How to get Innovation System Work in Agriculture and Rural Development? Reflection on methodological issues[1]

Tesfaye Beshah[2]

Abstract

Following paradigm shifts in 1980s that resulted from relentless efforts made by a few informed social scientists in the early 20th century, some lead international organizations, NGOs, and national research and extension organizations came to pronounce *innovation system* in agriculture and rural development. These are, in fact, results of decades of intellectual dialogues among scientists in general and social scientists in particular as to what methodological routes should be followed in pursuit of science and science for development. The majors taken in this regard received increasing importance with the realization that more than fifty years of development assistance, especially in the developing world, did not adequately curve down poverty and its multiple consequences, notably, environmental degradation. In spite of encouraging efforts underway the world-over by different agencies to promote what is named as a *sustainable development* through people's participation, achievements made so far seems to be far below the extent of responses required to cope up with multi-faceted challenges at hand. Moreover, there are still conceptual and methodological gaps that are adversely affecting the common intentions geared towards making a difference in poverty alleviation and reducing environmental degradation, among others. There is still substantial adherence to *technology transfer* while the intention is innovation system. For some, even using the term *innovation* seems to be a major shift in their approach. In my view, one of the major gaps in this respect is lack of shared understanding of methodological issues by scientists and development practitioners, both from social and natural sciences streams. This paper, therefore, attempts to shed some light on these issues and propose ways to get innovation system approach work better in agriculture and rural development.

Key Words: Paradigms, ontology, epistemology, methodology, innovation, innovation system, experiential learning, hard system, soft system, action research

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[2] Post Doctoral Scientist, ILRI, Hyderabad, India

1. Introduction

A change in agriculture and rural development is very crucial at the global level, but more so in the context of developing countries whose sheer numbers of people derive their livelihood from agriculture in very fragile eco-systems. What is even more challenging is the fact that there is wide evidence that generating technology is not as big a problem as ensuring its utilization by the intended users.

During the last fifty years, agricultural development has predominantly followed a transfer of technology approach. Recently, an alternative approach to studying agriculture in the developing world has emerged and this has widespread acceptance. The approach is generally known as the innovation system approach.

Despite the seeming acceptance, the practical application of the innovation system is very thin at best and in worst case it ends up with just lip service – continuing with a business as usual attitude.

This paper tries to revisit some fundamental issues in methodology that underpin innovation systems and suggests how to build on fertile ground to promote the approach. In this endeavor, it tries to highlight the concept of innovation, relationships between innovation and learning, and underpins why innovation system is required in agriculture and rural development. Moreover, it provides why soft system methodology and action research are suitable for innovation system perspectives and how they could be used for better understanding, designing and implementing of agricultural and rural development programs.

The second section of this paper presents highlights on source of methodology. Section 3 revisits the argument for the innovation system perspective. Under this section, three key areas, namely, innovation, learning and system thinking are linked. Section 4 deals with methodological gaps in the innovation system and provides options. The paper concludes in section 5 by positioning the innovation system as a soft system where soft system methodology is akin to its study rather that the conventional quantitative methods.

2. The Source of Methodology in Science Development

The paradigm shift that made its mark in 1980s has spurred the research and development agenda, especially in the area of agriculture and rural development. This nearly thirty-year journey has allowed development of several tools and techniques in research and development that are collectively called participatory research and development approaches (Chambers et al. 1989, Prety 1995).

Moreover, the paradigm shifts have allowed a widespread acceptance of system thinking though the mainstream research and development failed to embrace it in their agenda. In this connection, the development of system thinking attained greater acceptance and reached its highest visibility after 1980, when the soft system emerged as a complementary thinking to hard system (Checkland 1993). This perspective on system

allows our understanding of the wider environment around us in its most natural way where complexities are at work as a result of the interplay between and within social and natural phenomena. Innovation system thinking, which has been picked up and is being promoted by the World Bank, UN agencies such as FAO, dozens of international donors, universities and NGOs, has evolved through this paradigm shift.

The paradigm is, therefore, the basis of how research and development are conceived, a basic orientation to theory (Kuhn 1970, cited in Neuman 1997). In general, the paradigm is a set of beliefs, a set of assumptions that denotes our world-views.

In the research and development arena, the paradigm operates and shapes our actions by guiding our methodology. Here, by methodology, the intention is not to refer to specific tools and techniques related to data, or collective study of methods, rather it refers to the method of inquiry – how we know about what we know. Put in other words, it is the general principle behind research rather than the practice of research in terms of strategies and techniques (Ibid).

