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Continuity and Change: Themes of Mental Model Development Among Small-Scale Farmers

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Continuity and Change: Themes of Mental Model Development Among Small-Scale Farmers

Abstract

Farmers' mental models of farming influence their learning, decisions, and actions. Sometimes realizing opportunities for success requires farmers to challenge assumptions embedded in their mental models. The qualitative study described here explored how a group of small-scale farmers developed mental models of farming and the conditions under which their models changed. Two themes emerged indicating that farmers developed and reinforced existing mental models through discovery learning and problem solving and that an "activating event" may trigger transformation of an existing mental model. Understanding how farmers develop mental models can help educators design learning programs and services that enable farmers to succeed.

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Small-scale farming is an endangered way of life in many parts of the United States. Agricultural land and family farming enterprises are experiencing heavy pressures from real estate development, consolidation, conflicts over water, and other trends that lead more farmers to exit than enter the occupation every year (Golden, 2004; U.S. Department of Agriculture, 1998). At the same time, niches of opportunity exist in farming (Burros, 2002; Ortiz, 2004). Operators of small farms who can produce organic, specialty, or value-added products can often maintain and even improve their economic well-being (Burros, 2002; Greene, 2000). Moskin (2005) noted "the concentration [of these types of enterprises] is especially high in the Northeast, where a small farm near an urban area can now survive solely through farmers' markets, restaurants, farm membership (in which customers pay in advance for a season's worth of produce) and other direct outlets."

Ingenuity and innovation are keys to success, and these qualities are integrated in successful small-scale farmers' mental models of farming (Eckert & Bell, 2005). Mental models are defined as "inventions of the mind that represent, organize, and restructure domain-specific knowledge" (Seel, 2001, p. 408). Related research by Eckert and Bell (Eckert & Bell, 2005; Bell & Eckert, 2005) found that prior experience, values and beliefs, and knowledge influenced a farmer's current mental model of farming. In turn, the mental model served as both a filter and guide for his or her actions, decisions, and use of information. This was true regardless of the type of farming operation, marketing practices, or approach to farming (for example, sustainable, organic, or conventional).

For many farmers, success requires overcoming assumptions embedded in mental models of farming that keep them tied to their current practices and prevent them from seeing possibilities for success (Berton, 2001; Eckert, 2003). A better understanding of how farmers develop their

mental models of farming and the conditions under which their models may change is needed for agricultural educators to maximize the impact of services and enable farmers to improve the viability and profitability of their farms. The qualitative study described here, which focused on a group of small-scale farmers in the Northeast, represents a first step towards this goal.

Method

Ten operators of small farms in the northeastern United States comprised the sample for this study. The sample was selected through a process of peer and service-provider referral, which resulted in a list of successful small-scale farmers representing different farming approaches, commodities, marketing strategies, and geographic regions. The sample emphasized sustainable and organic practices to reflect growing trends in the Northeast and the USDA Small Farms Commission (1998) policy recommendations emphasizing sustainable agriculture as a profitable, ecological, and socially sound strategy for small farms. A profile of the sample is presented in Table 1.

Each participant met the operational definition of "successful new farmer" based on a multifaceted typology of new farmers developed by the Northeast New Farmer Network Project (Sheils, 2004). The typology was designed to enable service providers to better meet the needs of the region's new farmer clientele and accounts for differences in levels of farming experience, responsibility, commitment, resources, and risk. By definition (Sheils, 2004), the farmers in the sample had completed re-strategizing efforts, which typically involves going "through a critical phase of modifying or restructuring their operations" (p. 6) and "they were on their way to becoming established farmers" (p. 6). All of the farms were full-time operations, though many of the farmers had additional sources of income.

