook group is cost effective for the farmer participants, given the time convenient and travel free nature of the involvement. For rural professionals Facebook conversations challenge typical forms of extension with the agenda being set by individual members asking questions, not the administrator setting the agenda topics, however it provides excellent opportunities for participatory engagement.

The closed groups which have high levels of privacy on Facebook, provide a secure environment for open and frank conversations. Among participants there appears to be a willingness to help each other in a supportive manner within the online community. "*This is a great way to meet like-minded farmers where you can be bluntly honest*" quote from a UK farmer in the group. Conversations typically begin with a question that sets the frame for the resulting posts. Farmer members take each 'agenda setting question' and resulting conversation on merit and try to contribute positively by adding information and solutions gained from personal experience. The responses are based on farmers' 'tacit knowledge' which provide information for the discussion. However, validation of knowledge and support

for on-farm decisions or changes in farm management thinking, modes of operation and strategic direction, were also an important component of the knowledge exchanges.

Topics reflect the time of year and the seasonal cycle of tasks on a dairy farm for the farmer who initiates the question/conversation thread. The nature of the comment responses, display a high level of experience, knowledge and expertise. Opinions and observations are challenged. The personal 'storytelling' is powerful, effective and appreciated by other group members. The administrators do initiate new conversations but their main activity is establishing community norms for the group.

Each group has a strong social identity created by the nature of the group diversity, community norms and participants posts contribute in a supportive way. The online social behaviour appears to reflect life in rural or learning communities, although each group is distinctly different. Group A are mainly farm managers and sharefarmers from New Zealand whereas Group B is international, gender diverse and mainly farm owners or key decision makers. The time-zone differences within the international group (group B) act to increase the hours of conversation and conversations that are 'out of season' and non-English speaking farmers appear to have more limited engagement in conversations e.g. the French speakers tend to be passive observers not often posting. While farming in a different country usually excludes interest in buying or selling livestock or responding to social media livestock advertisements. Farm staff advertisements are often written to attract potential staff from different countries. Group B's support for advertisements in their posts enables participants to advertise for staff without paying commission or fees.

Possible reasons for Group B being a much more active group in 2017, include it being a larger, more diverse community which is more experienced in using social media. The new membership appears more active in seeking information and more willing to offer solutions based on their tacit experience.

There appears to be a visible pathway from passive observer to active participant (Observation – Comment - Curate and Create) in the way in which farmers communicate knowledge exchanges on Social Media. All farmers are learning how to use these new SM tools to the advantage of the farm business and their own personal learning. *"Thank you for your responses. I never expected to learn so much from joining this Facebook group. This is so helpful for a beginner farmer like me."* Quote from a French farmer member in Group B.

Social Media knowledge exchange processes

Figure 2 reveals a simplified visual conceptualisation of how social media (SM) knowledge exchange develops in online communities such as Facebook. Conversation threads start with a question which effectively sets the agenda. The more detail and setting of the context or background for the question, the more likely the question will get responses from the online community.

