Farmers’ Knowledge Networks: Facilitating Learning and Innovation for a Multi-functional Agriculture

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Abstract

This paper examines the role of agricultural networks in facilitating farmer innovations in complex agro-ecological farming systems through a qualitative study of a sample of organic farmers in the northeastern tier of New York State. Building on a knowledge systems and social learning, it illustrates how learning is triggered and diffused among a broader community of producers through interactive, participatory, and shared style of problem solving. Finally the paper links farmers’ social learning processes to extension through a critical reflection on the potential niches in organic farmer management for extension practice.
Introduction

Across the United States, a growing interest and momentum in sustainable agriculture is being accompanied by an increase in alternative modes of agricultural production different than the conventional, high input industrial agriculture. It is estimated for example that organic agriculture products now constitute a $7 billion market that has been growing at a rate of 20% a year. Organic agriculture is constitutive of a set of farming practices that balance ecological and social sustainability with livelihood diversity, while linking consumer interests in healthy and nutritious foods with producer interests in profitability with rural vitality production. Some scholars and practitioners in agriculture are beginning to see organic agriculture and other alternative modes of production as a means to reduce unintended environmental and social consequences of the conventional chemical intensive agricultural system in the US. Increasingly, organic agriculture is being perceived as one expression of an alternative approach to agriculture embodied in sustainable agriculture. However because sustainability goals are values driven, the components of a sustainable production system tend to be contested and meanings are imprecise.

This contest over meaning and precision reflects the fundamental complexity of systems (such as organic agriculture) oriented towards sustainability goals. Notwithstanding the definitional challenges, there is generally overall agreement among scholars that a sustainable production system is one that:

- Minimizes the use of external inputs and non-renewable inputs, substituting regenerative agricultural innovations and designs such as integrated pest management, integrated nutrient management that require farmers’ understanding of plant nutrients and soil bacteria as well as biologically based agricultural technologies such as nitrogen-fixation.
- Is diversified and oriented toward optimization of plant-animal interactions that can enhance natural soil fertilization and soil health by building on synergies within such systems.
- Encourages broad-based participation of diverse social actors in the agricultural and food system in problem identification, analysis and innovation in ways that facilitate a more holistic decision making process.
- Supports local experimentation and innovation of farmers and other rural actors while integrating emergent, more efficient scientific technology such as GIS and satellite mapping that help control the application of fertilizer to specific sites. Economic viability is enhanced rather than hampered when system components are creatively balanced.
- Centers on people and their learning rather than on technologies because of its strong orientation towards management intensive practices and a growing recognition of local creativity and farmers’ capacities to innovate.

Alternative management production as a dimension of sustainable agriculture is a process that helps trigger learning that is transformative because it encourages the active involvement of producers in experimentation and innovation that validates their role as cognitive actors. This is very different than conventional agriculture in which the farmer’s role is often limited to the passive adoption of technology through linear extension communication. A growing number of scholars and practitioners are now suggesting that
alternative agriculture is directly linked to the emergence of a local agricultural knowledge system, components of which are actively co-generated through joint experimentation and participation of like-minded farmers, researchers and other local actors.

The process of local knowledge generation in alternative agriculture links learning to social interaction as diverse actors partner and collaborate in local experimentation, monitoring and assessing innovations in specific contexts. Scholars have referred to such a mode of learning as social learning. Social learning is a process that advocates an interactive, participatory and shared style of problem solving through democratic facilitation, negotiation and reflection (Leeuwis and Pyburn, 2002). Dimensions of such social learning processes include, interactive exchange of experience and learning emerging from experimentation and observation, outcomes of innovative practices, and the diffusion of learning through formal and informal networks. Among interested farmers and other social actors in alternative agricultural production, such interactive learning and interchange increasingly take place in diverse types of agricultural networks.

