The Farmer-Learning Project: improving the design of agricultural extension to promote learning

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Abstract

New Zealand has played a key role in developing innovative extension models designed to support farmers to adopt new, evidence-based, farming practices. However, this momentum has been lost over recent years. A fresh and innovative model of extension is needed to ensure that New Zealand farmers learn about highly-effective technologies. The Farmer Learning Project, now in its third year, is a multi-disciplinary research venture that aims to find out how to promote farmers' learning and adoption of evidence-based practices. This paper provides an overview of the Farmer Learning Project at Massey University and its innovations designed to promote learning about herb-mix pastures containing chicory, plantain and red and white clover. Five critical success factors shown to support the farmers' learning are discussed. These include the importance of participation in a sustained and inquiry-focused farmer-scientist learning community, and their engagement in a variety of repeated and relevant learning experiences that are aligned to science. Underpinning these success factors are seven educational principles that need to inform design innovations in agricultural extension. Early findings are also shared from the second phase of the project, which investigates the farmers' practice change as a result of their learning about herb pastures and its ability to create high performance sheep grazing systems.

Keywords: agricultural extension; herb pastures; farmer learning; innovation; community of learners; practice change

Introduction

The ability of New Zealand farmers to increase and sustain on-farm productivity and profitability requires them to learn about scientifically-based information and to consider its adoption into their farming systems. Yet, much of what happens in the name of agricultural extension falls short of the conditions necessary for learning and practice change (Leeuwis & Aarts 2011). This paper argues that in order to promote farmer learning and practice change, understanding is required of how farmers learn, and that these educational factors inform new innovations in agricultural extension.

Contemporary thinking to develop agricultural extension and innovation adoption, points to the value of transforming industry partnerships with universities so that farmers can interact with scientists in their research (Pannell et al. 2006; Llewellyn 2007; Lyon et al. 2010; Hunt et al. 2012). Central to these authors' argument is the value of knowledge exchanges and collaborative partnerships between farmers and scientists that focus on evidence and innovation (e.g. Sherson et al. 2002; Röling 2009; Franz et al. 2010; Lyon et al. 2010; Eastwood et al. 2012). Such partnerships re-think the role of communication and knowledge by creating a discursive space for farmers and scientists to share and challenge ideas, to co-construct new ideas, and to negotiate new action (Llewellyn 2007; Leeuwis & Aarts 2011). These participatory approaches to farmer learning and their dialogic exchanges create "the oil that makes things happen" (Coutts 2000), contrasting with extension models based on the transmission of information from 'expert' to 'farmer' in a linear, depersonalised and top-down way.

Materials and methods

An 12-month pilot study was conducted bringing together pastoral farmers with an interdisciplinary team of three animal scientists, one agronomist and three social scientists in a sequence of innovative learning experiences designed broadly around lamb and pasture growth data from a herb pasture experiment at Massey University. The experiment (with replicates) is part of a three-year research project comparing two herb and legume pastures: i) plantain (*Planatago lanceolata*) with red (*Trifolium pratense)* and white (*T. repens*) clovers and ii) chicory (*Cichorium intybus)* plus plantain and red and white clovers; with iii) ryegrass (*Lolium perenne*) and white clover pasture. Interest in these herb mix pastures is based on studies showing that they result in increased multiple-bearing ewe and lamb performance and increased growth rates in weaned lambs, in comparison to an industry standard perennial ryegrass and white clover pasture (Kemp et al. 2010).

A purposive sample of 18 farmers provided a mix of participants who were located within two hours of the university, and who had diverse farming geographies, goals and practices. The farmers were also known to be adopters or non-adopters of herb mix pastures with farming experience ranging from 15 to 45 years. The role of the scientists was to design and oversee the experiment in collaboration with their

Table 1 Example of data (live and carcass weight production) from the mixed-herb pasture experiment given to farmers.

Data	Spring year one			Spring year two			Spring year 3		
	Pasture	Plantain	Chicory	Pasture	Plantain	Chicory	Pasture	Plantain	Chicory
LW production (kg/ha)	276	288	255	321	406	371	392	467	425
Carcass weight (kg/ha)	141	162	146	122	182	165	133	181	176

doctoral students, to observe and analyse lamb and pasture growth data and discuss this with farmers, as well as to collaborate with the social scientists to design ongoing learning experiences. The role of the social scientists was to collect and analyse data about the individual, social and cultural processes underpinning the farmers' learning and to suggest ongoing learning experiences.