The anatomy of a Facebook group knowledge exchange conversation

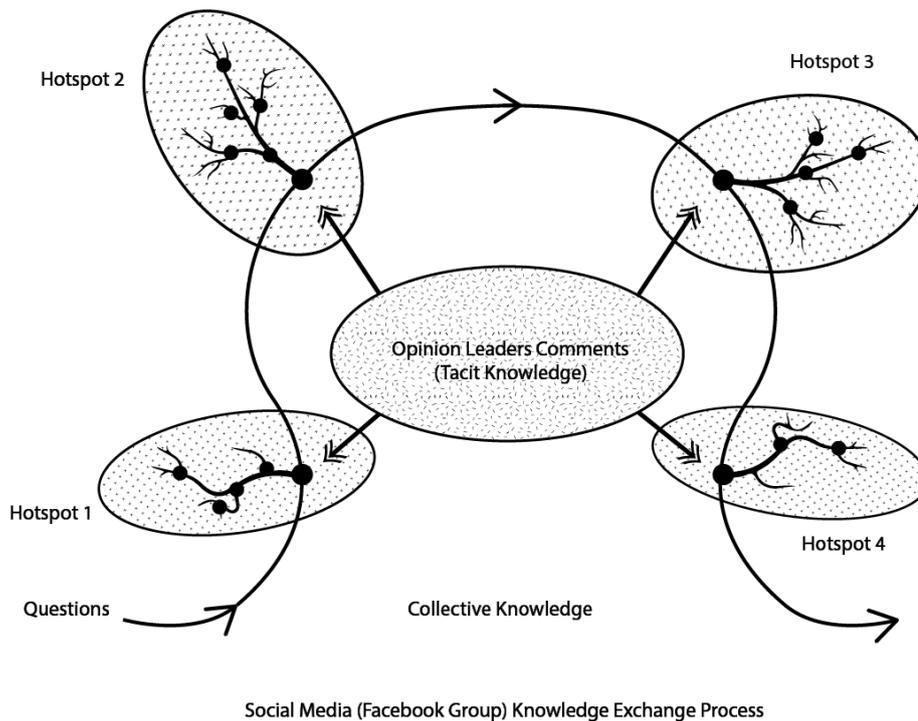


Figure 2. Simplified visual conceptualisation of the social media knowledge exchange process amongst Facebook users

Opinion Leaders (OL) provide detailed responses based on their tacit knowledge. These OL posts that are often media rich with photos, figures, videos and links create a burst of SM activity called a ‘Hotspot’. It is this ‘media richness’ and self-efficacy of individual posts that identifies Opinion Leaders. Within the ‘Hotspot’ the OL plays an important role of providing further information and answering questions. The conversation is quick, not a linear process and can be ‘interrupted’ by a second or third OL. These OL comments in turn create their own ‘Hotspot’.

The following excerpt from the dairy farmers’ Facebook conversation saw hotspots of social media activity develop around opinion leaders’ media-rich comments.

Conversation Original Question (UK):

I'd be interested to see photos and 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?"

Opinion Leader Comment (UK):

"£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." (6 photos included in post)

Opinion Leader comment (Germany):

“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” (3 photos included).

Opinion Leader comment (New Zealand):

“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 regrassing 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!! Its considerably cheaper and the paddock is returned to the rotation a lot quicker for grazing.” (2 photos included in post).

Conversations range from 2-150 hours and often end abruptly, either because the conversation has run ‘its’ course or it is being pressured by the presence of new topics and engagement in new conversations. There are rarely conclusions drawn nor summaries of the complete conversation unless the original questioner does so. There is no facilitator nor chairperson managing the discussion. Furthermore, opinion leaders in one conversation about a topic are rarely OL in a different topic.

Conversations are spontaneous and unpredictable. Vigorous discussion (based on the number of posts/day and the degree of media richness) is likely to encourage more posts. Facebook archives the conversation which adds to the collective knowledge of the network or community. The nature of most knowledge exchanges would suggest a strengthening of both buffer and adaptive capacity (Shadbolt et al 2013) rather than evidence of transformability. The social environment is supportive, either neutral or positive and encouraging of individuals ‘learning efforts, providing evidence of ‘social bonding.

Conversations are much more complex than suggested by the above conceptualisation. The main reason for this complexity is that not everyone is in the same room at the same time, compared to a face to face meetings as detailed by Raaijmakers et al. (2008). Using the actual time each post is logged on Facebook, with participants being to be identified in login order and the time and date recorded, the complexity would become more apparent. To analyse the conversation, posts could then be identified as questions, comments, requests, answers or likes and the emotions (positive, negative or neutral) adapted from Raaijmakers et al. (2008). This methodology for social media analysis is being explored further by the authors and may include Twitter ‘knowledge exchanges’ which the authors believe could be similar.

Results: Part B - Comparing Rural Professionals and Farmers use of Twitter.