Methodologies of science are emanating from different paradigms that inform scientific research. Scientific researches in social science are informed by three paradigms. These are positivist social science, interpretive social science and critical social science (Ibid). Positivist science is the paradigm borrowed by early contributors of social science from the natural science that pioneers scientific investigations. Indeed, what is commonly presented as a scientific approach is the natural science method that owes its credit to patterns of modern education and is the center of its dissemination world-wide, especially the western epistemic culture.

In my view, much of the controversies surrounding scientific methodology, including how development is undertaken, emanates from explicit or implicit commitments and understanding of paradigms guiding actions of all those who are involved in these practices. This is true for both research and development activities.

Key areas where paradigms influence differences among social sciences include assumptions to explain the nature of reality (ontology), assumption about the nature of knowing the nature of reality (epistemology), assumptions about the ways of inquiry into the nature of reality (methodology).

Even though this is not the place to entertain a debate that has lasted over two centuries' among scientists on paradigms and their influences, it is worthwhile to highlight some aspects of this debate based on its latest resolve and works on the subject area (Neuman 1997, Sarantakos 1998, Guba and Lincon 1989). In so doing, we can better understand methodological gaps and options in contemporary perspectives such as innovation system (section 3.3).

Positivist social sciences hold that social and physical realities are real. That is, they exist "out there" and are waiting to be discovered. Basic patterns of social reality are stable, and knowledge of them is additive. That is, regularity of social reality does not change

over time, laws discovered today will hold in the future. Therefore, we can study many parts of reality one at a time, then, add the fragments together to get a picture of the whole.

Contrary to the positivist view of reality, interpretive social science says that social reality is what people perceive it to be. This group of social scientists holds that people create their own world by interacting with the phenomena around them where they create meanings in the processes of social interactions.

The third approach to science, critical social science, mainly agrees with the interpretive social sciences, while it shares some of the views of the positivist science with regard to views on social reality. Even then it sees such reality from a historical realism point of view where the realities are constantly shaped by the interplay among social, economic, political, and cultural factors. In agreement with interpretative social science, critical social science posits social reality as changing and subject to socially created meanings. However, it differs with interpretive social science that focuses on micro-level interpersonal interactions and its acceptance of any meaning system, by putting micro-events in the context of macro historical contexts.

Positivist epistemology is founded on the subject-object duality in the process of cognitions.

When it comes to epistemological points of view, interpretative and critical social sciences share the same view, which is commonly addressed as constructivist paradigm. In this regard, constructivist epistemology denies the possibility of subject-object dualism in the research process and any other interactions, including development (see action research, section 4.2). It rather emphasizes multiple levels of social interaction to ensure social learning in time and space.

Stemming from its ontology and epistemology, positivist methodology is characterized by experimental manipulation of subjects of treatment. In this process, ensuring logical coherence, consistency of observation and replication are absolutely necessary. Non-experimental social sciences that subscribe to the positivist paradigm use rule of statistics to infer from large samples.

On the contrary, the methodology of constructivist paradigm (interpretive and critical social sciences) takes full accounts of the hermeneutic/interpretive interactions among the actors in the construction of social reality. This includes all parties in the research or development processes, including researchers in the case of the former. Constructivist paradigm is ideographic and inductive, even though some use of deductive logic is possible selectively among critical social scientists. In this paradigm, the unique features of specific contexts and meaning are essential to understand social meanings. According to this view, facts are not impartial, objective and neutral.

Having sketched the methodological routes of research and development, I can now move on to the main subject of this paper, which is the innovation system. In the next

section, I present key features of the innovation system and debates surrounding its roles in order to lay grounds for my suggestion on alternative methodological directions to make it work better in the context of agriculture and rural development.

3. Why innovation system perspectives?

3.1 Understanding innovation

In order to appreciate methodological issues in the innovation system, we first need to develop a common understanding of the key concepts such as innovation, learning and system.

The term innovation is derived from the Latin word *novas* or new. The conventional view posits innovation as a linear process. Innovation, according to the traditional diffusion of innovation school refers to new ideas, methods or practices that are regarded as new by an individual. Innovation is also seen as an individual phenomenon. Moreover, it is expected to bear a universal character. For instance, Rogers states that innovativeness is the degree to which an individual is relatively earlier than comparable others in adopting innovation (Rogers 1983).

It is now widely accepted (Engel 1997, Hall et al. 2000, Hall et al. 2004, Leeuwis 2004) that innovation is a collective rather than an individual phenomenon. The focus is on the process rather than on product or technology *per se*! Innovation is more of processual rather than rational or logical deduction. Owing to complexity of the innovation process, it may not be achieved necessarily through planning. The social construction of innovation requires networking among social actors where negotiation and social learning take place. To that extent it is not limited to the formal scientific research processes and organizations. The formal research system is, therefore, one of the possible actors in innovation (Hall et al. 2004).