In this paper, I offer networking among a community of interests – producers, researchers, and consumers as a process that triggers learning that is both relevant to context and results in critical reflection on the social, economic and ecological implications of agricultural practice for sustainability. Networking agricultural knowledge and learning through such interactive processes can be viewed as a concrete operationalization of Kolb’s (1984) experiential learning theory because it facilitates a context for reflection on experience and negotiation of diverse constructions of similar experience in location specific contexts. New learning occurs that lead to subsequent innovation and action. Guijt and Proost (2002) have identified the following elements as some of the practical possibilities that networks facilitate:

- Practical discussions of agro-ecological topics
- Information sharing and exchange in a horizontal, interactive environment
- Experiences are compared and explained
- Information processed into ideas for action
- Prior knowledge is activated
- Ideas and opinions are tested
- Experimentation is conducted (which some farmers on their own would not have the confidence to do)
- Group meetings facilitate other farmers visiting other people’s farms

As interest in organic agriculture has grown in momentum in the US, so has the need to understand the dimensions of this local ecological knowledge system (LEKS), the role of networks in its diffusion, and its implications for extension practice in agricultural communities. Advocates suggest that alternative agriculture farmers may be important repositories of knowledge that can make important contributions to soil health, environmental vitality, local food systems, and overall sustainability of the natural resource base.

Attending the increased interest in alternative approaches to farming are growing demands for a public extension system responsive to these sustainability concerns that call for a better understanding of farmers’ local innovation, knowledge generation and diffusion of innovations. It is argued that alternative agriculture farmers may not only have a different
perspective on agricultural knowledge and innovation, but may also have developed a
different perspective on farmer learning and adoptive behavior.

In the Northeastern United States, a discernible group of organic farmers have been
emerging. Their practices and modes of interaction reflect strong orientations towards
innovative management and knowledge generation that support regenerative agriculture.
Moreover beyond their experimenting with innovative technologies such farmers have
devised creative ways of sharing and learning based on active farmer networks. The question
then becomes, what are the dimensions of the agro-ecological innovations/knowledge
produced by network members? In what ways do such farmer based networks approximate a
critical learning community? What are the relationships and implications for extension
practice relating to farmer based networks in the region?

Purpose of the paper

The research on which this paper is based set out to empirically examine how organic
farmer groups innovate, share and disseminate their local ecological and technical knowledge
through a study of organic farmers who are members of one or more organic farming
networks in the Northeastern tier of New York State, US. In this paper I examine the role of
farmers’ networks as a social innovation where members’ management practices and local
experimentation are supporting the development of an ecological knowledge system. I
explore the relational elements that characterize the modes of interaction in such networks as
a social learning process for a multi-functional agriculture, thus illuminating the role of
facilitation in its evolution.

The specific objectives of the paper are to: 1) to identify the dimensions of farmer
innovation based on analyses of data collected, 2) examine the role of farmer based networks
in the diffusion of innovations among alternative agriculture farmers 3) Identify the relational
elements that characterize this mode of interaction as a social learning process and, 4) reflect
on its implications for a responsive a public extension system.

Conceptual Framework

This paper explores organic farmer innovation and networking knowledge from two
different but complementary theoretical perspectives –an ecological knowledge systems
perspective, and a social learning perspective (Röling and Wagmaker, 2002). Acceptance or
commitments to regenerative or agro-ecological approaches to agriculture and the associative
social goals of rural quality of life and economic viability imply accepting an alternative
epistemology of agriculture different than, but not mutually exclusive of elements of
conventional scientific agriculture knowledge. In the latter, the process of technical
innovation (experimentation) is seen as a linear, random and rational process of observation,
which leads putatively to the accumulation of objective scientific knowledge and technology
to be used in the management of agricultural production (MacRae et al., 1989). Critics have
contended that the assumption of random selection and control of extraneous variables in the
scientific agriculture knowledge production context is fallacious because it is impossible to
obtain an absolutely representative sample in any agricultural population, or even control all
possible extraneous variables in the environment at any given time (Suppe, 1987).
In the same way, social innovations (institutional arrangements) including extension systems are conceived as a one-way, hierarchical set of relationships between differentially located social actors (scientists, extension agents and farmers). The conventional extension system is credited with moving technological innovations from scientists’ laboratories and experimental fields to farmers’ field for the purpose of maximizing production outputs. This conceptualization however assumes a single, rather than a multi-functional characteristic of agricultural production (Pretty, 2003).

Röling (1996) asserts that the process of technological and social innovation is multi-functional and multi-layered, and is best understood as the result of interaction among different actors with complementary contributions in which technology development, pluralistic knowledge generation and its diffusion is revealed as a participatory process (1996:31). This participatory process approximates an interactive agricultural science context in which groups of social actors through interactive discourse develop an inter-subjective system of concepts, practices, beliefs and understandings based on experiences and observations (see box 1).

