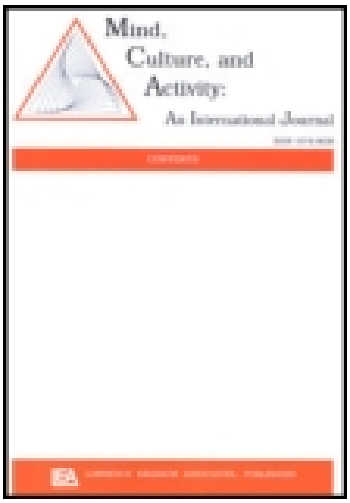

Mind, Culture, and Activity

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/hmca20

Working With Cultural-Historical Activity Theory and Critical Realism to Investigate and Expand Farmer Learning in Southern Africa

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Accepted author version posted online: 19 Jan 2012.Version of record first published: 26 Sep 2012.

To cite this article: Mutizwa Mukute & Heila Lotz-Sisitka (2012): Working With Cultural-Historical Activity Theory and Critical Realism to Investigate and Expand Farmer Learning in Southern Africa, Mind, Culture, and Activity, 19:4, 342-367

To link to this article: http://dx.doi.org/10.1080/10749039.2012.656173

Mind, Culture, and Activity, 19: 342–367, 2012

ISSN 1074-9039 print / 1532-7884 online
DOI: 10.1080/10749039.2012.656173

Routledge
Taylor & Francis Group

Working With Cultural-Historical Activity Theory and Critical Realism to Investigate and Expand Farmer Learning in Southern Africa

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This article uses the theoretical and methodological tools of cultural historical activity theory and critical realism to examine three case studies of the introduction and expansion of sustainable agricultural practices in southern Africa. The article addresses relevant issues in the field of agricultural extension, which lacks a theoretical "bridge" between top-down knowledge transfer and bottom-up participatory approaches to learning. Further, the article considers the learning environments necessary for sustainable agriculture. Such environments provided research participants with encounters with "postnormal" scientific practices that recognise and engage plural ways of knowing. Our research explored why farmers learn and practise sustainable agriculture, how they learn and practise it, the contradictions they are facing, and how these contradictions can be overcome in a context of change-oriented learning.

Contemporary proposals for enhancing food security on the African continent strongly support the introduction and expansion of sustainable agricultural practices. However, little has been said about the *learning innovations* needed to establish and expand such practices. This article addresses this silence by utilizing the theoretical and methodological tools of cultural historical activity theory (CHAT) and critical realism to examine three case studies in southern Africa. The article addresses relevant issues in the field of agricultural extension, which lacks a theoretical "bridge" between top-down knowledge transfer and bottom-up participatory approaches to learning. Further, the article considers the learning environments necessary for sustainable agriculture. Such environments provided research participants with encounters with "postnormal" scientific practices that recognise and engage plural ways of knowing.

Sustainable agriculture discourses and practices are situated within a global movement toward sustainable development. The aim of this movement is to encourage development that is simultaneously socially just, economically viable, and ecologically sustainable (UNESCO, 2005).

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Sustainable development and its related practices arose from concerns about ecological degradation and a realisation that current development practices, informed by "normal science," are producing a risk society with serious consequences for current and future generations (Beck, 2000). An industrial society is characterised by scarcity linked to the control and distribution of goods, whereas a risk society is characterised by insecurity and the distribution of "bads" (Beck, 2000). Mythen (2004) noted that the meaning of risk has evolved over time. In the past, uncertainty and risk were separate concepts, the former being associated with outcomes that could not be fully predicted. But today this distinction has been blurred—risks are seen as hazards or dangers associated with future outcomes. Risk and uncertainty are critical matters in agriculture and, therefore, their impact on both learning and practice needs to be taken into account (Markwei, Ndlovu, Robinson, & Shah, 2008).

In their 2011 *State of the World Report,* the Worldwatch Institute (WI) noted that the current condition of the global environment requires renewed efforts to practise sustainable agriculture. Climate change, in particular, has significant implications for agricultural practices (Christensen et al., 2007) and is a key motivator for sustainable agricultural proposals and practices. Conventional agricultural practices have contributed significantly to climate change because these practices use fuel to farm land, require the application of fertilisers and pesticides, and release greenhouse gases through soil tillage. In southern Africa, where the data for this article were collected, the effects of climate change are linked to an increased frequency and duration of droughts, higher risk of flooding, and increased climate variability. This has created complex conditions for farming, increasing food insecurity and crop vulnerability (Lotz-Sisitka, 2010; Whiteside, 1998).

Sustainable agriculture has been identified as an important way to improve agricultural development on the African continent (Hulme, 1996; WI, 2011). Pretty (2002) noted that sustainable agriculture projects in Africa and elsewhere have demonstrated the capacity to produce more food. Similarly, the WI (2011) argued that a "paradigm shift" is needed: away from monoculture and reductionist forms of agricultural development toward forms of agricultural development that strengthen social-ecological innovations that "nourish people and the planet alike" (p. 12). This paradigm shift will require an interrelated system of innovations that includes technical innovations, governance innovations, and evaluation innovations (WI, 2011). However, there is another innovation necessary that the *State of the World Report* (WI, 2011) neglected to discuss. This is the *learning innovations* needed for an agricultural development paradigm shift to take place, which is the focus of this article.

PLURAL WAYS OF KNOWING, COGNITIVE JUSTICE, AND LEARNING INNOVATIONS

Dealing with environmental risks and developing innovations to address these risks require more inclusive ways of knowing and doing, as noted by Pimbert (2009), who stated that "more inclusive ways of knowing are required to bring together the partial and incomplete perspectives of different actors faced with uncertainty, diversity and change" (p. 22). Funtowics and Ravetz (1994) proposed the adoption of "postnormal science" as a way to deal with uncertainty and high stakes in a risk society. Their key point was that it is important to draw on the knowledge, experiences, and values of a wide range of people—not only scientific experts—when dealing with

new, emerging, and complex issues with uncertain and potentially risky consequences (as is the case for contemporary agriculture).

Similarly, Visvanathan (2006) suggested the concept of *cognitive justice* involving "simultaneous congregation of knowledges and knowledge-makers to debate their assumptions . . . a parliament of knowledges for science, where a sense of plurality prevails" (p. 167). He argued that this is as an important tool for addressing complexities in a risk society. Cognitive justice intends to "create a pluralist world of cognitive possibilities where emergence rather than reduction . . . [is] emphasized" (Visvanathan, 2006, p. 169).

Drawing on the work of Whiteside (1998) and Scoones, Thompson, and Chambers (2008), it is possible to identify the historical emergence of five main approaches to agricultural research and extension in southern Africa: (a) Transfer of Technology, (b) Farming Systems Research, (c) Train and Visit, (d) Farmer-First or Farmer Participatory Research, and (e) People Centred Learning and Innovation (Mukute, 2010). These approaches are largely differentiated by the nature and degree of farmer participation in knowledge generation and use processes and by farmers' interest in cognitive justice and epistemological pluralism in the extension/learning process.

Technology transfer is based on a top-down learning and development approach: Scientists do the research and design, extension workers disseminate the knowledge and technologies generated, and farmers use these research products. People Centred Learning and Innovation, on the other hand, emphasizes the importance of putting farmers at the centre of identifying research needs and codeveloping knowledge and technologies to address them. In southern Africa, where the whole range of learning approaches is still being practised, one of the key challenges has been to find a theory that "bridges" the top-down and the participatory agricultural learning and development approaches (Leeuwis, 2004). This article proposes that CHAT potentially addresses this bridging theory because it provides tools for working with such contradictions and its assumptions about learning and development (Mukute, 2010).