The Twitter component of this social media study examined the Twitter activity of 48 New Zealand agricultural Twitter accounts, posting 23765 tweets over a 5-month period (YTD 2014). These accounts were chosen because they were experienced Twitter users. The 24

farmers had posted in total 60,428 tweets (average 2518 per account) and the rural professionals 40,174 tweets (average 1674 per account). The farmers had an average of 550 followers each and the rural professionals 484 followers per account. This research did not examine either Twitter forums or the use of hashtags.

Twitter generates metrics that code the tweets according to an array of variables and we have used Twitonomy to collect these scores. The general approach is aggregating Twitter metrics to create composite variables that measure online interaction. This sort of approach is frequently used, especially by the copious marketing research done on Twitter. For example, a common way of measuring a tweeter’s market ‘engagement’ is to sum their replies, retweets and mentions. It compounds what can be distinguished as the values of bridging (retweets) and bonding (replies and mentions).

Twitter activity among the selected group of farmers and rural professionals in New Zealand shows relationship building through active communal conversation. This is most evident in the high proportion of replies as the means of communication, and suggests twitter use among rural professionals and farmers is well evolved with open participation, collaboration (retweeting) and fuller engagement (asking questions, providing answers/replies) dominating one-way messaging (new/ original tweets) – see Figure 3.

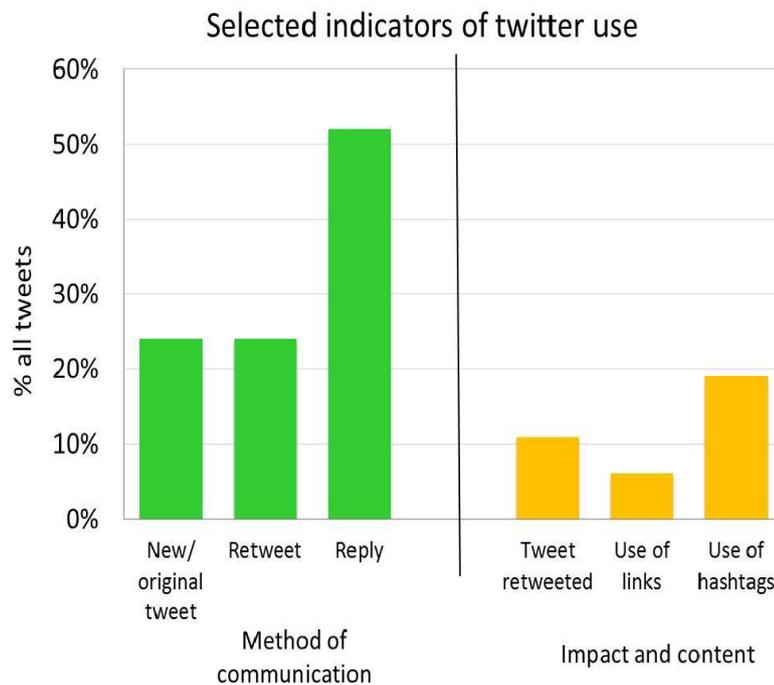


Figure 3. Twitter activity among selected farmers and rural professionals in New Zealand

There were key differences in approach between rural professionals and farmers. Rural professionals made greater use of retweeting, links and being retweeted, all forms of bridging capital. Farmers were considerably more active ‘repliers’, mentions, being favoured, following and being followed (bonding social capital). Initial findings suggest farmers used twitter more conversationally (question and answer). 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 (incidence of tweets being retweeted – see figure 4) and content (inclusion of externally created content)

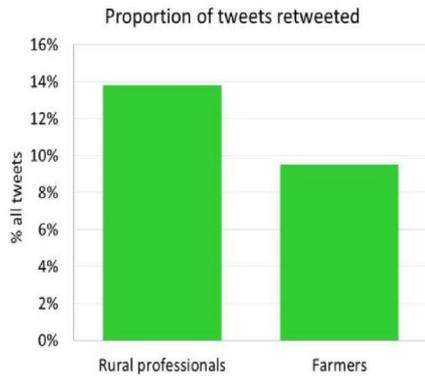


Figure 4. Comparison of tweets retweeted by farmers and rural professionals.