Innovation is a term that has been in use in science and technology literature for a very long time. However, its understanding has considerably changed with time. Nowadays, innovation is understood as "… a successful combination of hardware, software and orgware, viewed from a social and or economic point of view" (Smits 2002).

The term innovation is also confused with invention and technology in general, particularly when it is written as "innovations[3]". Invention is a process of creating new knowledge, methods, or a set of discovery. Innovation in contrast, encompasses the factors affecting demand for and use of knowledge in novel and useful ways for society (World Bank 2007). As indicated in the work of Smits (2002), such innovation may deal with new creations of social and economic significance, improvements in technical, managerial, institutional and policy spheres. The most important issue to draw from here is that innovation is not about artifacts, products or services. It is about the process through which knowledge is generated, crafted from various sources and put into use. In this context, what can be shared is, therefore, not innovation per se, rather, the learning

[3] Noun form of innovation is equated with technology or artifact (Niels Roling 2006).

principles that can be adapted to new contexts for every actor configuration in any innovation process is unique (context dependent). As will be shown later, this process requires different arrangements of actors for efficient and effective operation (Engel 1997, Salomon and Engel 1997).

One of the crucial view points about innovation, compared to its conventional view, is the fact that it is the work of multiple actors spatially distributed and with differential access to resources, knowledge and power. Moreover, it is related to the adaptation and/or adoption of some new invention, process or discovery on the level of behavior, meaning, and action. Hence, innovation involves new behavior, new habits, new interlocking expectations and new interlocking patterns of roles or institutions (Hall et al. 2004). To that extent, it requires structural change at the internal memory or cognitive map of an individual and habits and practices of organizations in order to accommodate the new roles and practices at societal or systems level. On this basis, there would be a co-evolutionary process (Smits 2002).

Despite its appeal in dealing with complex problems, innovation theory has some subtle gaps in its approach (Smits 2002). The focus of innovation studies so far reveals two approaches. The first one puts its emphasis on *innovation process* and tries to understand better the dynamics of socio-technological innovation processes. The second approach focuses on the analysis of innovation systems (*system approach*) and is used to search for ways of deepening the level of understanding of the genesis of new organization (institutional, structure, systems). While the author acknowledges the complementarities of these two main approaches, he also underlines that the two approaches "separate and offer no explanation for the co-evolution of institutional structures and innovation (and learning) processes" (Ibid). This observation hints to methodological challenges of using the innovation system that require attention during implementation.

3.2 Innovation and learning

Learning is one of the human properties that are widely studied by various disciplines in science. Nowadays, it is extensively appreciated in both science and development circles.

Owing to the ability of human beings to adapt to the environment, new things or new aspects of the existing one are created in the process of learning. Further learning continues as mankind in general does not remain with the existing discovery without any *evaluation,* either in the form of a decision to continuing with it or modifying it or discarding it altogether. This often emerges from the post-decisional reflections (evaluation) that social psychologists call dissonance (see Box 1 below). In general, one learning leads to another learning and so on. Educationalists put this notion as learning to learn.

Despite appreciation for learning, there seems to be lack of a shared understanding of systems of learning. For instance, unparalleled theory of learning contributed by Kolb (1984), which eloquently presents the classical works of social psychologists, is seldom used in its full meaning. A notable contribution of Kolb's work is *experiential learning*

model that lays the foundation for individual, organizational and societal learning (Box 1). These features are well promoted in recent works, for instance, Leeuwis and Pyburn (2002), Leeuwis (2004), Wals (2007).

Box 1: A brief Description of Kolb's Learning Cycle (Kolb 1984)

A decision-maker reflects upon an 'image' he perceived through the cognition process. The outcome is not always consistent with the desired state or solves the felt need. Agencies involved may have different views on the likely outcomes. Therefore, there is *divergence* on ideas, tastes and products. The decision-maker chooses from range of alternatives he is exposed to in the process of cognition. Depending on the complexity of the initial problem and likelihood of a suitable solution, actors involved, the decision-maker decides on his candidate course of action and forms an abstract concept about it through the *assimilation* process. The final test of the option is when it is applied in a new situation to solve the encountered problem or answer the knowledge gap or query. The decision-maker achieves this through *convergence* of the abstract ideas to the real world problem whereby an action would be taken. Depending on the performance of the action in solving the original problem, the selected idea or action is incorporated into the decision maker's or learner's experience through an *accommodation* process.