Table 1.
Description of Farmers Interviewed

Name^a	Age (years)	Years in current operation/Years prior farm experience	Farming first career/Farm only source of income	Type of farm/Approach to farming
Adam	38	10 / 15	No/Yes	Vegetables/Conventional
Joe	32	9/6	Yes/Yes	Dairy/Conventional
Ellen	56	5/2	No/No	Vegetables/Organic
Melinda	27	1/19	Yes/No	Dairy/All-natural, local
Kevin	37	3/24	No/No	Livestock and poultry/Organic, grass-based
Jim ^b	48	8/0	No/No	Vegetables, Goats/Organic
Carla ^b	45	8/0	No/No	Vegetables, Goats/Organic
Tom	54	13/0	No/Yes	Urban vegetable/Organic
Cathy ^c	44	12/0	No/No	Vegetables/Organic
Mike ^c	46	12/12	No/No	Vegetables/Organic

^a To protect the identities of farmer participants, pseudonyms have been substituted for their real names
^b Spouses interviewed together
^c Spouses interviewed together

The 10 farmers who participated in the study were interviewed on site at their farms. Interviews were completed between February and August of 2002. The semi-structured, tape-recorded interviews lasted 60 to 90 minutes. The interview protocol focused on farmers' perceptions of significant experiences in the course of their learning how to farm and the meanings they attributed to being a "successful" farmer. Consistent with qualitative interview strategies (Strauss & Corbin, 1990), the protocol was revised on an ongoing basis to elicit more focused responses from participants and to accommodate themes that emerged in early data analysis.

Data analysis entailed alternating between open coding and thematic coding using themes suggested by the literature on mental models (e.g., Greeno, 1989; Johnson-Laird, 1983; Seel, 2001) and verifying or revising themes based on the data (Miles & Huberman, 1994). Trustworthiness of data collection and analysis were maximized using a variety of strategies, including member checking, peer debriefing, review of transcripts and interpretations by a farmer advisor, and review of current literature. Results are presented in the following section. Relevant information about interview participants is incorporated into the discussion.

Results

Based on the interview data, the researchers developed a definition of a mental model of farming. A mental model of farming is an individual "mental map" or set of propositions that includes the individual's values and beliefs about the ideal and the actual state of farming. It includes the role and relative importance of values, beliefs, knowledge, and skills, as well as ways of processing information, learning, and applying skills to solve problems (Eckert, 2003; Eckert & Bell, 2005).

Two themes emerged in the data regarding how small-scale successful farmers developed mental models of farming:

1. **Continuity.** Farmers built upon and reinforced their existing mental models of farming through discovery learning and problem-solving.
2. **Change.** In some cases, farmers transformed their mental models as a result of an activating event (Cranton, 2002) that triggered articulation, questioning, and revision of their values, beliefs, knowledge, and skills.

Continuity: Farmers Develop and Reinforce Existing Mental Models Through Discovery Learning and Problem Solving

Participants in this study developed, reinforced, and refined their existing mental models of farming primarily through discovery learning and problem solving. Farmers spoke of trial-and-error and of learning without necessarily knowing the outcome in advance, in short, of learning through discoveries. According to Tuovinen and Sweller (1999), "Discovery learning requires learners to discover concepts and procedures that might otherwise be communicated by direct instruction" (p. 334). Seel (2001) attributed mental model development to activities such as exploratory learning and problem solving, including both self-guided and other-guided discovery learning. In the interviews, participants described both types of discovery learning experiences.

Carla and Jim, who operated a goat dairy and grew vegetable crops, provided an example of how their mental model of insect pest control was refined through self-guided discovery learning. They described their use of chickens to eat the bugs in their greenhouse and their use of praying mantises to control harmful insects:

Jim: We found that a way to keep the greenhouse bug free is to let about 20 chickens in there for about . . . (pause in tape) . . . scratch the heck out of everything . . .

Carla: And then we got those praying mantis cases, that's another big--

Jim: All over the farm, we find them everywhere cause we don't spray, so we bring them in to a central location and put them in the greenhouse--

Carla: Two a week.

Jim: Yeah, a couple at a time, and they'll hatch out, and then when we carry our plants

out and put them in the field, they're already covered with praying mantis.

Interviewer: So how did you come up with that and the chickens?

Carla: It was his idea.

Jim: It was my idea.

Carla: Chickens are great bug eaters.

Jim: Accidental farming.

Organic vegetable growers Cathy and Mike also described several discovery learning activities, both self-guided and other-guided, that contributed to their proficiency in controlling harmful insects. An example of other-guided discovery learning was their participation in an agricultural researcher's project on controlling Mexican bean beetles with a parasitic wasp. An example of self-guided discovery learning was their planting of nicotiana next to their tomatoes, "just because we happened to like the plant," and then discovering that tomato hornworms liked the nicotiana better than the tomato plants.