**Box I: Elements of An interactive agricultural knowledge system**

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epistemology</td>
<td>constructivism</td>
</tr>
<tr>
<td>Concept of truth</td>
<td>multiple perspectives (diversity)</td>
</tr>
<tr>
<td>Nature of treatment</td>
<td>interactive, participatory</td>
</tr>
<tr>
<td>Goals</td>
<td>multiple, often in conflict with each other</td>
</tr>
<tr>
<td>System Concept</td>
<td>soft, a concept and a path to collective action</td>
</tr>
<tr>
<td>Policy</td>
<td>arises from interaction among stakeholders</td>
</tr>
<tr>
<td>Role of science</td>
<td>active partner in the social construction of reality</td>
</tr>
<tr>
<td>Type of science</td>
<td>hybrid of nature and social science</td>
</tr>
<tr>
<td>Role of extension</td>
<td>facilitating learning, stimulating participatory methods</td>
</tr>
</tbody>
</table>

Adapted from Röling, 1996

In consonance with Roling (1996), other scholars have advanced similar arguments for a dialectical agricultural science paradigm for sustainable agriculture (Raedeke and Rikoon, 1997; Turnbull, 1997; Millar and Curtis, 1999)). Grounding their arguments in a constructivist framework, these scholars conceptualize agricultural knowledge for sustainable agriculture as a dynamic process in which farmer knowledge and conventional agricultural knowledge mutually interplay in guiding organic farmers’ management practices. The application of this resulting interactive knowledge however, while it critically orients towards sustainable agriculture, increases important risk factors in production because of overwhelming reliance on individual capacities to make informed judgments. There is also the lack of a supportive policy environment that includes the absence of federal farm support programs for organic agriculture that can minimize farmers’ risk perceptions. Collective experimentation, participation and cooperative exchange of knowledge through social learning minimize the risks of innovation that include access to technologies, markets and minimizing costs).

Woodhill and Röling (1998) argue in favor of social learning based on active participatory, multi-layered democratic processes, and critical reflection. Social learning,
however, does not happen by accident, but requires conscious design and facilitation of networks of social actors whose underlying values connect with the core principles of social learning (Woodhill 2002). Social learning for sustainable agriculture facilitates sustained dialogue among actors in agriculture and natural resource management and engenders the articulation of multiple perspectives and experiences from diverse but similarly committed actors to inform agricultural system design. Such actors evince both a capacity for innovation and change and a capacity for reflective thinking that coalesces on platforms of joint learning processes into an interactive agricultural science, ethically and ecologically attuned to sustainability concerns.

Organic farmer networks are central to the diffusion of such an interactive agricultural science in which different types of agricultural knowledge are acknowledged. Networks for alternative agriculture in the US have been around for a long time. For example, Frost and Lentz (2003) articulate that farmers in southwest Minnesota in the early 1900s were part of a rich information exchange network, in which ideas about farming were spread across the landscape in a horizontal fashion (2003:68). More recently, such farmer networks have functioned as “invisible colleges” on the margins of the dominant capital-intensive agriculture (Berry, 1977; Rodale, 1970). Networking agricultural knowledge is seen as a process of learning from, and interactively with other farmers and actors. They are dynamic and fluid, and take on many forms, but often linked by a common philosophy and ethos—a commitment to making sustainable change happen in the way a complex multi-functional agriculture (Fig. I) is practiced, its effect on the environment, quality of life and, farmers’ financial viability (Guijt and Proost, 2002). Generating agricultural knowledge and local solutions relevant to practices, while building a supportive social environment are key motivators in the formation of networks.

Trust and reciprocal relations that emanate from solving farming problems together, generating knowledge relevant to place, and becoming “learning communities” are defining elements of organic farmer networks. Using data generated from a sample of organic farmers belonging to one or more networks in the Northeastern tier of New York this paper assesses the two dimensions of farmer innovation (social and technological innovations) and the role of social learning in networks in the diffusion of innovations among alternative agriculture farmers.
Figure I: Farmer Networks for a Multifunctional Sustainable Agriculture

Key Elements

- Develop pride in local values, capacity and knowledge
- Generate knowledge
- Improve farmer capacity to access services and negotiate with external agencies
- Improve capacity for critical analysis
- Increase, conserve and use local biodiversity
- Increase diversity of new technologies
- Build management skills
- Stimulate and accelerate farmer experimentation
- Link farmer experimentation to formal extension
- Participatory/social learning