Nowadays, the notion is captured by a metaphor of learning loops or order of learning (Figure 1). Leeuwis (2004), based on the work of Argyris and Schon, indicates that *single loop* learning takes place when learning deals with "how to do things better". In this case, level of learning does not question the beliefs, assumptions and principles that influence the corresponding actions. The *second loop* learning takes place when basic assumptions and principles themselves become the subject of learning. Then, a *triple loop* learning takes place when learning questions the current methods, techniques and forms of feedback through which learning is organized. However, this understanding does not contradict the fact that learning is a continuous human process. In the context of innovation theory, a fundamental learning is that in which learning is about the innovation process itself, in the sense that we question assumptions and concepts in use, approaches and methods.

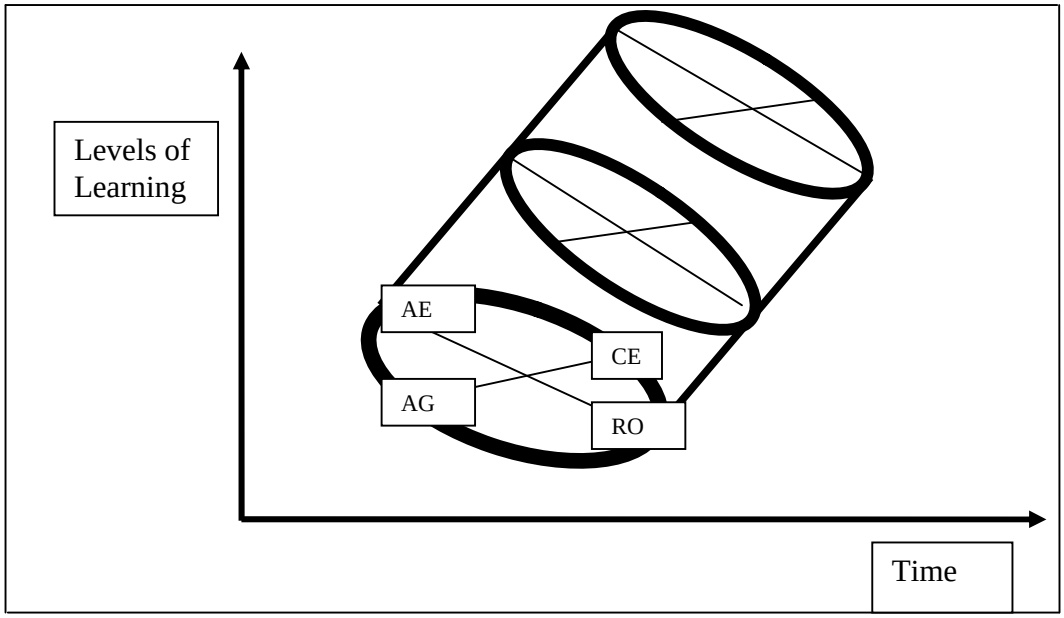

Figure 1: Schematic representation of levels of learning over time.

It should be noted that each level of learning follows its own learning cycle. This is manifested as we try to evaluate and pass judgment on our performance associated with a specific level of learning. Note that the four elements of Kolb's learning cycle, viz., concrete experience (CE), reflective observation (RO), abstract generalization (AG) and active experimentation (AE) are represented by each axis in Figure 1 (see Box 1 above for details).

In our time, innovation itself is widely understood as an emergent property (Roling 1994). Therefore, studying innovation through system thinking can also be seen as an emergent property of social learning that takes place in the society. To that extent, the principles applied are defined and redefined in a day-to-day learning process rather than prescriptive sets of ideas to be applied universally.

For societies that drive their livelihoods from dry land management such as in Africa and elsewhere, innovation is the only way out to ensure survival without depleting the resources. This is true more than ever before where there has been years of neglect on the part of human agency at various levels and when mother nature is tightening its face perhaps in response to our own neglect. Hence, understanding of innovation, the role of learning in the innovation process and learning about innovation within a system perspective is the order of the day as explained in the following section.

3.3 Innovation and system thinking

System thinking is widely discussed elsewhere (Pickel 2007, Walby 2007, Checkland and Scholes 1990). Even though there is now a growing body of literature on innovation system thinking (Hall et al. 2004, World Bank 2007) the link between innovation and

system is still a gray area with respect to methodological issues (Smits 2002, Spielman 2006).

The word system is derived from the Greek verb *sunistáni*, which meant "to cause to stand together" (Senge et al. 1994). This original meaning vividly illustrates that system is what we perceive it to be. That is, it is put together to stand in some organized way through our cognitive process. This 'organizedness' has to do with system structure, which is a pattern that is built out of the meaning system and designation given to the entity in question, by people.