THEORETICAL LENSES: CHAT AND CRITICAL REALISM

To engage the aforementioned issue and to theorise and investigate cognitive justice and plurality of perspectives in change-oriented agricultural extension and learning, we utilised CHAT and perspectives from the first phase of critical realism[1] to inform our research. We used critical realism as the underpinning philosophy for CHAT to allow for ontological depth and explanatory critique (Bhaskar, 1998) of the learning conditions and mechanisms shaping the learning interactions of farmers. CHAT provided a bridging theory for investigating agricultural extension (outside of the duality of top-down and bottom-up discourses) through three interrelated forms of learning (Lave & Wenger, 1991):

1. *Scaffolding*, where the learner moves to the next level of understanding with the assistance of a more knowledgeable other who leads the learner to mastery;

[1]Dean (2006) differentiated between three phases of critical realism involving the ontological phase, the dialectical phase, and the meta-reality phase.

2. *Cultural interpretation of learning*, where a more knowledgeable other uses instructional conversation to help a novice make connections between his or her everyday knowledge and scientific knowledge; and
3. *Collectivist interpretation of learning*, where a group of people with different experiences and perspectives work together on the same object and seek to jointly develop new knowledge or tools to address the problems.

CHAT is an epistemological theory that posits that learning takes place through collective activities that are purposefully conducted around a common object. It has three main components: the system, learning, and development (Dick & Williams, 2004). It uses systems-based thinking to gain insights about the real world. It is based on the proposition that learning is a social and cultural process that draws on historical achievements. Engeström (2001, pp. 136–137) suggested the following five principles for CHAT:

1. The prime unit of analysis is a collective, artefact-mediated, and object-oriented activity system, which is seen in its network relation to other activity systems.
2. Activity systems are multivoiced and are a nexus of many points of view, traditions, and interests. The multivoicedness of the activity systems is a source of both tension and innovation.
3. Activity systems take shape and are developed over long periods. An activity system should be analyzed in terms of its history, objectives, and outcomes, as well as in terms of the genealogy of conceptual tools that have shaped it over time.
4. Contradictions between and within activity systems are potential sources of change and development. Activity systems are also seen as open-ended learning systems that can adopt new elements from outside, which can create contradictions.
5. Activity systems have the potential for expansive transformations, which occur through relatively long cycles of qualitative transformation. Expansive transformations happen when the object and motive of an activity have been reconceptualised to embrace a much wider horizon of possibilities than originally imagined.

Critical realism is a theory with ontological depth that complements the empirical possibilities of CHAT. Critical realism allows for in-depth explanatory critique that goes beyond empirical experience to uncover causal mechanisms that would otherwise be "invisible," thus avoiding the fallacy of actualism (Bhaskar, 1998). Benton and Craib (2001, p. 120) noted that critical realism has the following key features:

1. A dialectical foundation and that encourages the "fertility of contradiction," which is based on the thinking that inconsistency in knowledge can be an important source of new knowledge.
2. An emancipatory intent that is committed to changing unsatisfactory and oppressive realities, such as those in a risk society.
3. An assumption that the surface appearances (empirical evidence) are potentially misleading and an insistence that researchers go beyond or behind the empirical layers to the actual and real layers. Empirical reality is that which can be observed; actual reality is the second layer of reality and it is what happens when events are activated. The real is whatever exists, whether people are aware of it or not, and it can be social or natural. It is associated with causal powers.

4. An assertion that our knowledge of the natural and social world is both fallible and provisional because our experience of the world is always theory laden and open to correction in the light of new experiences, such as dialogues, experiments, interpretations, and observations.

Our combined use of CHAT and critical realism allowed us to engage in explanatory critique, which helped to reveal, for example, how vested interests in agriculture create contradictions in sustainable agriculture activity systems, and how cognitive injustices are maintained through the power of "normal science." Explanatory critiques such as these reveal underlying causal mechanisms structuring learning in activity systems. Explanatory critiques also help to provide further insight into the highly complex and contradictory triple object of sustainable agriculture—ecological, social, and economic sustainability—and how this triple object is of intergenerational interest. Critical realism also provided us with in-depth insight into structural constraints and enablements that influence learning in individuals, institutions, and society. In addition, the combined use of these theories allowed us to build on historical and evolving developments in agriculture.

RESEARCH OBJECTIVES AND QUESTIONS

Because of current agricultural development needs—the need for sustainable agriculture, the need for *change-oriented* learning processes that are grounded in lived reality, and the need for a plurality of perspectives in learning and in practice—we identified the following research goals:

1. To investigate learning processes that expand the current scope of sustainable agriculture practices, and
2. To develop mediating tools to support expansive learning of sustainable agricultural practices.

Questions that guided this study include:

1. Why do farmers learn about sustainable agriculture?
2. How do farmers learn about sustainable agriculture in their workplaces?
3. What are the current limitations and contradictions of sustainable agriculture learning processes among farmers?
4. How can farmers better learn about sustainability and practise it more reflexively in their workplaces?
5. What conceptual artefacts can be developed to support expansive learning for sustainability in farmers' workplaces?

RESEARCH DESIGN AND METHODOLOGY

Supported by the theoretical perspectives just outlined, the study drew on a CHAT-informed methodology called Developmental Work Research, which provides a process framework for

expanding learning and can be used to overcome current contradictions in and between activity systems. Developmental Work Research draws on the strengths of joint analysis and concrete transformation of current practice (Engeström, 2005) and is a change-oriented or innovation-centred methodology. Expansive learning takes place within three major and interrelated contexts: the context of criticism, which involves resistance, questioning, contradiction, and debate; the context of discovery, which involves experimenting, modelling, symbolizing, and generalizing; and the context of application, which involves the social relevance and embeddedness of knowledge, community involvement, and guided practice (Engeström, 2005). Expansive learning has the following stages:

1. Questioning: Drawing on research data to question existing practices or existing wisdom.
2. Analysing: Invoking "why" questions to seek out explanatory principles. Historical-genetic analysis aims to explain a situation by tracing the origin and evolution of a contradiction, whereas the empirical analyses trace the inner systemic relations involved in a contradiction.
3. Modelling: Constructing of new ways of working or engaging in practice.
4. Examining the model: Experimenting with the new model to fully grasp its dynamics, potential, and limitations.
5. Implementing the model: Working with the model in real-life situations and monitoring its impact.
6. Reflecting: Using monitoring data to evaluate the model for refinement.
7. Consolidation: Implementing the refined model into a new, stable form or part of practice. (Engeström, 1999, p. 384)

We deployed a multiple case study research design because the complexity of the object required that we understand social phenomena within naturally occurring settings: farmers practising, learning, and enhancing sustainable agriculture while interacting with sustainable agriculture promoters, high-input agriculture extension workers, and the corporate sector in the context of new climate uncertainties (Mukute, 2010). Looking at three case studies allows us to investigate contemporary events that have time-space configurations that are not easy to manipulate (Yin, 2003). Multiple embedded case studies (Yin, 2009) are made up of cases within a case. The case study design also resonates with intensive research designs that are typical of research studies utilizing critical realism (Sayer, 2000). Researchers can use case study designs to gain an in-depth understanding of something, which can then be used to influence policy, procedures, practices, and future research (Merriam, 2001).

Study Sites

Selection of study sites was largely determined by the breadth and depth of the research questions, which were devised to both explore and expand learning and practice of sustainable agriculture in southern Africa. The following criteria were used to select the case studies:

1. Sustainable agriculture practices that had a relatively long history in southern African countries (at least 10 years) and that had demonstrated potential for efficacy in any country of the southern African region,
2. Extensive application of sustainable agriculture practices,

3. At least one of the agricultural practices had to be indigenous to southern Africa,
4. Incorporation of sustainability in farming,
5. Farmers needed to be working on relatively small holdings (as such farmers form the majority of farmers in the southern African region), and
6. Diversity between and among the case studies in terms of socio-political and agro-ecological conditions.