Learning innovation

The farmers attended five learning sessions at a Massey University farm, each lasting between 6-24 hours. The first learning session was held in June 2011 and thereafter, every three months until May 2012. The core feature of these learning experiences was observation and discussion of data relating to pasture growth and live and carcass weight production from the experiment, where batches of lambs were finished on the three treatments in two to three monthly consignments. An example of data shared with farmers is shown in Table 1.

Table 2 identifies the variety of experiences designed to promote learning about herb pasture establishment and grazing management and the impact of these pastures on growth production. Informal social times including shared meals were also planned to support the development of relationships. Newsletters were sent to farmers between the learning sessions to provide updates on lamb growth data as well as to make arrangements for their next learning session.

Some activities were designed simply to appeal to the farmers' wider interests. One such left-field activity was an autopsy conducted by a veterinarian, at which the farmers could see abscessed teeth, worms in the lung (lungworm) and intestinal disease in the gut (Johnes Disease). The farmers immediately linked the animal's poor condition to their inability to chew, and this triggered dialogue about animal health problems. Another related activity was learning about the meat quality of lambs grown on the plantain and chicory pastures and its intra-muscular fat content and flavour differences. The topics of after-dinner speakers included issues that would be of interest such as the potential impact of precision agriculture on farmers' decision-making and the effect of farming on water quality.

Data collection and analysis

At the end of each learning session, an audio-recorded focus group discussion (FGD) was conducted with six randomly selected farmers to find out the ways in which the learning activities had supported their learning – feedback that informed subsequent learning session. Semi-structured pre- and post-intervention interviews were also conducted with two farmers (a herb adopter and a non-adopter) to find out about their farming systems, experiences, motivations, and their actual learning in the project. Participant observation was a third means to collect data through being part of conversations and watching the interactions throughout the learning sessions. These field notes, illustrated with photographs, gave triangulation to the themes emerging in the interview and FGD transcripts.

Using Yin's (2003) five phase cycle of qualitative analysis, transcriptions were compiled of FGD and interview data. Qualitative software, NVivo 9.2 (QSR 2012) was used to manage, shape and make sense of the data to identify emerging themes. Tentative interpretations were made and discussed before final conclusions were drawn. Quoted conversations in the results come from all the participants. Approval to undertake this study was given by Massey University Human Ethics Committee.

Results

Five critical success factors were shown to support farmers' learning - the most important of which was the development of a farmer-scientist learning **community**. Also significant in promoting

Table 2 Examples of learning experiences designed to promote farmers' learning.

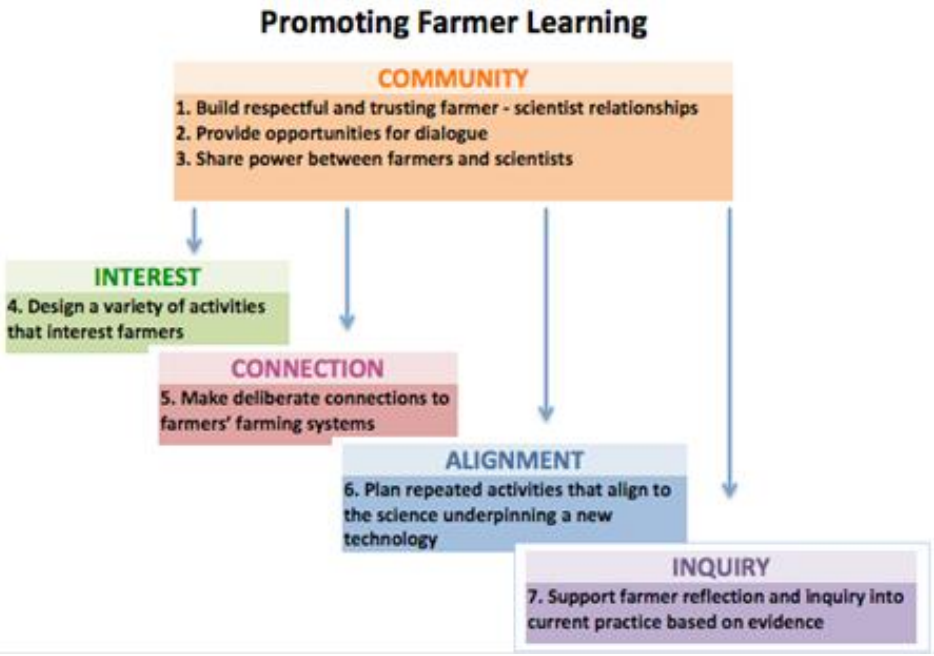
Observing the herb experiment	Discussing data from experiment	Digging up the herb plant	Talks from experts with brief summary	Glasshouse experiments on herb pasture	Visiting farms that integrate herb pasture
To observe growth of herb-mix pastures and to discuss principles of effective herb pasture establishment and management.	To learn about pre- and post-grazing sward heights, carcass weight production (kg/ha), and botanical composition in different seasons and years.	To learn about taproot and leaf growth and reserves and its impact on grazing decisions.	To learn about weed control, how to manage pasture and parasites, and how to conduct feed budgets.	To learn more about the capability of herb pastures under controlled levels of stress.	To learn from farmers who had changed their herb pasture practices.