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 (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.

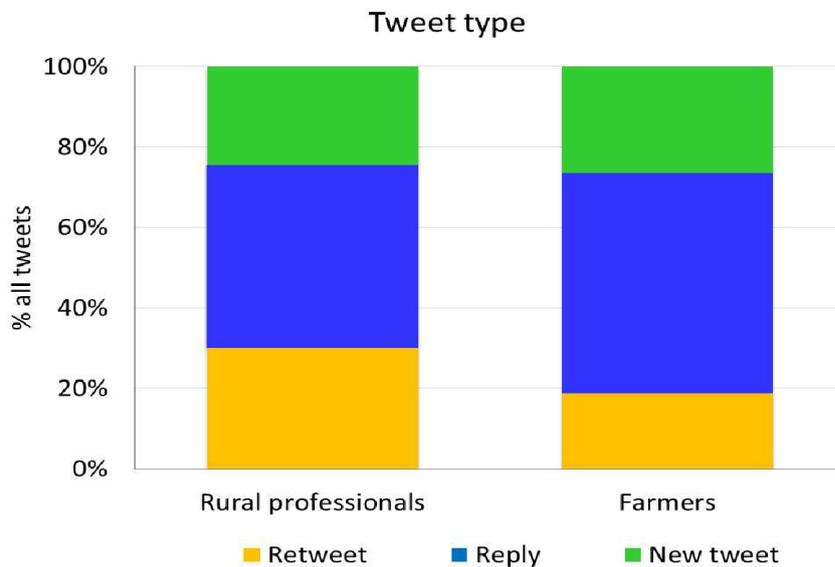


Figure 5. Comparison of farmers’ and rural professionals’ tweet types.

Dairy farmers used Twitter between 4am-10pm 7 days a week and 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 help fellow farmers problem-solve. The social ties are even weaker than the Facebook closed groups. By posing questions members set the agenda. Conversation is very fast and can rapidly engage multiple players worldwide. Social media connects farmers and rural professionals to enhance on-farm decisions.

Interpreting Farmer and Rural Professionals use of Twitter

Participants use Twitter to seek and share information and to gain social support through expanded online networks. Qualitative analysis of tweets revealed they were mainly about farming and personal experiences of the user. With no expectation of a response to their tweets, 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 favoured by followers. Users analysed in this research, appeared to be acutely aware of their audience even if there was little direct feedback from that audience. One New Zealand farmer who had 999 followers clearly enjoyed others following his tweets and

offered to reward his 1000th follower with a chocolate fish (an iconic kiwi sweet) as he had done for his 100th and 500th followers.

Tweets were frequently written as informal comments about life on the farm, and sometimes included links to interesting media stories and websites. Pictures were also posted to share with others about 'life at the office'. Although Twitter was more commonly accessed by users in this study on a computer, its accessibility via a smart phone 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. Twitter enabled people to stay connected according to their daily routine. One rural professional app developer tweeted during the night as he worked and was quiet during the day when he slept. Social media does not require real time audiences.

Farmers' use of twitter displayed a visible evolutionary pathway (Observation, Comment, Curate and Create):

1. Just Observation
2. Low Engagement (One Way Messaging)
3. Open Participation to Collaboration (retweeting)
4. Fuller Engagement (Creating Two Way Conversations)

Whereas rural professionals twitter usage is largely 'Low Engagement' with mostly one-way messaging. This suggests a more linear and traditional 'top down' approach to 'extension' thinking and philosophies and does not appear to maximise the potential of social media as a platform for collaboration or knowledge exchange. The farmers on the other hand have in relatively short time moved from just observing to an effective use of the SM tools in Facebook and Twitter, to create two-way conversations and fuller engagement with the communities they have joined. This is a 'network model' of knowledge exchange as described by Jespersen et al (2014).