The sustainable agriculture practices studied at the three sites were permaculture, organic farming, and the machobane farming system (MFS). These practices were selected because of their relative high prevalence in Zimbabwe, South Africa, and Lesotho, respectively. The three case studies were differentiated by the type of agricultural practices involved, as well as by the place or country in which the practices were exercised. Case Study 1 was of the Schools and Colleges Permaculture Programme (SCOPE) in Zimbabwe, which had been in operation for 15 years and focused on St. Margaret Primary School and its community. SCOPE implemented permaculture since 1994. Schools often provide important centres for learning and extension in rural community contexts. Case Study 2 was of the Isidore Organic Farm and its community of organic producers and a marketing company, Earth Mother Organic, in Durban, South Africa. Case Study 3 examined the machobane farming system farmers, promoters, and agricultural extension workers in Mafeteng and Mohale's Hoek districts of Lesotho. The MFS-promoting organisations worked with the Machobane Agricultural Development Foundation and the Rural Self Development Association.

The units of analysis in Case Study 1 were the farmers and the school activity system and SCOPE itself; in Case Study 2, the units of analysis were farmers, organic facilitators, and organic marketers; and in Case Study 3, the units of analysis consisted of the MFS farmers, MFS trainers, and government extension workers. In each case study, the activity systems were connected to each other because they had a shared object, which is depicted as a small circle including all three groups (see Figure 1). It is at this "boundary crossing" that possibilities for recognition of and engagement with plurality of knowledge perspectives occur.

Data Generation

The used research process had two phases: exploration (Phase 1) and expansion (Phase 2). The methods used in Phase 1 were document analysis, semistructured individual and group interviews, and observations. This phase involved meeting 59 people from the three case studies, many of them in groups. Engagement with research participants was done at a number of levels, such as through (a) insider experience, as one of the researchers worked for 10 years in those socio-ecological areas; (b) interaction with gatekeepers; (c) document analysis; (d) 1-week visits to each research site; and (e) continual contact with research participants, which was done by sending interview transcripts and case study reports for participant feedback. The interviews in Phase 1 resulted in about 160 pages of transcribed conversation. The prolonged contact was extended into Phase 2, where there were two layers of direct contact and many layers in between to share reflections and emerging tools, conclusions, and recommendations. Phase 2, on the other hand, was based on the Change Laboratory (CL) workshops model, defined as "the place and a process where 'disturbances' of daily work processes are materials for analysis and interpretation"

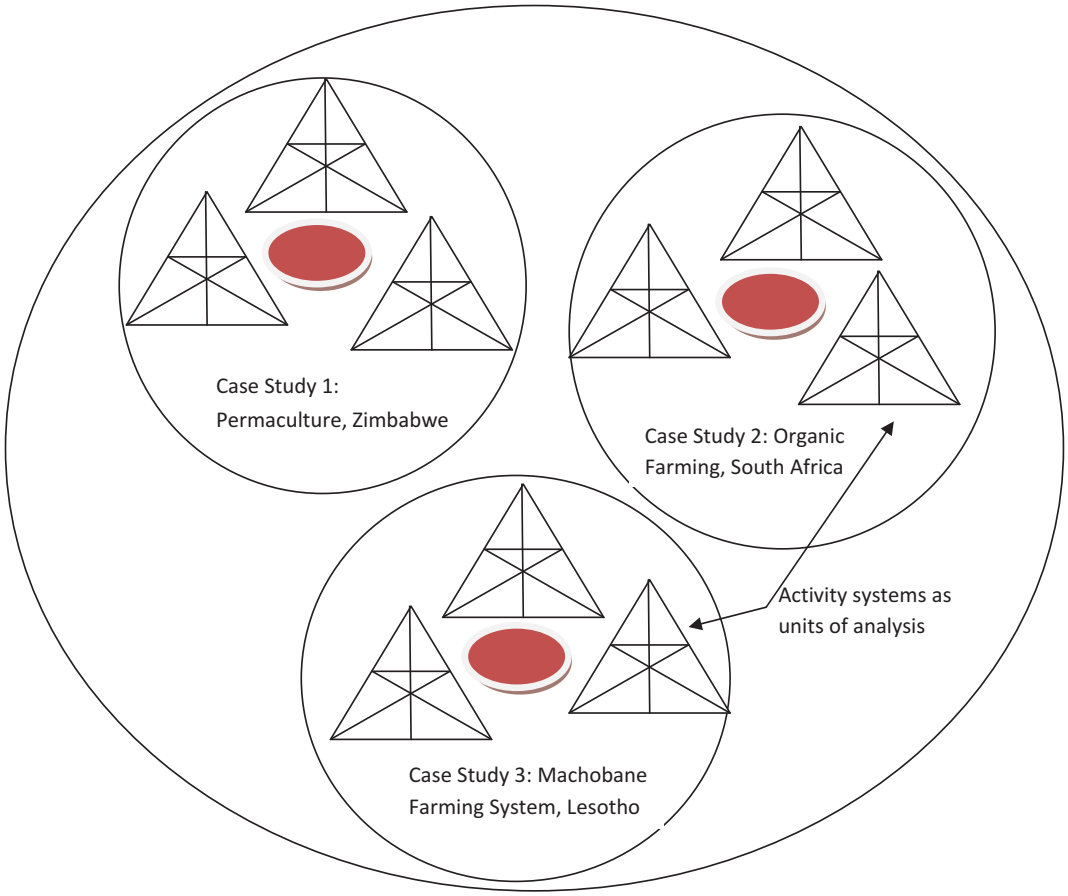

FIGURE 1 Multiple case study design (color figure available online).

(Engeström, 2007), as well as seeds for defining the zone of proximal development (ZPD; Ala-Laurinaho & Koli, 2007, p. 26). Altogether, 80 participants took part in the CL and feedback workshops. The video-recorded material from the CL and feedback workshops was also transcribed for subsequent analysis. The number of speech turns recorded during each of the three CL and three feedback meetings ranged from more than 100 to 500 turns. The transcripts were useful for agentive and reflective talk analyses.

Table 1 contains a summary of the phased data generation process. CL workshops we utilised did not always correspond to the basic structure and setup typically presented and reported in publications concerning CL methods (Engeström, 2007). The cycle of Expansive Learning included the participants' analysis of the history of the activity system and their revelation and elaboration of the present contradictions in their work activity in the CL sessions. In the present study, contradictions are outcomes of analytical work by researchers based on generated with research participants (Phase 1), and the results are used as a mirror to provide material for participants to consider during CL workshops.

TABLE 1
Summary of the Research Process

	Case Study 1	*Case Study 2*	*Case Study 3*
Phase 1: Exploring	• Document analysis • Semistructured individual and group interviews • Observation of farmer fields and gardens	• Document analysis • Semistructured individual interviews • Observation of farmer fields and gardens	• Document analysis • Semistructured individual and group interviews • Observation of farmer fields and gardens
	Data generated from the first phase fed into the second phase as "mirror data."		
Phase 2: Expansive	• Change Laboratory workshop • One day feedback workshop • Process observation • Practice observation	• Change Laboratory workshop • Three feedback interviews • Process observation • Practice observation	• Change Laboratory workshop • One day feedback workshop and one feedback meeting • Process observation • Practice observation
	Data generated from the second phase included some field-level analysis with research participants as well as the modelling of solutions.		

Data Analysis

Data analysis involved field immersion and dialogical analytical work, as well as distancing analytical work. Latour (1999) used a notion of chains of transformation to connect "field" and "cabinet" in a long and complex process of knowledge generation. Data analysis involved producing new signs at each stage, which results in loss, such as loss of locality, particularity, and continuity, and in gain, such as compatibility, standardisation, and relative universality (Latour, 1999). Inductive analysis was used to make sense of the data generated by clustering data into categories based on the notion of "letting data speak." This process provided the bridge between the two spaces of the "real world" and the "representation." Another task was to engage with theory-reality congruence (Mukute & Lotz-Sisitka, 2009), which was achieved through abductive and retroductive analysis that gave shape to the critical realist project of not only linking the data with theory but also trying to establish what must be the case. Danermark, Ekstrom, Jakobsen, and Karlsson (2002) defined these forms of analysis as follows: *inductive analysis* enables one to make sense of data by clustering it into categories; *abductive analysis* occurs when one uses theoretical lenses to make sense of and recontextualise data, a process characterised by movement from the concrete to the abstract; and *retroductive analysis* involves establishing explanations based on what must be the case for things to be the way they are by using historical analyses, counterfactual argumentation, and thought experiments.