farmer learning was: maximizing farmer **interest**, making **connections** to their farming systems, ensuring **alignment** between the learning activities and the science behind the new technology, and supporting farmers' **inquiry** into their current practice. These five critical success factors, give rise to seven educational principles of learning (see Figure 1). Each of these principles is justified from a synthesis of educational theory and research (Aitken & Sinnema 2008). A brief discussion of these success factors and their underpinning principles follows. See Sewell et al. (2013) for more extensive findings and discussion.

A farmer-scientist learning community

Developing and sustaining an inclusive learning community where farmers and scientist were jointly engaged in learning was key to the farmers' learning. The farmers and scientists interacted openly and responsively, developing mutually respectful and trusting relationships. The farmers respected the scientists' wealth of evidence-based knowledge. Their *"insistence on measurements to provide a basis for decisions"* and their *"remarkable passion"* for learning about herb-mix pastures. The farmers also valued the scientists' openness to share both the positive outcomes of their experiment as well as less favourable results. This led to the belief that *"there's often more learning in the downside stuff".* Also appreciated was exposure to accurate content knowledge that was free from commercial bias and

Figure 1 Success factors and educational principles promoting farmer learning.



vested interests: *"You can trust what they're saying….This is based on hard facts and hard data... independent, neutral and scientific"*. The science team positioned themselves as learners - valuing the farmers' diverse experiences, viewpoints and knowledge.

Another important hallmark of the farmer-scientist learning community was the opportunity for informal dialogue. The farmers preferred to talk with the scientists or other farmers in small groups of 5-6 so they could confidently *"bounce ideas off someone else and trigger new ideas"* about herb-mix pastures and their different farming systems. These informal dialogic spaces opened up *"exposure to other people's thinking"*. Over time their interactions became more confident and *"more intimate…you can just walk up and talk to them*". The farmers came to see the project as a *"place to hatch new ideas"* compared to the one-way nature of talk that commonly transpired at field days *"when you're in a big room with a whole lot of people listening to them talk to you the whole time ... you just get fed the recipe."* In some experiences, scientists shared their knowledge in one-way forms of communication (i.e. they told farmers some of their extensive content knowledge), at other times, activities were designed to encourage dialogue and co-inquiry.

The third important feature of the farmer-scientist community was the ways in which power was shared. Power did not reside fully with the science team by virtue of their expertise; the practical experiences and expertise of the farmers was highly regarded and called upon. Key examples of power-sharing included: valuing both the farmers' and scientists' expertise, sharing the thinking processes behind decisions made on the experiment, as well as thinking together about new learning experiences and future research opportunities. This power-sharing culture served to open up scientists' and farmers' thinking for scrutiny which became the focus of ongoing dialogue and inquiry. The value of power-sharing was highlighted by comparing the interactions in the project with what typically happened in a discussion group:

I always find they're overpowered by consultants ... He directs everything and makes it all about what he wants to talk about… and they wouldn't admit it wasn't doing that good. Whereas with this, this is much more open and people ask whatever question they want.