Mike described how they incorporated things that they had "noticed over the years that they've been beneficial to our operation." Mike said, "For me, rotation is so important to control the quality of the ground and what bugs are there, and use of green strips in your fields to isolate. The bugs travel, [so] if you put in grass or something like that it's hard for them to sort of get through so they'll stop." The activities that Cathy and Mike described were in keeping with Mike's summary of his own learning as occurring largely through trial-and-error. All the activities occurred within the farmers' established mental model of being successful in organic farming.

The discovery-learning and problem-solving activities described above were undertaken with a conscious awareness on the part of the farmers of how the activities fit their mental model and contributed to their success. Cathy said, "They know at the experiment station that if they have something that is organic that they want to try, that we're very open to trials, we're very open to trying new techniques." Her explanation that she and Mike were open to organic trials indicated her unwillingness to participate in non-organic trials. Non-organic trials would have been outside of her mental model of farming that delimits, or frames, her practices and learning. Cathy described seeking experiences that would contribute to her ability to apply knowledge skillfully and to be successful within her chosen mental model of farming.

Most of the learning activities described by farmers in the sample served to maintain the continuity of an existing mental model. Some experiences, however, were *activating events*, which triggered articulation, questioning, and sometimes transformation of the farmer's mental model.

Change: Farmers Sometimes Transform Their Mental Models as a Result of an Activating Event

For some farmers, the process of becoming aware of one's mental model or its components happened over a long period of time. In other cases, the farmer's mental model was challenged by an activating event--an occurrence that caused the mental model to become explicit and open to reflection, refinement, and sometimes transformation. Cranton (2002) used the term *activating event* to refer to an event that "typically exposes a discrepancy between what a person has always assumed to be true and what has just been experienced, heard, or read" (p. 66). Half of the farmers interviewed described experiences that were indicative of activating events.

In his interview, Kevin, a livestock and poultry farmer, explained how he came to understand farming using a different mental model than the "industrial model" that framed most of his learning experiences in college. Upon completing a conventional herdsman program in a vocational college, he believed that he did not have the land, infrastructure, or capital to begin farming for himself, so he worked in a conventional hog farming operation. Kevin described the experience of disease decimating the livestock population, saying, "There was periods of time when we lost every pig in the whole room, and you just, you know, pitching 'em out the door for hours, piles this high outside the . . . it's pretty discouraging." When asked about critical incidents in his development of proficiency, he returned to that experience, saying:

Well, I think my "aha" incident would have been working in the hog barns, 'cause, you know, before that time I thought, "Well, this is the way you go, you know, this is the future, this is the way it is," and after that experience that kind of changed my outlook . . . There was a couple of times when things were just, everything was dead! . . . and we were doing everything we could do, in terms of vaccinating and treating and cleaning and all that to prevent it, but it still happened. So I would say that kind of changed my, totally changed my thinking, which also changed whether I could start farming on my own, because if you don't need a confinement barn to start farming, if all you need's a couple of strings of wire and an electric fence and some animals and some grass, that's all you need, then it makes it a whole lot more practical to start.

Kevin explained that as a result of the change in his mental model triggered by the activating event, he was able to begin farming in a way that was consistent with his transformed mental

model and that was not resource-intensive.

Carla described and contrasted two activating events. First was her knowledge of a farmer who died of liver failure after applying pesticides without taking the proper safety precautions. She said, "I had always gardened and had never used chemicals anyway, but that was like the convincing argument for me--OK, this stuff can kill people, we're not gonna use it." Later in the interview, she described the difficulties she and Jim had in learning how to communicate with their customers and asking for their input, saying, "We should have taken the risk of actually communicating the same a couple of years ago rather than waiting so long. And I just, I just didn't think that I was really ready, I didn't know what would happen, I was scared to take that risk, you know, of asking people to come and talk about the future of the farm." Then Carla contrasted the two experiences, saying:

We knew other people [who successfully communicated with their CSA members], we knew the model, in our brains. But it didn't get translated to our hearts, to action, to really believe in it until we did it. You know, there's other things that you believe. Okay, I didn't really see anybody die from getting sprayed . . . but I know that. I didn't need to, you know, kill one of my kids before I got that! So there are some things that you learn that you act on and there are other things that you have the knowledge but not the belief.