Social Innovations

Technical Innovations

Methodology

Data for this research were collected in 2003 through a variety of strategies. The analysis employed both an interpretive approach and descriptive statistics. The latter was mainly used to illustrate the background characteristics of farmer participants. The strategies for data collection include participant observation of network activities and semi-structured telephone interviews with a purposive sample of organic producers (N=20). A listing of New York certified organic farmers published by the Northeast Organic Farmers Association, listed by county was used to identify the population of organic farmers in six contiguous counties in the Finger Lakes region of New York. The counties are, Cayuga, Seneca, Schuyler, Chemung, Cortland and Tompkins. A total of 38 organic farms were listed under these seven counties. The intention was to interview 100% of the listed farmers. However a total of twenty farmers agreed to participate in the semi-structured interview sessions. The researcher was also aware through reviewing other listings of sustainable farms in the research area, that there are other organic farmers in the area delineated for the study who are not certified. However, the decision was made to include only certified...
organic producers because it was concluded that they might be operating under strict certification requirements that may influence their behavior and practice differently.

Each of the twenty farmers who participated in the telephone interviews were asked to reflect on their activities in relation to the technical and social innovations conceptualized as defining elements of a networking arrangement supporting sustainable agriculture (Figure 1).

The researcher and associate collaborating on the project also participated in several farmer workshops in the study region. Informal notes from farmer meetings were supplemented with network newsletters for content analysis. These were then uploaded into a qualitative research software, QSR for coding into thematic categories and interpretively analyzed. Responses from the semi-structured telephone interviews were similarly coded based on the thematic elements articulated in the Figure I. The interpretive approach attempts to understand the world of lived experience, and how people give meaning to their personal experiences and actions (Denzin, 1989; Miles and Huberman, 1994).

Analysis and Discussion

Characteristics of interviewed farmers

The farmers who participated in the study were relatively younger farm operators. Approximately 50% of the farmers were between 20 and 38 years old and relatively well educated, with either a community college or University degree. Some of the farmers had either worked on a farm, or had parents who owned a farm when they were growing up. Twenty-three percent of the interviewed farmers have been in organic production for between five to ten years. Of the twenty farmers interviewed fourteen of them operate specialty horticultural crop enterprises. One farmer had a pastured chicken and goats enterprise integrated with horticultural production while the remaining four farmers were cattle producers who had transitioned to grass-based farming.

Table I: Characteristics of sampled organic farmer network participants

<table>
<thead>
<tr>
<th>Characteristics of Farmer</th>
<th>Number of farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>16-21</td>
<td>N</td>
</tr>
<tr>
<td>22-38</td>
<td>11</td>
</tr>
<tr>
<td>40-49</td>
<td>7</td>
</tr>
<tr>
<td>50-59</td>
<td>2</td>
</tr>
<tr>
<td>60-65</td>
<td></td>
</tr>
<tr>
<td>&gt;65</td>
<td></td>
</tr>
<tr>
<td><strong>Sex of Farmer</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>9</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
</tr>
<tr>
<td>Farmer couple</td>
<td>6</td>
</tr>
<tr>
<td><strong>Level of education</strong></td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>4</td>
</tr>
<tr>
<td>College/University</td>
<td>16</td>
</tr>
</tbody>
</table>
Technical innovations of interviewed farmers

All interviewed farmers indicated that their primary management approach is diversification of their farming system. Farmers’ innovative practices constitute a conscious effort to increase both spatial and temporal diversity on their farms based on the particular characteristics of the production system. Farmers perceive this as a key element in sustaining the viability of their farms. Spatial diversity refers to variations in species across a farmer’s landscape or entire area of production.

Table 2: Management practices spatial and temporal configurations on interviewed farmers’ farms

<table>
<thead>
<tr>
<th>Number of crops grown per season</th>
<th>Number of farmers</th>
<th>Sequence of rotations over time</th>
<th>Number of farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N</td>
<td>3-4 years</td>
<td>14</td>
</tr>
<tr>
<td>2-4</td>
<td>8</td>
<td>5-7 years</td>
<td>6</td>
</tr>
<tr>
<td>5-8</td>
<td>9</td>
<td>8-10 years</td>
<td>-</td>
</tr>
</tbody>
</table>

As shown in Table II, participants’ farms reflected a range of diversities across a continuum of management strategies and spatial configurations, with nine of the interviewed farmers indicating that they grow up to eight crops on their farm, eight farmers indicating that they grow up to four crops on their farms. Some of the farmers interviewed, as noted earlier integrate livestock and crop production in their farming system whilst a significant number of the farmers (14) operated either a cropping or a livestock system. All of the livestock producers except one indicated that they had shifted from a conventional confinement system to grass-based management.