Latour (1999) preferred to call data generated and interpreted in these processes "achievements." It was at a researcher's study station (the cabinet) that these achievements (the recordings, interviews, field notes, and reflection notes) were brought together for a unifying gaze to address the research questions. Analytical perspectives, used as "mirror data" in the CL workshops, formed the basis of the expansive learning process.

Validity and Research Ethics

The need to achieve validity and to work ethically required "correctness or credibility of a description, conclusion, explanation, interpretation or any other sort of an account" (Maxwell, 1992, p. 106). The two main threats to validity in qualitative research are researcher bias and participant reactivity (Maxwell, 1992). The researchers used dialectics, reflexivity, and the search for causal mechanisms to limit bias, an important validity measure given our interest in plurality of perspectives and cognitive justice. Working with boundary-crossing, networked learning systems also helped to mitigate potential biases and to allow for a plurality of perspectives. There were several ways in which the research process minimised participants' reactivity. These included intensive, long-term involvement; rich data obtained through interview transcription and rigorous interpretation; and member checking and triangulation of source and method. Upon final reflection, however, the researchers concluded that a longer stay at research sites and an increased number of stakeholder groups involved in the research could have yielded more rigorous research results, especially given that expansive learning processes can take two to three years to complete a full cycle (Engeström, 2005).

Reflexivity was one of the three sensitizing concept used in the study, and it is one of two concepts that helped ensure data trustworthiness. In the study reflexivity involved participants' capacity to continuously and progressively reflect on, review, and change individual actions in response to internal and contextual factors. The study sought to establish how everyday experiences of farming communities could be reflected on so as to consciously build new knowledge and tools to address agricultural concerns and to tap into new possibilities for the communities. This involved iterative learning and collective and relational agency along an expansive learning path, as research participants navigated across their jointly defined ZPDs. The researchers exercised reflectivity at multiple levels: technical, conceptual, and field based. At the technical level, the researchers improved data collection by replacing note taking with audio–video-recording, allocating more time per session and allowing for the use of both English and the local language in CL workshops. In the first two workshops (Case Study 1 and 3), the object was defined based on a conflation of activity systems in the case studies, but when this was realized, the last CL workshop defined the object at two levels: that of each activity system and that of interacting activity systems—a shared object. The solutions were modeled both within each case study and across studies. Feedback sessions were added to CL workshops. To exercise field-based reflexivity, the researchers learned and applied new things about the research methodology and sustainable agriculture practices. This article is based on methodological and theoretical reflexivity. Researchers strengthened their reflexivity by working with the team to conduct "member checking" and, more important, by working with students, agricultural experts, and international scholars of social learning to gain critical perspectives.

Abercrombie, Hill, and Turner's (2006) concept of dialectics—"the view that development depends on the clash of contradictions and the creation of a new, more advanced synthesis out of the clashes" (p. 107)—was also used to ensure data validity. The study worked with the concept of dialectics as proposed by Macey's (2000) three laws: (a) the law of unity and conflict, which states that all phenomena consist of mutually contradictory elements and that change is a result of addressing their internal contradictions; (b) the law of the transition of quantity into quality, which argues that quantitative changes lead to qualitative ones; and (c) the law of negation of the negation, referring to the fact that a new approach is itself negated as contradictions

arise and new solutions are sought. This concept underpins both Critical Realism and CHAT and was used in the study to allow for robust engagement with complex matters that forced both the researchers and the participants to go beneath the obvious and to appreciate different points of view. Dialectics allowed for the interpenetration of different perspectives, motives, and knowledges that research participants groups (e.g., farmers, extension workers, and sustainable agriculture facilitators) brought to the expansive learning process.

Bassey (1999) discussed three central ethical issues in research: (a) respect for truth, (b) respect for democracy, and (c) respect for persons. In our research, respecting truth meant faithfully recording interviews and proceedings of workshops and communicating these recordings back to participants as "mirror" data. Research participants had the opportunity to reject misrepresentations of their actions and expressions. Respecting democracy meant allowing for a plurality of perspectives so that research participants could articulate their concerns, analyse their issues, and model and review solutions jointly. This necessitated that we dealt with difficult issues in a democratic fashion, such as in Case Study 2, when the exclusion of certain stakeholder groups from implementation of the jointly developed solution became an issue, and in Case Study 3, when one of the contradictions in the promotion of the practice was associated with the tension between individualism of the MFS promoting institution and cooperation amongst the wider group. Respecting persons meant encouraging participants to speak in their mother tongue and addressing research participants according to local custom (e.g., addressing elderly men in Lesotho as *Ntate*). It also involved dealing with complex social protocols, such as in Case Study 1, when one of the research participants (whose relative had passed away the day before) requested help with transporting mourners and a coffin to a funeral site. This created a dilemma between appearing insensitive and delaying the change laboratory workshop. Although we ended up starting the workshop late, workshop participants understood the need and were accommodating.

Another ethical tension involved producing an academically rigorous account while making sure that research participants could benefit from the study—hence the choice of the developmental work research methodology and interventionist research orientation.

FINDINGS

The following findings are discussed sequentially around the aforementioned research questions: (a) why farmers learn and practise sustainable agriculture, (b) how they learn and practise it, (c) what the contradictions are that they are facing, and (d) how these contradictions can be overcome in through change-oriented learning. The findings also utilise Engeström's (2008) three layers of causality of human action (Table 2) and shed light on the core issue being addressed in this article, namely, how to bridge top-down and participatory approaches to extension in ways that allow for change-oriented learning innovations.

Why are Farmers in Southern Africa Learning and Practising Sustainable Agriculture?

The question being addressed here is concerned with the interpretive layer of human action (Table 2) and involves inductive analysis. In CHAT, the notion of motive is embodied in the object of an activity system, which also drives what happens in the activity system. The object evolves

TABLE 2
Three Layers of Causality in Human Action

Interpretive layer	In the actor	Takes into account according to this and that logic	If X, then Y Rule, law
Contradictory layer	As participant in collective activities	Is driven by contradictory motives	Searching for resolution by often unpredictable actions
Agentive layer	As potential individual and collective agent	Takes intentional transformative action	Inventing and using artefacts to control the action from the outside

Note. Source: Engeström (2008, p. 17).

culturally and historically and carries collective meanings and motives with it (Daniels, 2008). This makes it important to understand why farmers and promoters of sustainable agriculture do what they do in their different activity systems, an important dynamic of plurality of perspectives. The main finding was that farmer learning is motivated and influenced by both intrinsic and extrinsic factors, which are socially-ecologically determined. Extrinsic factors include the need to (a) produce adequate, safe, and nutritious food and surplus in order to generate income; (b) improve the community's resource base for their own good and for the benefit of future generations; and (c) generate ecological services from agricultural practice. At the same time some farmers have taken up the "trade" because they have a passion for it—a disposition to farm. They easily identified with farming because they had been socialised into seeing farming as a calling. Bourdieu's (1980) theory of practice was useful for explaining how the force of habit (*habitus*) influences what activities people engage in and how what people do cannot be understood merely by looking at their conscious intentions.

How are Farmers Learning Sustainable Agricultural Practices?

A key finding was that farmers learn sustainable agriculture in numerous ways and that this learning is scaffolded by diverse actors including scientists, extension workers, and fellow farmers. These actors help learners to link everyday knowledge, which is context specific, to scientific knowledge, which is context free. These ways of learning enable internalisation and appropriation. Much of farmers' learning has a practical orientation and includes learning by doing, observing, trying, and innovating. This entails practice and externalisation of what has been appropriated. However, although farmers' learning seems to require forms of reflexive deliberation with others, farmers in all sites lacked systematic mechanisms for continuous and strategic learning around their emerging needs and interests.

There are many factors that shape farmer learning and practice of sustainable agriculture in southern Africa (Table 3). As shown in Table 3, one of the interesting findings is the importance of a diversity of mediating tools for facilitating farmer learning in ways that accommodate plurality of knowledge and perspectives. Some mediating tools are good for sharing explicit knowledge (such as the tools of "normal science"), and these include books and/or training manuals. Other tools are good for communicating tacit and experiential knowledge, and these include demonstrations, look-and-learn visits, and experimentation.