Hence, when we talk about system, we are talking about something we perceived – in our mental map - and collectively shared. For instance, such a designated entity could be in the form of a social system or human agency that consists of components with specific functions that contribute to a given goal or purpose. What is absolutely important here is interrelationships of components of that system which ensure satisfaction of the overall system. Interrelations among systems and among components within a system are ensured because of the degree of openness of the system that allows their dynamics and growth or otherwise. In the case of human purposeful system, the element that flows to ensure dynamism of the system is information, unlike energy in the case of bio-physical systems. Also note that information is the form in which knowledge is shared among actors.

Some systems are nested and ordered hierarchically, while others are non-nested and overlap with others in the environment within which they are relevant. This last property is because of differential spatial and temporal reach of systems. However, each concrete system is directly or indirectly related to all other systems which form their proximate or distal environment. On the whole, time and space are crucial dimensions in accounting for systems - eg, path dependency, co-evolution (Pickel 2007).

Since 1970s, the concept of system thinking was used with knowledge, information and innovation by different authorities. Consequently, concepts such as knowledge systems, agricultural knowledge systems, agricultural knowledge and information system, and agricultural information system were used to analyze research, extension and associated institutional and organizational process (many authors cited in Rivera et al. 2005). Recently, FAO and the World Bank coined the term agricultural knowledge and information system for rural development (FAO/World Bank 2000).

Innovation requires systemic view as it involves various dimensions that are contributed by different actors, institutional, technological artifacts, economic issues, etc. However, the scope of a system, with respect to sub-systems and environment within which it operates varies from situation to situation.

System thinking is nowadays being used in a wider context, beyond agriculture, as innovation system, and national[4] innovation system (Hall et al. 2000, 2004).

[4] This concept was much developed in the industrialized world and only recently brought to the developing economies where agriculture is still serving as a backbone of the economies.

According to the World Bank (2007), an innovation system can be defined as a network of organizations focused on bringing new processes and new forms of organization into social and economic use, together with the institutions and policies that affect their behavior and performance. However, putting this inviting network into full action is at an early stage. Is this a systematic adherence to the old paradigm or the inherent complexity of the process of its realization? Whether the problem is both of these issues or another, the challenge is for those of us who are convinced that this is an alternative way of building on the good part of the past.

National innovation system is "…that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store and transfer the knowledge, skills, and artifacts which define new technologies." (Metcalfe 1995, cited in Rivera et al. 2005).

Since early 1980s, developments in system thinking gave rise to complementary perspectives of system. These are hard system and soft system thinking. The classical thinking in system theory was from the hard system perspective, which posits the world to be systemic and constructs models to represent the world to optimize. On the contrary, the soft system thinking creates the process of inquiry as a system, epistemologically. The aim of the soft system methodology is not to generate knowledge that enables us to predict about the nature of world reality (ontology), rather to enhance understanding of the reality through a purposeful action which involves negotiation, consensus and accommodation (Checkland and Scholes 1990, Bawden 1995, Röling 1997, Engel 1997).

What is very important to note is that the hard system methodology is informed by the positivist paradigm, whereas soft system methodology is based on constructivist paradigm. In this regard, it is worthwhile to also note that constructivist perspective selectively combines the hard and soft system methodology in research and development rather than depending on one methodology fix to answer the whole complex problem of the real world.

Given the characteristics of innovation system that is fluid in its nature and cannot be planned in a rigid way to use the principles of positivist science or hard system, we need to adapt constructivist methodology, which uses soft system methodology that accommodates hard system too when it is appropriate. Therefore, in this paper, innovation system is seen as a soft system.

When we define a system, the essential issues about system are the pattern of organization and its structure (Capra 1997). For innovation system in the context of agriculture and rural development, the structure of such a system could be configured from actors such as research, extension, farmers, NGOs, private sector, parastatals, cooperatives, farmers, and community based organizations. However, a system intended to perform certain functions is made up of only those who determine that specific pattern

of organization and provide that structure which influences the process of innovation. In other words, even though all the above-mentioned actors have the potential to make up an agricultural innovation system in a given context, a mere collection of these organizations cannot give us an operating innovation system that has a capacity to innovate (Hall et al. 2007a). For instance, beef and dairy innovation systems have their own unique features, but share a lot as part of the larger livestock system. In this context, we are not referring to the hard component as in livestock system or cropping system, but the contextual factor (social, economic, policy, institutional and bio-physical) in which the livestock system is embedded. Indeed an innovation system requires an organic link and connectedness among actors and drivers to achieve a common goal.