Learning experiences that interest, connect and align to science

The observation of herb pastures and discussion of the data arising from the experiment was regarded as the most valuable learning experience, because *"if you see what it looks like, and then you see the figures, you can get much more of an idea than if you just see figures."* The farmers showed high interest as they listened and talked about: the data from the experiment, grazing management, weed and parasite control. This appeal to the farmers' interests enabled them to engage with important pasture and grazing management concepts. As one farmer said: *"the whole crux to actually being here, was the performance they're getting from the sheep on these trials … the figures were just phenomenal."*

The learning experiences were designed to respond to farmers' interests, and to their different goals and motivational needs. While the farmers shared the same goal of optimising lamb growth, some farmers bred the lambs they finished, while others bought-in lambs to finish. This diversity of goals, viewpoints and experiences became a valuable source of learning. Maximising farmers' interests using a variety of relevant and engaging activities enhanced their motivation to keep learning *"unlike one-off field days [these experiences] were places of learning... of being charged up."*

All the learning experiences were deliberately designed so that the farmers could readily make **connections** to their own farming systems. Farmers were able to use the data as points of comparison to the growth rates they were getting from their own management of herb-mix or more traditional pastures. Similarly, examination of the plantain and chicory taproots supported understanding and application of grazing principles:

I was just inspired by the large taproot ...and being shown the whole plant each time and talking about it. That was one of the real take home messages about chicory – I need to farm the root…. [and see] how that's reacting at the same time as the grazing is going on… I went back and dug a few of mine up to see what they were like."

Coonections were also enhanced by the use of written language that was inclusive of all the farmers. Instead of providing academics papers about herb-mix pasture management, the scientists wrote about and illustrated key concepts so that complex ideas were made accessible to the farmers. The farmers referred to these as their "*normal person notes"* or *"one-pagers".*

Most learning experiences were designed to **align** directly to essential concepts of herb pasture management and grazing. Revisiting these important concepts at three-monthly intervals through a range of different experiences was important for the farmers' learning. The farmers saw these repeated learning activities through different seasons as *"reinforcement to what we got last time."* The ongoing nature of activities aligned to the science of herb pastures, helped the farmers to see beyond a set of rules, to understand the complexity of herb pasture management and grazing: *"There's so many different moving parts... it's a lot more complex than just the one page set of rules."*

Developing a disposition for inquiry

As the project evolved, the farmers began to participate with the scientists in their inquiry processes. Initially, most of the farmers felt unqualified to contribute ideas, but by the third learning session, they were increasingly confident to question the scientists' decisions, interrogate the data

with the scientists, and to contribute their own knowledge based on shared experiences of herb pastures. Sometimes this co-inquiry was in response to a deliberately posed question, but at other times it came up in an open exchange of ideas. Knowing they could contribute ideas and that there was still so much more to learn, served to motivate the farmers.

There's still a lot of unknowns. The science team don't know which plot is going to deliver the maximum yield…. at the scientific end they're still exploring chicory and plantain and finding out new things ...actually there is plenty of room for discussion on it.

Increasingly evident, was the reflective thinking that each farmer engaged in, both at the learning sessions and back on their farms. This reflection in and on their farming practices formed the basis of individual and ongoing inquiries that linked their learning about new technologies to their unique farming systems. These individual and shared farmer inquiries, motivated through inclusion in the scientists' formal research, became an important source of ongoing learning: *"We're always thinking about our own system...there's much more we've got to learn about it, this is only a precursor of things to come".*

Learning leading to change

While this study was not designed to capture the impact of farmers' learning on practice change, evidence showed that their engagement in the project did support the identification of misconceptions and previous mistakes with herbs, and this herb learning provided the motivation to try again or to increase the area in herbs:

We did 4 hectares of chicory, didn't do it right, didn't understand it, it didn't persist, so we thought, waste of time. Now we're digging it again, but actually listening, learning from others, and actually starting to do it a bit better. We'll still make mistakes.