Table 3 also shows that cultural-historical factors are not the only factors that influence learning in agriculture. Material and physical factors such as soil composition, ecology, and weather

TABLE 3
Factors that Shape How Farmers Learn

Factor	*Explanation*
Time and place	Time is a central explanatory factor in farmer learning of sustainable agriculture. It is necessary for mastering a practice; building soil ecology; enhancing agro-biodiversity and improving ecological services. Time is necessary to build the resource base so that farming becomes viable. Place determines what can be feasibly raised, when and where depending on seasonality, rainfall patterns, snow and frost periods, soil quality and topography. This has time implications in terms of rate of progress toward sustainable agriculture.
Sociocultural backgrounds and work opportunities	Social and cultural backgrounds shape people's dispositions to go into farming with those that have a history of farming in their families and neighbourhoods likely to develop an interest in it. Circumcision schools, *mafisa, matsema,* and *lesielo* are some of the traditional practices being built on to incorporate sustainability into agriculture. Gender relations also influence choices. At the same time, opportunities and work affordances can also encourage people to go into farming irrespective of their backgrounds.
Economic and social capital	Generally, the low economic capital of organisations promoting sustainable agriculture has undermined the quality of training as facilitators mostly receive short-term training. This in turn reduces the efficacy of training they offer to farmers, which results in a stunted growth and performance of the practices. Farmers' levels of formal education—a form of cultural capital, are generally low and training language and materials employed by facilitators are generally not suitable mediating tools.
Policies and budgets	Mainstream agricultural and educational policies in the three countries where the study sites are found, are still inadequate and ineffective to support the growth and development of sustainable agriculture and generally favour high external input agriculture, especially in terms of financial, technological and human resources support.
HIV and AIDS	HIV and AIDS have been shown to have ambivalent effects on the learning and practice of sustainable agriculture. On one hand, they have created the demand for safe and nutritious food while, on the other, AIDS has killed able-bodied people who are better placed to deal with its labour-intensive nature.

patterns substantively influence what is learned and how. As shown by the cases under investigation, an exploration of farmer learning processes suggests not only a cultural-historical activity system as a unit of analysis but also a *social-ecological and cultural-historical activity system*. As environmental conditions deteriorate on the planet and human–environment relations come under renewed scrutiny (as discussed in the opening of this article), such a conception of activity systems may become more necessary and visible.

What are the Current Limitations and Contradictions of Sustainable Agriculture Learning Processes among Farmers?

Located within the contradictory layer of Engeström's (2008) three layers of agentive talk for human action (Table 2), this research question helped to illuminate contradictions in and between the different activity systems in each case study. The contradictions discussed here are based on using the farmers' activity system as the central activity system in each of the three case

studies. The four categories of contradictions in CHAT, as identified by Engeström (1987), are as follows:

1. *Primary contradictions*, which appear within elements such as artefacts or rules;
2. *Secondary contradictions*, which occur when there is tension between one element and another in the activity system;
3. *Tertiary contradictions*, which happen when an old activity system clashes with a more advanced version of the activity system; and
4. *Quaternary contradictions*, which occur when the central activity clashes with any of its neighbouring activity systems.

Figures 2 to 4 show the kinds of contradictions identified in each case study, some of which were subsequently worked through in the course of expansive learning in the study sites. Using retroductive analysis from critical realism, it was possible to determine what may have caused the contradictions within and across activity systems. Some of these causes are discussed next.

Causal power of past actions. Drawing on knowledge of the history of sustainable agriculture, we determined that the interests of agro-businesses and the interests of ordinary farmers often pull in opposite directions. This history provides an explanatory principle. In particular, the stigmatisation of all forms of sustainable agriculture can be viewed as an indicator of the contested nature of the practices under discussion. The stigmatisation of sustainable agriculture in South Africa, Lesotho, and Zimbabwe can be traced back to colonial and apartheid era tactics to discredit traditional agricultural practices so as to create labour reserves for gold and diamond

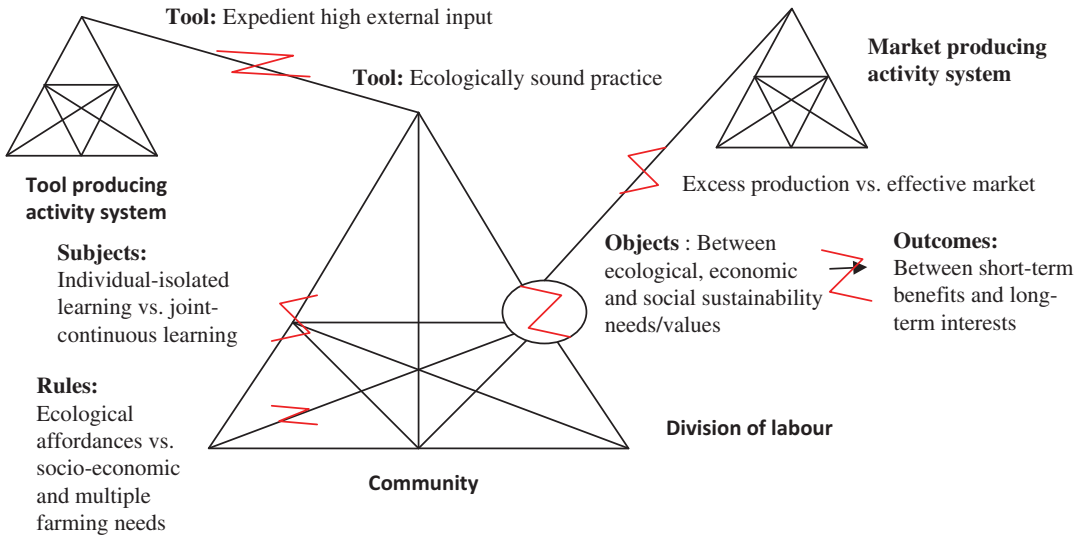

FIGURE 2 Contradictions in the Schools and Colleges Permaculture Programme farmer activity system (color figure available online).

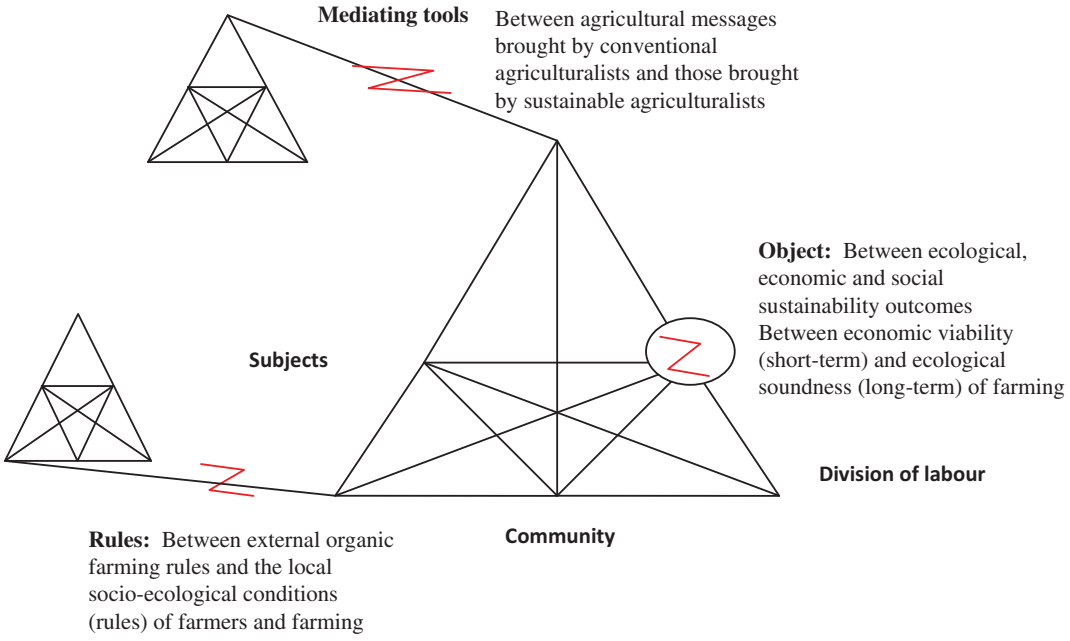

FIGURE 3 Contradictions in the Isidore Organic farmer activity system (color figure available online).