In the process of experimenting with various management strategies and spatial configurations, interviewed farmers indicated they developed considerable insights and technical knowledge on systems manipulation to enhance their yield potential. The inclusion of a more diverse set of alternative crop species in effect reflects a dynamic learning process as farmers observe the outcomes of new crop-micro-environment interactions within specific agro-ecologies. It has been found that this process of learning through experimentation extensively sharpens farmers’ “performative” skills (Richards, 1985).

All the farmers interviewed had substantive understanding of the relationships of crop rotations integrating legumes N-fixing legumes to soil fertility, pest management and soil protection. All the interviewed horticulture farmers identified disease and nutrient management as the most critical components of their experience and learning because as one farmer put it: “there is very little “out there” to inform you about how you can decrease the population of pests when there are three to four different crops on your land at the same time with different bugs doing the same damage without using some chemical product.”

Another area of technological innovation that emerged from the interpretive analysis of interview results relates to fallow management strategies. Through experience and conscious experimentation, farmers seemed to have come to an understanding of what works within the particular context of their farming environment. According to one of the
interviewed farmers: “the conventional understanding is that minimum tillage is always good because it helps the soil to capture and retain moisture, minimizes runoff and improving the soil, but my experience suggest otherwise on my farm. The challenge is learning through incremental adjustments to conventional equipment to learn which tillage technique works best for particular environments, and rotations strategy within the context of one’s own farming environment”.

Farmers’ fallowing strategies show that their management strategies are not always grounded exclusively within the context of their own local knowledge; they also draw critical insights and knowledge from scientific agricultural science. Thus as Roling (1996) has argued, alternative management strategies need to be understood as a function of a dialectical interplay of scientific and local/experiential knowledge. As Somers (1998) put it, sustainable agriculture can best be served by intensive interaction between scientific knowledge and the knowledge generated by farmers in their locality specific contexts.

Conventional research and extension are not institutionally organized to facilitate the validation or diffusion of this interactive knowledge. Such a process of social innovation has instead been gradually spawned through the informal and formal networks of farmers in the interactive knowledge community. However, there clearly is a role of extension in facilitating the deployment of this interactive agricultural science. The challenge is whether the fundamental institutional and organizational re-arrangements and policies required can be accomplished at all.

Social Innovations

The management of agro-ecological systems requires not only a coherent set of technological innovations but also a corresponding set of social arrangements among stakeholders that can facilitate interactions based on understandings that all stakeholders possess knowledge that are valid on their own merit. That facilitative process can be engendered through social learning. Analyses of the data in this study showed that the process of technical innovation which approximated initially an individual learning activity, became a process of shared and negotiated understanding, validation and shifts in cognition about farmers practices through the social networks the interviewed farmers were embedded.

Social learning and the role of facilitation

The findings show that farmers were embedded in a wide range of flexible networks, that included a small number of researchers and extension agents; and through these social networks innovative practices were being compared, shared and analyzed. Thematic coding of transcripts showed that sixteen out of the twenty farmers interviewed identified their need to validate their experience or knowledge as a motivation for their participation in farmer networks. Farmers felt they could trust other farmers engaged in organic agriculture although a number of the interviewed farmers (five out of twenty) indicated that they have also benefited from cooperative extension services in the region. Mutual support, motivation and reflection were among the critical descriptors used by respondents in relation to their social networks. The networks within which interviewed farmers were embedded encouraged all participants to be teachers as well as learners. Individual learning and experiences are brought into discussion forums for validation and iterative re-testing.
That farmers saw their farming networks as an interactive learning space in which co-
learners and teachers are engaged in critical reflection and negotiation of their individual
experiences was reflected in the following account by one of the interviewed farmers:

It was evident from the analysis that facilitation of the learning process is a critical
factor. Two thirds of the farmers interviewed mentioned the role of an Extension Associate
(the first extension professional) recently employed for organic agriculture programming at
Cornell University in facilitating networking activities of organic farmers in the region.
According to these interviewed farmers, the sharing of experience through on and off farm
activities was sustained as a result of the motivation and catalyzing influence of this
Extension Associate and his skills in relationship building and facilitating connections among
the organic farmers with whom he interacted. The analysis revealed that most of the
interviewed farmers felt that this Extension Associate’s facilitation supported their learning
processes in a very transformative way. Rather than being directed as a conventional transfer
process, the learning and the diffusion of innovations that was occurring in farmer networks
was being facilitated as an interactive and dialogical diffusion of learning and innovation.