Learning of another farmer's experience with unsafe use of chemicals was an activating event that influenced Carla's strategies in managing pests. The event triggered reflection and articulation of values that filtered her learning and her assessment of pest problem solutions. The experience of being "afraid to take that risk" of discussing the future of the farm with their CSA members, and the experience of finally doing so, were activating events that lead to a major change in Carla's mental model concerning the consumer's role in her and Jim's farming operation.

Many of the activating events described by farmers in this study concerned moving from conventional to sustainable agricultural practices and serving special market niches. The changes farmers described included developing a better-articulated and better-integrated understanding of farming and the ability to apply that knowledge more skillfully. While the farmers who were interviewed did not explicitly discuss changes in profitability that resulted from transformation of their mental models, a review of profiles of "innovative" operators of small farms featured in the *New American Farmer: Profiles of Agricultural Innovation* (Berton, 2001) did address such concerns. In many cases, transformation of the mental model and the resulting changes in practice made the difference between failure and success.

Conclusions and Implications for Agriculture Educators

Previous researchers (e.g., Eckert, 2003; Raedeke & Rikoon, 1997) have identified the important role that mental models of farming play in farmers' learning, decision-making, and adapting to change. The findings of the study described here provide insight as to how farmers develop their mental models of farming and the conditions under which their models may change. For the small farm operators in the study, the processes of discovery learning and problem-solving served as primary means for mental model development. Farmers approached learning in ways that reflected existing mental models, and the outcomes of learning experiences often served to reinforce their models. Sometimes, an activating event threatened the stability of a mental model, triggering reflection, challenging assumptions, and ultimately transforming the mental model.

Because this was a qualitative study, the results cannot be generalized beyond the sample of farmers who participated in the study. The results are consistent, however, with previous research on mental model development indicating that an individual's current mental model can direct the course of learning and problem solving (Seele, 2001) and that an activating event can trigger a significant transformation in a mental model opening up new possibilities for learning (Cranton, 2002).

The mental models of farming held by farmers who were not participants in this study likely reflect a continuum of beliefs, values, assumptions, knowledge, and skill sets. In light of prior research, the possibility exists that regardless of the specific nature of a farmer's mental model, learning and problem solving will be consistent with one's current model. Additionally, the model will be relatively stable, but change may occur following a significant experience that challenges the underlying values and assumptions on which the model is based.

Agriculture educators often direct programs and resources to support farmers in adjusting their practices to improve the viability or profitability of their operations. Because learning experiences appear to shape farmers' mental models of farming and mental models serve as guides for decisions and actions (Eckert & Bell, 2005), understanding how farmers develop mental models can help educators design learning programs and services that better enable farmers to succeed.

The current model of education through presentation or dissemination of information does not take into account how that information will interact with farmers' existing mental models and practices. When educators consult with farmers on their farms and when they bring together farmers with similar practices to share information and experiences, they provide opportunities for farmers to tailor the information they get to their individual needs and situations. While such outreach activities may be less efficient than those that involve presentation by an expert to a group, they

are more likely to be effective, that is, actually used to improve farming practices.

In both Extension and academic settings, educators can extend current best practices by:

1. Demonstrating to farmers that they recognize the knowledge, skills, and values farmers have developed through discovery learning, problem solving, and activating events.
2. Using farmers' knowledge, skills, and values as the starting point for assessing needs and offering additional information and resources.
3. Offering opportunities for discovery learning and problem solving within structured educational programs (for example, through problem-based learning and hands-on activities).
4. Creating conditions that support self-directed discovery learning for individual farmers at their sites of operation (for example, through collaborations between farmers and researchers, and consultations with farm advisors).
5. Balancing offering information and solutions with providing resources that support problem solving.

Sometimes, a component of a farmer's current mental model poses a barrier to change that would lead to improved viability or profitability. When a farmer can benefit from developing further some aspect of his or her mental model, direct instruction or visits to other farms using similar approaches can prime the farmer to consider new possibilities.

However, when the viability of a farmer's operation is in danger because of his or her untenable mental model, change may not be possible until it is triggered by an activating event.

When working with farmers under these circumstances, a purely cognitive, reason-based approach by agricultural educators is probably not enough to trigger such transformation. In these cases, an educator may best facilitate change by supporting the farmer in sharing experiences with another farmer who has undergone a transformation in assumptions and beliefs that underlie his or her practice. If the farmer becomes open to change after this peer learning experience, the educator can follow up with information and resources--but the first step is the experience.

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