mines (Thomas, 1996). Archer (1998) noted that there are instances when the actions of previous generations can be more influential than the actions of the living. In critical realism, current human development, which includes learning, is often thought of as determined more by the past than by the present. As Archer noted,

> The actors here present are not responsible for creating the distributions, roles and associated interests within which they live. Equally important is the crucial recognition that the pre-structuring of actors' contexts and interests is what shapes the pressures for transformation by some and for stable reproduction by others, in the present. (p. 371)

Power relations. Another explanatory principle is the power relations that exist between different actors. Governments have the political power to decide on policies. The corporate sector has the economic and cultural power to push high external input agriculture. Universities and colleges have modern and institutional forms of intellectual or cultural power, which has tended to reproduce western/modern institutional forms of knowledge and agricultural practices along the lines of "normal science" (Shava, 2008). The economic power of governments, partly derived from donor aid from pro-conventional agriculture countries, has resulted in some programmes that entice farmers to use conventional farming methods by providing free or subsidised materials. Within rural communities in Lesotho, imbalances exist between the landlords and the landless. Power relations between women and men also influence activity in the agricultural sector; men generally have more access to and control over resources, yet women provide much of the labour power. These power relations are the sources of the contradictions encountered in the study sites.

Ignorance. Ignorance about sustainable agriculture practices partly explains why government extension workers fail to promote learning effectively. This was a common issue across all three case studies, as there are limited places for agricultural extension workers to learn about sustainable agriculture. None of the agricultural training colleges or degree programmes reviewed offered fully accredited courses on sustainable agriculture at undergraduate level, and none of the training programmes available take full account of pluralistic forms of knowledge in sustainable agriculture. There is also limited knowledge about sustainable agriculture in other important institutions and organizations, such as at the government policy-making level, in higher institutes of learning, among curriculum development workers, and among bureaucrats who allocate resources. These institutions and organisations promote (at best) the top-down/bottom-up duality identified by Leeuwis (2004) in extension training. The absence of sustainable agriculture in mainstream schools and colleges perpetuates ignorance.

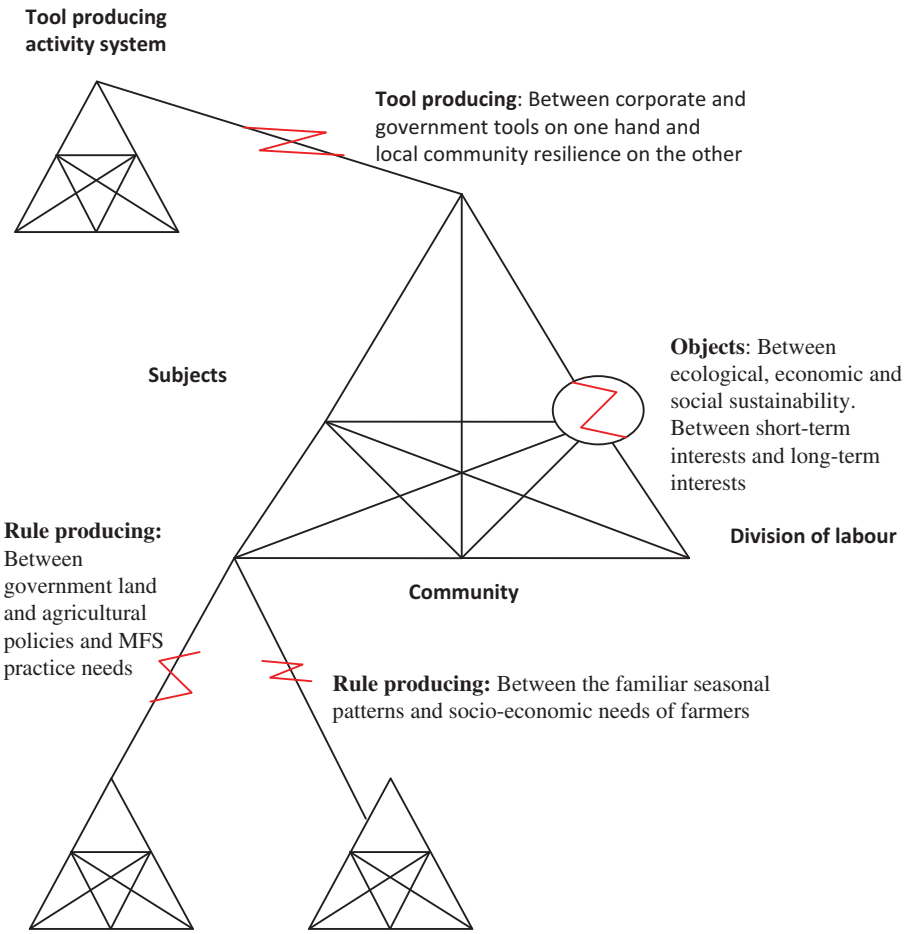

FIGURE 4 Contradictions in the machobane farming system farmer activity system (color figure available online).

Indifference. The exclusion of sustainable agricultural practices in mainstream curricula also explains the structural contradiction that pits local knowledge against western knowledge, practical ideas against theoretical ideas, and marginalised strategies against dominant strategies. Inadequate attention is being paid to knowledge plurality and to the relations between different actors along the agricultural production and distribution chain, as defined by Dean (2006):

> In the Marxian account, contradictoriness inheres in the spatio-temporal separation of necessary relations, practices and processes which promote the "indifference" of these separated elements to one another. "Indifference" expresses here a kind of "objective" unawareness of necessary interdependence (i.e. between production, circulation and consumption of goods) which, beyond a certain point, results in crisis. (p. 136)

How Can Farmers Better Learn about Sustainability and Practise It More Reflexively?

The contradictions identified (illustrated in Figures 2, 3, and 4) were used as fertile ground for improving sustainable agriculture practices in interrelated activity systems through solution modelling and implementation in each case study. Located in the third layer of Engeström's (2008) agentive model (Table 2), a five-session CL workshop was held and video-recorded at each case study site, lasting between two and four days, depending on practicalities. The outline of the sessions, which followed the expansive learning process, is indicated next:

1. Session 1: Orientation to the workshop and tools and working through a historical timeline of the practice and individuals in practice.
2. Session 2: Identification of contradictions by participants and presentation of mirror data (contradictions) by researchers.
3. Session 3: Analysing contradictions and developing solutions in groups.
4. Session 4: Sharing and critiquing solutions.
5. Session 5: Planning the way forward.

By way of illustration, one expansive learning process is outlined next (drawn from Case Study 1[2]).

Expansive learning in case study 1. In Case Study 1, the two main contradictions discussed here are (a) between the means of production and the object of production, and (b) between the size of production (supply), local demand, and farmer object. The school was unable to practise permaculture because its water pump did not work, as the village's electricity source had been cut. This worked against the school's objective to practise agriculture in order to generate food and income, to produce ecological services, to teach agricultural methods, and to support orphans at the school. Of interest, sustainable agriculture farmers in the local community were producing surplus vegetables but could not sell these vegetables because of the high costs of transportation to the marketplace, which were worsened by poor road conditions.

Proposed solutions to these contradictions included setting up a developmental committee to address the issues and writing letters to local authorities, such as school councilors and administrators and national energy supply representatives at the Zimbabwe Electricity Supply Authority.

[2]Full descriptions of the other cases can be found in Mukute (2010).