An innovation system perspective identifies iterative and interactive learning as a key innovation process. Moreover, it values hard science but also recognizes that value will be added by embedding scientific research in a wider set of relationships. This improves accountability of scientific organization to the society. This is achieved through a paradigm shift among practitioners regarding science and development in general (Hall et al. 2000, 2004). Moreover, Hall et al. (2007a) draw our attention to innovation capacity of the system in the sense of skills and knowledge held by individuals and organizations, institutions, patterns of interaction and policies developed, which enhances the knowledge processes – ranging from its generation to utilization.

For instance, when a technological artifact within a broadly defined and operationalized system is at an early stage of its development, a limited involvement of key actors might be sufficient. Even then, those primary actors who were charged with the initial stage of development should incorporate relevant views from the environment in which the artifact would be relevant. In addition, key actors in the environment should also be aware of the development in order to facilitate their future roles. In this respect, the innovation system in question should use an information system in order to inform all concerned. Note that this configuration of actors in some desirable way implies a felt need of all parties involved and a facilitation role of some organ for efficiency of communication. Such a facilitation role can be played by a champion body that may start and build up the process.

In a situation where improved performance of a given system requires interaction of multiple actors and multiple levels, an appropriate system should be initiated to work synergistically by ensuring contribution of all components of the system to achieve efficiency and effectiveness.

The issue of being a system is pronounced by communication loops that facilitate flow of information as deemed necessary within all nodes of the system. As mentioned earlier, simple designation of a system without such level of commitment and connectedness does not guarantee a system level performance, even if some individual components may be performing adequately (Clark 2002). Thus, system thinking is not an issue of mere center of excellence or involvement in ad-hoc activities. It is a matter of dealing with the bigger picture in a holistic manner by paying attention to each and every element and the relationships thereof. A typical example of misconception in the name of system is the

entity commonly called NARS or NARIs or NAROs. These are mere designations of organizations that do not engage in a synergic function towards major goals, ie, research for development. Hence, what is direly desired is to create a mechanism whereby these entities function as an organic system rather than a pseudo-system. The question is how to get there.

With this overview of major methodological issues on wider research and development, we come to the next section, which deals with highlights of methodological gaps and options for innovation system perspectives.

4. Methodological gaps in innovation system and options

A formal research on innovation system dates back to late 1980s when interactions between firms, and various public organizations were analyzed at national level (Freeman 1987 cited in Mamo Muchie et al. 2003). Further research in 1990s shed more light on the concept (Lundvall 1992).

Early research on innovation system focused on the experience of industrialized economies of the West, particularly on innovation policies. Work on innovation system studies began with the Agricultural Knowledge and Information System (AKIS) perspective in the late 1980s and 1990s (Roling 1988, Roling 1992, Engles 1995) that was further strengthened in the following decade (Hall et al. 2002, 2004, 2007a, 2007b).

In spite of that, recent works on innovation system (Smits 2002, Spielman 2006) highlight the methodological gaps in understanding the innovation system better. A similar view is echoed by researchers and practitioners in various fora.

The key methodological gap, especially in the agricultural innovation system, is use of descriptive-qualitative methods drawn from an action research approach (Spielman 2006). Options suggested include in-depth social and economic histories, policy bench-marking, cross-country comparisons, best practices, statistical and econometric analysis, systems and network analysis and empirical applications of the game theory. However, most of these methods and tools are rooted in positivist paradigm that cannot fully explain the processes of innovation systems.

The other area of methodological issues follows the line observed by Smits (2002) that deals with the orientation of innovation studies (process vs. system orientation of innovation studies discussed earlier). The question here is where should the focus be, the micro or the macro, or a combination of both?

While the inquiry for a better way of understanding the innovation system perspectives is welcome, to me the call for a methodological gap seems to have overlooked existing fertile grounds to develop the perspective and also the nature of paradigm that is pertinent for innovation and innovation system perspective.

Before taking this issue further, let me bring back salient issues from the previous sections.

The discussion in the preceding sections indicated how our paradigm guides us in our understanding of the environment around us. In other words, what we see depends on the kind of spectacles we are wearing. When our paradigm is that of constructivist, we tend to see the world around as a complex set that cannot fully be reduced to the smallest portion to be quantified. On the contrary, the positivist paradigm leads us into experimental manipulation and subject-object duality that entails quantification and proofs.

While uses of either approach are correct for what they are relevant for, the shortcoming is when we adhere to the dominant paradigm, positivism, to understand the world around us, even when complex issues such as innovation and climate change are the case in point.

The consequence of such orthodox subscription to positivism would prevent us from seeing the other side of the coin which cannot be quantified, but which, nevertheless, is part of the same coin.