It was also evident from the analysis that farmers’ social networks were not only
platforms for mutual and horizontal learning (farmer to farmer), but were also spaces for a
democratic engagement in shared learning between farmer and a growing number of
extension professionals and agricultural scientists. This clearly emerged as novel experience
since nearly half of the interviewed farmers either directly or indirectly pointed to the social
distance between their county extension agents and their networks. This pattern of
researcher/extension participation is worth more careful empirical investigation because of its
potential implications for institutional change and how it can be nurtured in the Land Grant
extension system.

Implications for extension

Cooperative extension has historically played a major role in bringing information to
farmers, but the increasing plurality and diversity of farming systems has been challenging
their capacity to respond effectively in emergent farming systems contexts grounded in agro-
ecological principles. Since the early part of this century, some scholars have shared
concerns about specialization at the expense of diversity in farming systems and research and
extension’s role in the process. For example James H. Hilton, the Iowa State University
President in 1961, openly admonished the land grant colleges to extend the sphere of
research and extension beyond economic and agronomic dimensions to include people and
their relationships to the ecological environment.

The foregoing analysis of the dynamic interplay of social and technical components
of agricultural innovations in alternative agriculture suggests a potentially important role for
extension. Linking extension practice to such emerging approaches to innovation and learning can
contribute to enhancing its relevance and reach among an increasingly diverse constituency
of stakeholders in the agricultural and food systems landscape. Organic farmers, for example,
may have interests in, and thus may need information on mechanical methods of weed
control.
Extension can also address the challenge of enabling effective communication and facilitating decision making that minimizes the risks inherent in more complex agricultural systems. Research and extension can work closely with farmers to test, and validate resource conserving agricultural technologies that fit particular farming systems while playing a major role in developing local leadership capacities among alternative agriculture farmers. Among the challenges for an engaged extension system—one that responds to the needs of this growing community of agriculturists will be how to shift from a focus on behavioral change of the individual farmer to one of consciousness-raising, and the facilitation of group processes of learning.

No doubt there are significant risks in the call for such institutional change as normative notions of expert-clientele relationships can be turned on its head under conditions of such institutional configurations. Jayaratne (2003) however argues that growing changes in societal demands for environmentally friendly production systems and food safety are requiring that the cooperative extension system responds to these demands in order to be a vital resource for agriculture and society.

Conclusions

This assessment of organic farmers’ technical and social innovations has shown that a move toward sustainable agriculture reflects an evolutionary process based on experimentation, changing role relations and risk taking. Farmers’ local networks help to minimize the risks while providing a space for the diffusion of ecological innovations spawned within an agro-ecological context through a social learning process.

Based on the insights revealed from analysis of data generated through a variety of strategies and sources, it can be concluded that the potential exists for a greater role of public extension systems in sustainable agriculture. However barriers such as prevailing institutional norms and an existing reward system that has not yet embraced the legitimacy or validity of pluralism in knowledge production limit the participation of researchers and extension agents. An increased role for extension in alternative agriculture will be dependent on its capacity to learn (Senge, 1990). Flexibility, cooperative strategies and systemic learning are fundamental capacities that will need to be nurtured and advanced for such an institutional transformation to occur.

Educational Importance and Implications for Extension

The increasing diversity of production systems in the US agricultural landscape, and the emergence of a growing number of consumers demanding alternative food systems require an approach to extension that integrates a learning systems orientation. Sustainable agriculture systems are multi-functional and complex. A multi-functional agriculture requires extension approaches that that facilitate critical learning and negotiation among diverse stakeholders. A learning approach embraces pluralism in the generation of knowledge, and recognizes the agency of situated actors in generating knowledge that can contribute to productivity while improving the vitality of the natural resource base. Farmer knowledge and social networks if institutionally supported through public/university research and extension can lead to sustainable transformations in agricultural-environmental relations and enhance socio-economic vitality in US production systems.
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