A follow-up study is investigating actual practice change of the 18 farmers and eight new farmers who subsequently joined the group. Preliminary results suggest that a majority of farmers have changed their herb-pasture practice by: i) adopting evidence-based establishment practices, ii) improving the persistence of chicory by changing grazing management practices based on their new understanding the role of the taproot, iii) adjusting their grazing duration and pre- and post-grazing residuals to optimise herb pasture production, iv) changing the class of livestock that use the herb pasture as part of their overall farming system v) increasing the area in herb pastures, vi) changing the herb pasture mix to better suit their climate, farming system and goals, and vii) more efficiently controlling the weed population in the pasture.

Discussion

This research has identified five critical success factors in the promotion of farmers' learning: community, connection, interest, alignment and inquiry (see Figure 1). The seven educational principles underpinning these success factors provide a framework for discussion.

The first principle of an improved agricultural extension model is building and sustaining mutually respectful and trusting relationships within the community of farmers and scientists (or engagement with other external experts who have evidence-based content knowledge). It is by building high levels of mutual support and 'relational trust' – well known to promote learning (Bryk & Schneider 2003), that learning relationships can develop. Contemporary sociocultural theories justify the development of professional learning communities (Stoll et al. 2006) by arguing that learning is a conjoint or relational activity - a process of co-construction and participation *with* others rather than one-off opportunities (Lieberman 2000; Rogoff 2003). This intentional re-ordering of relationships into a collaborative and participatory approach is key to successful innovation in agricultural extension (Llewelly 2009; Röling 2009; Franz et al. 2010; Lyon et al. 2010; McEnte, 2010; Leeuwis & Aart 2011).

The second educational principle of community is providing opportunities for dialogue so that in an exchange of ideas, new ideas can be generated and new knowledge co-constructed with community members who each bring their unique expertise (Wells 2000; Mercer & Littleton 2007; Alexander 2008). This dialogic approach is in contrast to traditional approaches where knowledge or content is transmitted from 'expert-provider' to 'novice-farmer'. Importantly, the farmers' misconceptions and the scientists' experimental mistakes or less favourable results became important resources for learning because they engendered open dialogue around evidence-based ideas.

The third principle highlights the importance of mutual power-sharing where all members of the community have opportunities to share expertise and to take responsibility for learning. It is in this open exchange of ideas that farmers were given the opportunity to *"hatch"* new knowledge. The success of their learning in a community, where power was redistributed, is explained in knowledge creation metaphors of learning (Paavola et al. 2004).

The fourth educational principle relates to designing a variety of activity types that arouse farmers' interest and enhance their motivation to learn (Brophy 2010). Aitken and Sinnema (2012) argue that arousal leads to engagement and motivation, which in turn leads to learning. The fifth principle highlights the importance of making deliberate connections between the focus of learning (the new technology) and the farmers' farming systems. When people experience relevant activities that meet their needs and connect to their experiences, the content embedded in those activities is more easily recalled (Nuthall 2007).

The sixth educational principle is about designing learning experiences and resources so they align with the science underpinning a new technology. The extent to which the activities align, in this case with

evidence-based herb pasture management and grazing practices, has a significant impact on success (Sinnema & Aitken 2012). In addition, sufficiently frequent opportunities need to be provided to enable farmers to revisit these evidence-based ideas so as to embed them in their long-term memories (Nuthall 2007).

The seventh principle emphasises the importance of creating opportunities for farmers to engage in their own inquiries to learn about new technologies, to reflect on the evidence underpinning them, and to consider the benefit for their own farming systems. As Sinnema and Aitken (2012) argue, practitioner inquiry is fundamental when selecting and applying new research findings in a new context. New extension models need to support and enable farmers to become inquirers into their own practice wherein they engage with evidence. Developing this disposition for inquiry will enhance learning and the possibility of practice changes that lead to increased production and profitability.

A key strength of this project is its interdisciplinary nature that brings together farmers, agricultural scientists and social scientists whereby educational theories have been incorporated into the agricultural science and extension literatures. The educational principles reported here, most particularly the opportunity to participate in a sustained and inclusive professional community of learners, have been shown in this research to support farmers' learning and their uptake of new herb pastoral practices. These principles need to now inform the design of new learning-focused innovations in agricultural extension so as to build farmer capacity in the uptake of new farming technologies.

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