Discussion

This work reveals that farmers are building new international networks on social media and are willing to work together toward meaningful change. They are using social media in online networks to advance their self-directed learning strategies, mostly with other farmers.

Facebook and Twitter conversations in this research showed that farmers used social media to connect with other farmers and rural professionals (bonding and to a lesser extent bridging capital.) Farming is noted for its social isolation caused by its geographical remoteness and long working hours (Alston 2012). Social media provides channels for breaking down this isolation by enabling rural actors to stay socially connected, while still being physically remote. While Twitter and Facebook both facilitated social connectedness, they achieve this in different ways.

Unlike Twitter, Facebook provided more scope for conversations, with an expectation from users that posts would be answered. Rural users used Facebook to solve problems, gather information and converse with virtual networks on topical and even controversial issues. Since the platform's accessibility was more suited for use on a computer, conversations typically started in the evening once work on the farm had ceased for the day. Problem solving discussions were largely designed to enhance on-farm decisions.

Like on-farm discussions, virtual problem-solving discussions, showed the constructed nature of knowledge production. In the virtual world, as in real world discussions, knowledge

that is not readily available is developed and adapted 'on the spot' through interactions between farmers, scientists and rural professionals (Leeuwis, 2004). This development is an important source of knowledge exchange for innovation, and corroborates recent findings by (Kaushik et al., 2018). In social media, however participants are often international. Local discussions became global discussions in the virtual world. While networks were largely dominated by farmers, rural professionals did join conversations. Members' responses were shaped by their personal characteristics such as the user's experiences, status on the farm, age and gender.

In the virtual world, non-verbal cues such as body language and vocal variation that are so critical for message understanding in face-to-face communication, appear to be replaced by language embellishments. Texting language - LOL (laugh out loud) or exclamation marks (!!!!!) are used to enrich comments in these virtual discussions. Female participants in the analysed conversations were more likely to add these language embellishments to their comments. The online community's diversity and gender balance (Woolley 2015) is a key factor in the quality of knowledge exchange.

Users in discussions, acted as a peer network consisting of weak ties. The importance of social networks in fostering change in the agricultural sector is widely recognised (Phillips, 1985; Ridley, 2005; Kroma, 2006; Sligo and Massey, 2007). The development of weak ties in networks is recognised as an important source of information for innovation development (Gielen et al., 2003). Problem solving discussion groups in social media therefore have the potential to provide a useful channel for fostering important weak ties that are deemed necessary for innovation development.

Conclusion

This research has shown that farmers use social media for knowledge exchange to support on-farm decisions. Knowledge that is not readily available is discussed, questioned and validated within online communities and potentially could give rise to rural innovation. Farmers using both Facebook groups and Twitter have mastered the skills of full social media engagement and have embraced the concepts of community (a network model) and collective knowledge. Whereas rural professionals are primarily using social media as a platform to disseminate information and do not appear to be maximising the potential for social media to engage in knowledge exchange. The nature of the social capital being employed by farmers (bonding) is quite different to that of rural professionals (bridging).

The role of 'Opinion Leaders' (OLs) has emerged as being very important in creating 'Hotspots' of high activity in online conversations. OLs share media-rich tacit knowledge and if the community is diverse, vigorous high-quality discussion can be created. The OLs demonstrate high levels of farmer self-efficacy and trust. Although the connotation of trust appears to be one of the distinguishing differences between social media activity and face to face farmer problem solving. In social media much of the knowledge collaboration appears to take place in the absence of existing social relationships. The initiating questions are random, chaotic and unpredictable. However, the personal storytelling is powerful, colourful and direct.

More research is required to develop a diagnostic methodology to fully unravel the complexity of online dialogue fragments and sequences and provide more empirical evidence that reveals the nuances of dialogue as well as group dynamics that occur in social media knowledge exchanges. By doing this should reveal more deeply how social media activity and communities contribute to agricultural innovation.

References

Aker, J.C., (2011). Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. 42, 631-647.