Here, the key issue is about understanding our paradigm that informs our methodology in both research and development. As mentioned earlier, the use of the term methodology means different things to different people. From philosophical points of view, there are only two sets of methodologies (Neuman 1997, Sarantakos 1998). These are methodologies of the positivist paradigm and that of the constructivist paradigm. However, this is not to suggest that there is no room for methodological pluralism as suggested by Little (1991), where quantitative and qualitative methodologies can be integrated for a rich understanding of a phenomenon at hand.

Furthermore, coming to the ontological issues of the world around us, while employment of the systemic perspective is very useful, application of the concept should be state-of-the-art and using its full scope, ie, with a due distinction between hard and soft systems in order to make sense of the world around us.

From the epistemological and methodological points of view, soft system methodology that mainly uses qualitative techniques, but also quantitative techniques selectively is the appropriate methodology to pursue innovation system in action (Checkland and Scholes 1990, Wilson and Morren 1990, Salomon and Engle 1997). In the same way, action research that uses the interpretative social science perspective[5] can be used to guide the operational processes of twinning research and development (see section 4.3).

In the subsequent two sub-sections, highlights of soft system methodology and action research are provided to substantiate my arguments to use these frameworks for innovation system methodology. For ease of presentation I will first identify the key

[5] Note that some action research traditions follow the positivist experimental design.

elements of soft system methodology and then illustrate how the SSM can guide the action research framework for innovation system.

4.1 Key elements of soft system methodology

Soft system methodology (SSM), as indicated earlier, emanates from the constructivist paradigm. Unlike hard system methodology (HSM), which is suitable for a hardware dominated system, SSM deals with problem-situations in which human perception, behavior or action seemed to be the dominating factor and where goals, objectives and even the interpretation of events are all problematic (Wilson and Morren 1990).

According to Checkland and Scholes (1990), inquiries of SSM are conceived as an interplay between a “real world” problematic situation and the system thinking or contextualizing processes. The conventional SSM consists of seven interrelated stages. These are (see Figure 2):

1. Problem situation considered problematic
2. Problem situation expressed
3. Root definitions of relevant purposeful activity systems
4. Conceptual models of the systems named in the root definitions
5. Comparison of models and real world
6. Changes in systematically desirable and culturally feasible
7. Action to improve the problem situation.

Note that Stage 3 and 4 are aspects of system thinking, while the other stages are considerations under the real world identified as a context of the problem. Moreover, the stages in SSM are not linear. Instead, they guide the inquiry process in a reiterative manner within and between the conceived real world and the system thinking about the real world.