Six months after the model for these solutions was drafted, researchers and participants held a feedback workshop, which demonstrated that participants had advanced along the expansive learning path after the CL workshop. The committee had mobilised local financial resources and the district Member of Parliament to have Zimbabwe Electricity Supply Authority address the energy problem, which resulted in the restoration of power supply and the continuation of production in the school. The committee managed to arrange for the produce to be ferried to the market regularly at a fair price that could be paid after delivery and sale. The farmers also decided to change their honey processing structure to include vegetable and fruit drying by negotiating with the development organisation.

The process of addressing the contradictions appeared to have mobilized knowledge plurality and increased the community members' capabilities to negotiate, to make connections with people with political and cultural capital, and to mobilise community resources. The solutions encouraged other attitudinal changes: A "yes-we-can" mentality was generated. In short, the expansive learning research process increased the group's individual, relational, and collective agency. From a critical realist perspective, the research participants exercised their agency by engaging with structures and systems of local governance. The agency for these changes in practice, which had hitherto lain "dormant" in them, was activated through engagement in the CL workshop. But as soon as these contradictions were resolved, new ones were identified, setting in motion a process of continuous improvement with the complex object of sustainable development driving the networked activity systems.

Conclusion on expansive learning across case studies. The expansive learning processes show that sustainability can be better learned and more reflexively practised through use of the space created for knowledge plurality and agency in change laboratory workshops and between them. CL workshops

1. Were a place where research participants were able to gain distance from their daily activities in order to reflect on them;
2. Provided a vantage point from which to reveal contradictions faced by farmers, sustainable agriculture facilitators, agriculture extension workers, and organic marketers and to work on them drawing on the distributed cognition and knowledge plurality available in the "room";
3. Illustrated the "researching with" orientation characterised with a levelling of the traditional power gradient between researchers and participants, without conflating the distinct roles that each played;
4. Provided opportunities for improving relational and collective agency among participants; and
5. Proved to be significant in enabling *change-oriented learning* that produces real life changes in social-ecological contexts.

The findings suggest that the expansive learning process can be an effective tool for researching change-oriented learning and sustainability practices where the intention is to stimulate responsible action and set change in motion within a postnormal scientific context where cognitive justice also matters.

What Conceptual Artefacts Can Be Developed to Support Expansive Learning for Sustainability in Farmers' Workplaces?

One of the issues identified through the study was an inadequate range of analytical and conceptual tools to fully make meaning of the expansive learning processes that emerged from engaging farmers in change-oriented expansive learning processes. A total of seven conceptual tools were produced[3] (Mukute, 2010), but this article discusses only two, which may have a wider appeal. These are (a) tools for identifying contradictions and (b) using contradictions for expansive learning.

Tool for guiding the identification of contradictions. Table 4 shows a series of steps that help with the identification of contradictions, which may be located in the first-, second-, and third-generation CHAT. In addition, the tool is informed by Bourdieu's (1980) theory of practice[4] and critical realism. This tool is useful for examining or reflecting on contradictions that emerge in farmer activity systems. It can help to refine or "test" the validity or scope of contradictions identified in particular activity systems. It is most useful when adapted to specific activity system contexts. As shown for the previous three case studies, tensions and contradictions were not the same in all of the case, but tensions and contradictions emerged in all of the spheres just noted.

Tool for expanding learning/working through contradictions. Expansive learning builds on contradictions that surface during the learning process (by using the tool just discussed above [Table 4], or by other methods for surfacing contradictions). As previously discussed, CL workshops are important socio-cultural interaction spaces where expansive learning can take place, but learning is not confined to the CL workshop itself. A "good practice process framework" for CL workshops was identified through reflections on the CL process. Reflection can provide useful guidance for researchers planning to use the CL process in expanding learning with farmers. Table 5 shows that learning should ideally be conducted in a series of interrelated sessions. Depending on a number of factors, such as language and the need for translation, each session may last for about 3 hr. The first five sessions discussed here took place one after the other but on different days. The last session was held at least 6 months after the fifth to give ample time for the implementation of a model solution.

[3]The seven tools produced in the study were for assessing the triple bottom line of agriculture, exploring existing learning processes, identifying contradictions, working through contradictions, agentive talk analysis, reflective talk analysis, and supporting reflexivity among farmers.

[4]Bourdieu's (1980) theory of practice describes the following dimensions of practice: practices are time and space bound, practices are experience laden in the sense that much of what is practiced is tacit or not made explicit but simply done, practices are not easily interpreted from descriptions of them, and practices are characterised by an improvisory or strategic logic. Bourdieu also explains that *habitus* affects our every action. *Habitus* is an underlying social structure shaping the way things are done and is therefore part of practices.

TABLE 4
Tool for Identifying Contradictions

Part 1: Practices, Purpose and Mediating Tools[a]		*Part 4: Rank and Prioritise Each Tension*	
What tensions exist within and between:	Tension between X and Y (Examples) Under each box in this column undertake your own analysis and indicate what tensions exist in your activity system	Rank 1–5 (with 1 as most important; 5 as least important)	Mark degree of ease to address tension: E = easy; M = medium; D = difficult
People and their aims?	Short-term needs vs. long-term needs		
People's aims and their existing knowledge, experience and values?	Interest in producing organically vs. only learned to produce using mono-cropping and artificial chemicals in agricultural training		
People, their aims, and what they do?	Farmers want to produce fresh organic food vs. lack of marketing mechanisms for organic food		
People, resource materials, and learning strategies?	English as a medium of instruction vs. people's proficiency in English		
Concepts and ideas that guide practice?	"Growth forever" vs. sustainable development		
Preferred practice and nature of practice?	Need to increase production and productivity immediately vs. long time necessary time to build the resource base		
Material tools?	Need for labour-saving technologies vs. availability and affordability of the tools		
Part 2: Practices and how they are governed in an activity system[b]		*Rank and Prioritise Each Tension*	
What tensions exist between:	Tension between X and Y (Examples) Under each box in this column undertake your own analysis and indicate what tensions exist in your activity system		
Policies and practice?	Government rhetoric in support of agriculture vs. budgetary and programme support in favour of high external input agriculture		
Cultural norms and practice?	Land inheritance vs. women's access to land		
Environmental factors and practice?	Poor soil conditions vs. low external input requirements of sustainable agriculture		
Community and practice?	Consumer awareness of food safety and nutrition vs. paying for the "real" cost of production		
Division of labour and practice?	Women do the farming vs. men make farming decisions and own the productive resources in farming		

(Continued)

TABLE 4
(Continued)

Part 3: Links to wider systems and actions of others[c]		*Rank and Prioritise Each Tension*
What tensions exist between:	Tension between X and Y (Examples)	
Resources produced outside the system and resources needed in the system	Efficient but damaging agro-chemicals vs. environmentally friendly agro-chemicals needed in the system	
Policies produced in the wider system and those produced in the system?	GMO supporting policies and messages vs. food sovereignty policies and discourses	
Needs for the development of the practice and needs of stakeholders and other practitioners?	Sick and weak (morbid) community being produced by HIV and AIDS vs. sustainable agriculture being labour intensive	
Current objects of the practice and past of future objects of the practice?	Producing for food vs. producing for fuel	
Environmental changes induced from human activities and natural conditions of the system?	Increased frequency and duration of droughts due to climate change vs. global willpower to mitigate and adapt to climate change.	

Note. GMO = genetically modified organism.
[a]This constitutes first-generation CHAT. [b]Parts 1 and 2 constitute second-generation CHAT. [c]This part constitutes third-generation CHAT.

CONCLUSIONS

We conclude this article with a reflection on working with CHAT in sustainable agriculture expansive learning contexts where cognitive justice and knowledge plurality is necessary for learning innovation. We reflect on CHAT-critical realism as a theoretical framework and examine key concepts that were particularly significant for our understanding of the agricultural contexts of learning in question, namely, the nature of agricultural cognition, contradictions, and collective ZPDs.