- Alston, M. (2012) Rural male suicide in Australia. *Journal of Social Science and Medicine*. 74(4): 515-522.
- Ballantyne, P., (2009). Accessing, sharing and communicating agricultural information for development: Emerging trends and issues. *Information Development* 25, 260-271.
- Bandura, A. (1989) *Social Cognitive Theory*. In: R. Vasta (ed). *Six Theories of Child Development* 6. Greenwich: JAI Press, 1–60.
- Bandura, A. (1997) *Self-efficacy: The Exercise of Control*. New York: Freeman
- Barr, N. (2011) I hope you are feeling uncomfortable now: role conflict and the natural resources extension officer. In: D. Pannell and F. Vanclay (eds.) *Changing Land Management: Adoption of New Practices by Rural Landholders*. Victoria, Australia: CSIRO Publishing 129–139.
- Bontcheva, K. and Rout, D. (2014) Making sense of social media streams through semantics; A survey. *Journal of Semantic Web*. 5(5): 373-403
- Bourdieu, P. and Wacquant, L. (1992) *An Invitation to Reflexive Sociology*. Chicago: University of Chicago Press.
- Boyd, D.M. and Ellison, N.B. (2007) Social Network Sites: Definition, History, and Scholarship. *Journal of Computer-Mediated Communication*. 13: 210–230.
- Cerkenková, E., Simek, P., Vogeltanzová, T., Stoces, M., (2011). Social Networks as an integration tool in rural areas - agricultural enterprises in the Czech Republic. *Agris on-line Papers in Economics and Informatics III*, 53-60.
- Chowdhury, A., Hambly Odame, H., (2013). Social media for enhancing innovation in agri-food and rural development: Current dynamics in Ontario, Canada. *The Journal of Rural Community Development* 8, 97-119.
- Constant, D., Sproull, L. and Kreisler, S. (1996) The Kindness of Strangers: The usefulness of Electronic Weak Ties for Technical Advice. *Journal of Organization Science*. 7(2).
- Drysdale, D., Harnett, M., Sewell, A.M., Gray, D.I., Kemp, P.D. and Wood, B.A. (2017) Measuring farmers' self-efficacy for managing perennial summer forages. *Rural Extension and Innovation Systems Journal*. 13(2).
- Durie, M. (2005). Indigenous Knowledge Within a Global Knowledge System. *High Education Policy* 18(301).
- Evans, K. Terhorst, A and Byeong, H.K (2017) From Data to Decisions: Helping Crop Producers Build Their Actionable Knowledge. *Critical Reviews in Plant Sciences*. Vol 36 (2): 71-81
- Faraj, S., Jarvenpaa, S.L., and Majchrzak, A. (2011). Knowledge Collaboration in Online Communities. *Organization Science* 22(5): 1224–1239.
- Fisher, R. (2013) A gentleman's handshake: The role of social capital and trust in transforming information into usable knowledge. *Journal of Rural Studies* 3: 13-22.
- Gielen P.M. and Hovee, A. (2003) Learning entrepreneurs: learning and innovation in small companies. *European Educational*. Vol 2 (1): 90-106
- Henwood, R., Wood, B., Sewell, A., Gray, D., Blair, H., Cranston, L., Hartnett, M., Kemp, P., and Kenyon, P. (2017) Engaging with individuality in agricultural learning: a sociocultural study of innovation in a farmer-scientist community. *Rural Extension and Innovation Systems Journal*, 13(2). 76
- Jespersen, L.M., Hansen, J.P., Brunori, G., Jensen, A.L., Holst, K., Mathiesen, C., Nalberg, N., Rasmussen, I.A., (2014) ICT and social media as drivers of multi-actor innovation in agriculture - barriers, recommendations and potentials. *Journals.sfu.ca*.

- Kaplan, A.M. and Haenlein, M. (2010) Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons*. 53(1): S59-68.
- Kaushik, P., Chowdhury, A., Hambly Odame, H., van Passen, A., (2018). Social Media for Enhancing Stakeholders' Innovation Networks in Ontario, Canada. *Journal of Agricultural & Food Information*, 1-23.
- Kelly, G.A. (1955) *The Psychology of Personal Constructs*. Vol 1, New York: W.W. Norton.
- Kroma, M.M. (2006) Organic farmer networks: facilitating learning and sustainable agriculture. *Journal of Sustainable Agriculture*. Vol 28(4): 5-28.
- Lave, J. and Wenger, E. (1990) *Situated learning: Legitimate peripheral participation*. UK: Cambridge University.
- Leeuwis, C. (2004). *Communication for Rural Innovation: Rethinking Agricultural Extension* (Third ed.) Oxford: Blackwell Science Ltd.
- Majchrzak, A., Faraj, S., Kane, G.C., and Azad, B. (2013) The Contradictory Influence of Social Media Affordances on Online Communal Knowledge Sharing. *Journal of Computer-Mediated Communications*. Vol 19(1): 38–55.
- Materia, V.C., Giarè, F., Klerkx, L., (2014). Increasing Knowledge Flows between the Agricultural Research and Advisory System in Italy: Combining Virtual and Non-virtual Interaction in Communities of Practice. *The Journal of Agricultural Education and Extension*, 1-16.
- Murthy, D., (2012). Towards a Sociological Understanding of Social Media: Theorizing Twitter. 46, 1059-1073.
- Nicholson A., Woods, C.R., and Hēnare, M. (2012) Umanga Whānaungatanga: Family Business. *Journal of Australian Indigenous Issues*.15(4):36-50.
- Parnell, D.J., Marshall, G.R., Barr, N., Curtis, A., Vanclay, F., and Wilkinson, R. (2006) Understanding and promoting adoption of conservation practices by rural landholders. *Australian Journal of Experimental Agriculture*.
- Phillips, T.I. (1982) How farmers use other people to assist them with their learning efforts. *Proceedings Dairy Production from Pasture Conference*. In: K.L. MacMillan and W.Taufa (eds), Hamilton, New Zealand: N.Z. Society of Animal Production.
- Phillips, T. I. (1985) *The Development of Methodologies for the Determination and Facilitation of Learning for Dairy Farmers*. Masters Research Thesis, Faculty of Agriculture and Forestry, University of Melbourne. [<http://repository.unimelb.edu.au/10187/18076>]
- Phillips T., Woods C., and Lythberg, B. (2016) An investigation into the aspirations, governance and management challenges of Māori farming trusts *Outlook on Agriculture*. Vol 45(4): 246-253 SAGE Publishing. doi: 10.1177/0030727016676713
- Piller F., Vossen, A., and Ihl, C. (2012) From Social Media to Social Product Development: The Impact of Social Media on Co-Creation of Innovation. *Die Unternehmung schweizerische Zeitschrift für Betriebswirtschaft* 66(1): 7-27.
- Poppe, K.J., Wolfert, S., Verdouw, C., Verwaart, T., (2013). Information and Communication Technology as a Driver for Change in Agri-food Chains. 12, 60-65.
- Putnam, R.D. (2002) *The Dynamics of Social Capital*. Oxford: Oxford University Press.
- Raaijmakers S., Truong, K., and Wilson, T. (2008) Multimodal subjectivity analysis of multiparty conversation. *Proceedings of Conference on Empirical Methods in Natural Language Processing*. P.466-474