Using Critical Realism to Support CHAT

One of the greatest attributes of CHAT is its ability to contribute to the generation of model solutions that take into consideration the origins of current limitations and contradictions, as CHAT provides a social-ecological and cultural-historical methodology for identifying sources of potential innovation and change. As previously mentioned, using critical realism as a support for CHAT

TABLE 5
Guidelines for Using Contradictions for Expansive Learning

Thrust	*Main Activities*
Session 1: Orientation	• Welcome and introductions • Presentation of workshop objectives and programme • Participants describe their histories in relation to the practice under review and identify key moments in that history and share these in plenary • Researcher presentation of the key concept(s) that are to be worked with: the first stimulation (problematic situation/contradiction); and the second stimulation (the expansive learning model, force field analysis, activity system). • Group work to develop an activity system from the perspectives of different actor groups such as farmers, facilitators/trainers, entrepreneurs and government representatives, documenting rules, mediating tools, community, practice object, subjects (who they are), and division of labour • Presentation and discussion of the activity systems (including finding ways of including the absent) • Discussions on shared objects by the different activity systems
Session 2: Identifying contradictions	• Reflections on Session 1 • Group work to discuss contradictions that are being faced in relation to the shared object • Presentation of mirror data by the researcher • Discussion of contradictions, clustering and sharpening them • Selection of the most important problems to work on through scoring, ranking and robust discussions on what must be prioritised and why
Session 3: Questioning and analysing contradictions	• Reflections on Session 2 • Agreeing on key terms to use (e.g., shared vision/object; contradictions/problems or issues) • Participants break into small groups to analyse their identified contradictions in terms of empirical and historical evidence: causes, effects and evolution • Plenary session to discuss contradictions analysed in groups to reach common and deeper understanding. Identify if further research is needed to understand the contradiction and why it exists.
Session 4: Modelling solutions to address disturbances	• Reflections on Session 3 • Mixed group work to model solutions to address selected contradiction(s) in relation to the shared object • Plenary presentation and examination of proposed solutions
Session 5 Planning the way forward	• Reflections on Session 4 • Develop a plan of action to ensure that the modelled solutions may be further examined and improved: √ Include plan to socialise the model solution and receive another level of input from relevant people who did not attend the workshop √ Include plan of implementation of the solution which specifies who will do what when
Session 6 Review of implementation	• To follow-up Change Laboratory feedback workshops (about 6 months later): √ How have participants completed tool development? √ How has the model solution been implemented? √ What are the enablements and constraints in solution implementation? √ What lessons have research participants learnt? √ What are the reflections of the researcher? √ What input can be done to improve the tool, its implementation, or the implementation environment? √ What new tensions/contradictions are emerging?

allowed us to identify deeper causal mechanisms that may otherwise have been missed. This provided a strong explanatory framework from which to "launch" the change or innovation process. We therefore conclude that using critical realism and CHAT together extends the potentially limiting constructivist aspects of CHAT that might cause researchers to focus on the outcomes associated with particular research participants and what they say and do. Deeper understandings of the structure-agency change (morphogenetic) process can also be realized when working with the theoretical tools afforded by a combined use of critical realism and CHAT.

Contradictions

All four levels of contradictions (primary, secondary, tertiary, and quaternary) were encountered in all study sites. This allowed us to analyse where tensions lay but made it difficult to interpret boundary crossing activity system where knowledge plurality was most significant for learning and change. Following the cognitive justice interest necessary for learning innovation and sustainable agriculture practice, the research emphasis at all three case sites shifted from examining site-specific contradictions to examining and engaging with contradictions that cut across all three activity systems. The classification of different types of contradictions ceased to be significant, as the shared object in the boundary crossing context became the determining factor for deciding what contradictions needed to be addressed in each case. When the notion of a central activity system was removed and the main unit of analysis became networked activity systems, the importance of analysing primary and secondary contradictions diminished and the tertiary and quaternary contradictions become more significant. Engaging contradictions in networked activity systems is particularly important for a postnormal scientific context where different forms of knowledge can come together in and for agentive decision making and change-oriented learning.

A second observation regarding contradictions in natural environment-based activity systems is that nature-culture tensions will always exist side by side as existential contradictions that "may be summarised by saying that human life is both predicated upon nature, yet it does not conform entirely to the natural order, and therefore is set off against it" (Cohen, 1989, p. 260). This tension, as previously mentioned, forces us to use notions of *social-ecological and cultural-historical activity systems,* bringing the role of nature in human interactions and learning to the fore. As global oil consumption patterns continue to rise, so does the average temperature of the earth's atmosphere, and resources such as water and arable land become more and more scarce. Such contradictions might inspire investigation into new ways to live sustainably. CHAT users in the natural resources field need to be on the lookout for such important opportunities for research.

Archer's (1998) theory of social change (morphogenesis) indicates that socio-cultural interactions (such as the CL workshop) are significant for enabling the agentive reflexivity necessary for structural elaborations or change. Our observations demonstrate that focusing on contradictions as sources for learning provides a context for reflexivity and change.

Agricultural Cognition and Cognitive Justice

Engeström (1995) has argued that clinical cognition is not constituted solely by the knowledge of expert health workers; it is also constituted by patients' lay knowledge. We similarly found that agricultural cognition involves the knowledge of educated scientists and extension workers

as well as local farmers' knowledge. Farmers participating in the study showed that they had a good understanding of local ecology and of what crops would grow best and when. Many of them showed that they had situated and practical knowledge of farming and that most of this knowledge was gained during years of "working with soil." Much of this knowledge was passed on through culture, families, and friends. Formally educated agriculturalists were often useful for explaining invisible processes and providing explanatory answers that contributed to farmers' cultural capital. Therefore, this research suggests that agricultural cognition is based on the interplay of local, situated knowledge and external, decontextualised knowledge. That is, agricultural cognition is a complex combination of the commonsense knowledge of farmers, facilitators, extension workers, and the scientific knowledge of scientists and formal educators. Sustainable agriculture learning and practice can integrate commonsense and scientific knowledge but needs to do so in a way that emphasizes an interest in social and ecological sustainability. A more complex perspective on agricultural cognition would therefore be needed to escape the duality of learning approaches in agriculture that currently characterises extension training in southern Africa (Leeuwis, 2004; Mukute, 2010).

ZPD

The concept of the ZPD was useful for our understanding of farmers' learning objects, processes, and current obstacles. It also structured our ideas about "the development to be attained" through the construction of a shared object in each case study. In this way, our understanding of development shifted from a focus on changes in individual farmers' practices to a focus on changes in the collective practices of farmers and those with whom they work. The ZPD was therefore co-constructed in each case study and between activity systems, within a collective framework of cognitive justice and plural ways of knowing. In all cases, the ZPD was concerned with the improvement of a sustainable agriculture practice that was collectively under review. However, in the process of working toward the collective "development to be attained," individuals also acquired new levels of understanding of their shared objects. This is revealed in some of the comments made by participants at the end of workshops and resonates with the assertion that expansive learning processes involve scaffolding, the linking of everyday knowledge with scientific knowledge, and collectivist learning that addresses new and emerging problems in a plural knowledge environment. Such a zone is socially and social-ecologically situated. However, we are also currently in need of a collective ZPD at a global level. The world needs to define the next form of sustainable agriculture—one that is more advanced than the current form, as evidenced by our case study site, and as expressed in the WI's (2011) most recent *State of the World Report*. As indicated in this article, such a global ZPD will require attention be given to learning innovations.

In conclusion, in this article we have worked with CHAT and critical realism to investigate and expand farmer learning in southern Africa. The article proposed that plural ways of knowing have become imperative in a risk society where "normal science" is no longer adequate to deal with the complex consequences of modern and postmodern development. Developmental work research methodology, which draws on distributed cognition to address new and emerging complex development challenges, proved useful in the collective construction of learning innovations that "nourish the earth." Research findings explored why farmers learn and practise sustainable

agriculture, how they learn and practise it, the contradictions they are facing, and how these contradictions can be overcome in a context of change-oriented learning.

ACKNOWLEDGEMENTS

We thank the South African Qualifications Authority for its partnership in the research project and for providing the necessary funding. We are grateful to the research participants, especially the farmers, extension workers, development facilitators, and organic producers and marketers from Lesotho, South Africa, and Zimbabwe whom we researched with.

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