- Reed J. (2014) How social media is changing language. OxfordWords Blog.
<http://blog.oxforddictionaries.com/2014/06/18/social-media-changing-language/>
- Rhoades, E., Aue, K., (2010) Social agriculture: adoption of social media by agricultural editors and broadcasters.
- Ridley, A.M. (2005) The role of farming systems group approaches in achieving sustainability in Australian Agriculture. *Journal of Experimental Agriculture*. Vol 45 (6):603
- Sensis (2017). Sensis Social Media Report 2017. <https://www.sensis.com.au/about/our-reports/sensis-social-media-report>
- Sewell, A.M., Blair, H.T., Gray, D.I., Hartnett, M., Kemp, P.D., Kenyon, P.R., Morris, S.T and Wood, B.A. (2014a), The farmer-learning project: Improving the design of agricultural extension to promote learning, Napier: New Zealand Society of Animal Production, pp. 166-172.
- Sewell, A.M., Blair, H.T., Gray, D.I., Hartnett, M., Kemp, P.D., Kenyon, P.R., Morris, S.T and Wood, B.A. (2014b) Hatching new ideas about herb pastures: Learning together in a community of New Zealand farmers and agricultural scientists. *Agricultural Systems*, 125: 63-73.
<http://dx.doi.org/10.1016/j.agsy.2013.12.002>.
- Sewell, A.M., Hartnett, M.K., Gray, D.I, Blair, H.T., Kemp, P.D., Kenyon, P.R., Morris, S.T and Wood, B.A (2017), Using educational theory and research to refine agricultural extension: Affordances and barriers for farmers' learning and practice change. *Journal of Agricultural Education and Extension*. Vol 23(4):313-333 <http://dx.doi.org/10.1080/1389224X.2017.1314861>.
- Shadbolt, N. and Martin, S. (2005) *Farm Management in New Zealand*. Oxford University Press.
- Shadbolt N.M., Olubode-Awosola F., and Rutsito B. (2013) Resilience of New Zealand Dairy farm businesses. <http://www.onefarm.ac.nz>
- Shanthy, T.R., Thiagarajan, R., (2011). Interactive multimedia instruction versus traditional training programmes: Analysis of their effectiveness and perception. 17, 459-472.
- Sligo, F.X. and Massey, C. (2007) Risk, Trust and knowledge networks in farmer learning. *Journal of Rural Studies*. Vol 23(2): 170-182.
- Sproull, L., and Arriaga, M. 2007 *Online communities*. In H. Bidogl (ed). *Handbook of Computer Networks*, 3. New York: John Wiley and Sons.
- Sulaiman V., R., Hall, A., Kalaivani, N.J., Dorai, K., Reddy, T.S.V., (2012). Necessary, But Not Sufficient: Critiquing the Role of Information and Communication Technology in Putting Knowledge into Use. *The Journal of Agriculture*
- Tapsell, P. and Woods, C.R. (2008) A spiral of innovation framework for social entrepreneurship: Social innovations at the generational divide in an indigenous context. *Emergence: Complexity and Organisations*. 10(3): 25-34.
- Thomas, L.F. and Harri-Augstein, S.E. (1976) *Learning to Learn. The Personal Construction and Exchange of Meaning*. Centre for the Study of Human Learning. Brunel University.
- Tough, A.M. (1978) Major Learning Efforts: Recent Research and Future Directions. *Adult Education*, 28 (4):250-263.
- Wenger, E. (2000) Communities of practice and social learning systems. *Organization* Vol 7(2): 225–246.
- Wood, B.A, Blair, H.T, Gray, D.I, Kemp, P.D, Kenyon, P.R (2014) Agricultural Science in the Wild: A Social Network Analysis of Farmer Knowledge Exchange. *PLOS ONE* 9(8): e105203.
<https://doi.org/10.1371/journal.pone.0105203>

Woolley, A.W., Chabris, C.F., Pentland, A., Hashmi, N., and Malone, T.W. (2010) Evidence for a Collective Intelligence Factor in the Performance of Human Groups. *Science*. 330 (6004): 686–688. doi:10.1126/science.1193147

Woolley, A.W., Aggarwal, I., and Malone, T.W. (2015). Collective Intelligence and Group Performance *Current Directions in Psychological Science*. 24(6): 420–424. doi:10.1177/0963721415599543.

World Economic Forum (August 2017) What happens in an internet minute in 2017?
<https://www.weforum.org/agenda/2017/08/what-happens-in-an-internet-minute-in-2017>

Acknowledgements

The authors would like to acknowledge the inputs of P. Edmond, B.A. Wood and Lyndon S. Phillips.