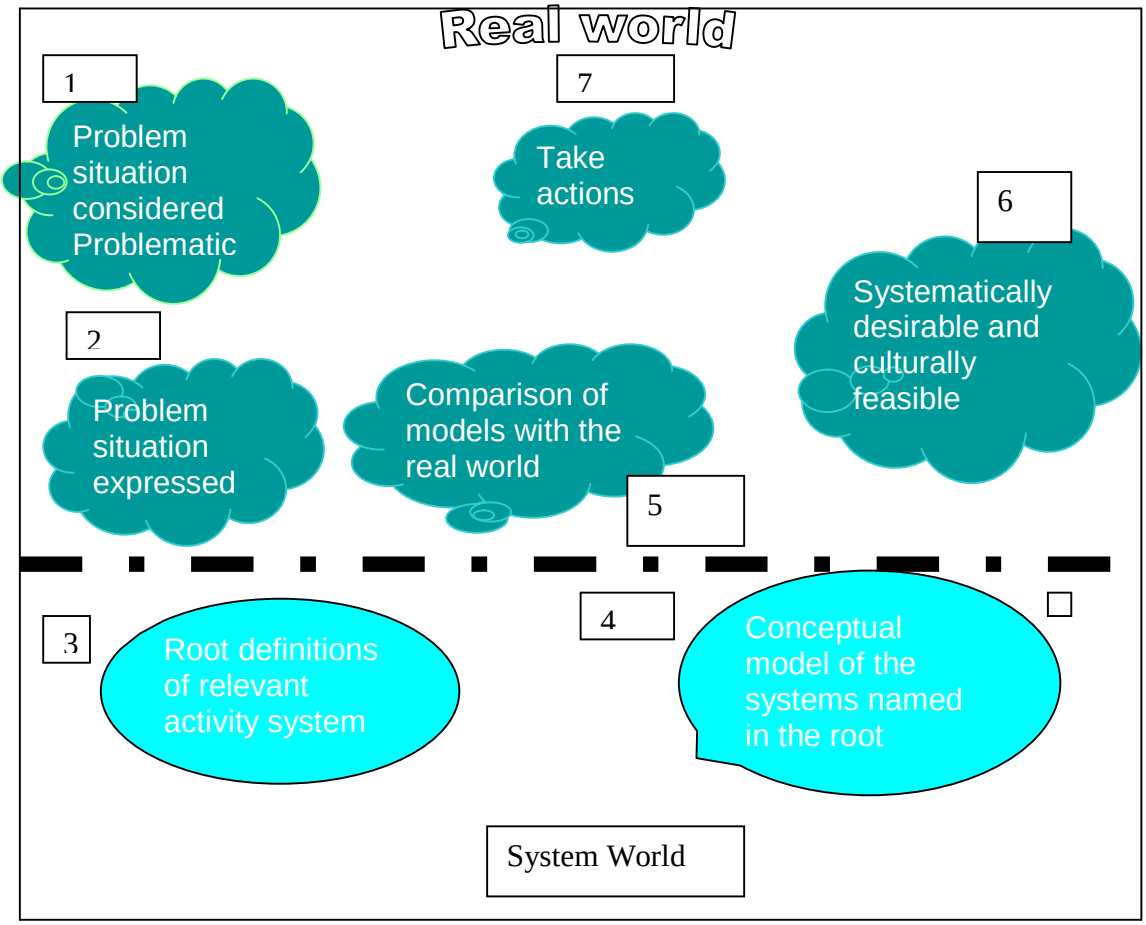

Figure 2: Seven stages of Soft System Methodology (Checkland 1993).

Stage 1 and 2: These two stages are usually combined for practical purpose. The overall purpose at this level is to develop a rich picture of the problematic situation in which the expressed problem or issue emerges. Here facilitators of the inquiry process which hereafter is referred to as learning processes, together with other stakeholders primarily use reflective observation to make sense out of the concrete experience of the real-world in which the problem occurs. Here every effort should be made to involve people whose lives are touched by the current state of the problem and likely action to be taken at a later stage. Therefore, what is commonly addressed as people's participation and empowerment have more meaning at these two stages. To have a better understanding at these levels, one can use a combination of tools such as rich picture, stakeholder analysis tools, secondary data sources, individual interviews, focus group discussions, community meetings, etc.

Stage 3: This stage takes the inquiry process from the real-world to the system thinking about the real-world. Its purpose is to define relevant systems using a mnemonic called CATWOE. From my discussion with graduate students in my university (Ethiopia), this and the next stages make the SSM inaccessible for field application and sharing with non-experts.

Table 1: Elements of CATWOE

Customers (C)	Beneficiaries or victims of transformation process
Actors (A)	Those who would do the transformation
Transformation (T)	The central transformation of the desired situation
Weltanschauung (W)	The world view or paradigm that makes the transformation meaningful
Owners (O)	Those who could stop the transformation process
Environment (E)	Elements outside the system that might affect the transformation process

Elements of CATWOE in stage 3 require in-depth assessment of human agencies involved in one or multiple capacities or roles. For instance, it is evident that customers, actors and owners could overlap in some systems. In addition, in-depth understanding of the environment and self-conscious of the W that is driving the transformation process helps to look for where to bring in the hard system initiatives into the picture.

Stage 4: After defining what needs to be changed through the transformation process, if the future state is to be improved, stage 4 moves onto conceptual modeling, which is abstract generalization in the language of Kolb (1984). The main concern of this stage is developing a model of learning that describes what could be done in the future to achieve an improved state. The major type of model to be developed at this stage is the human activity system (HAS). This shows centrality of human or institutional issues over perhaps, technical issues, which are governed under HAS. Development of HAS revisits the root definition, in order to address the efficacy, efficiency and effectiveness criteria. At this stage too, different types of methods and techniques can be used to enhance the modeling process.

Stage 5: This stage involves the comparison of the conceptual model with the real-world identified at stages 1 & 2, with possibility of amendment in the process. The major purpose of this stage is consensus building. This is highly desirable as there are multiple interests due to diversity of stakeholders who are affected by the proposed transformation. At this stage, facilitators should use their convergence skills to accommodate multiple interests. For this purpose, they can use methods such as informal discussion and formal questioning to see the opinion of the people involved.

Stage 6: The task of stage six of SSM is to find out whether the proposed change is desirable and feasible. This is further examination of the conceptual model by focusing on **W** and **E.** Desirability is the issue of value. How do different actors see themselves in the changed future situation? E refers to external and internal capacity to implement the proposed transformation process.

Stage 7: This stage is concerned with the detailed planning process to implement accepted options for improvement. With the inception of actions for change, monitoring and learning continues concurrently.

4.2 Action Research

Action research dates back to the work of Kurt Lewin in 1940s. Since his sterling contribution, action research has become common place in social science research. Owing to its diverse application, action research is considered to be a controversial research approach. Some of its key issues include, scientific rigor and relationship between the subject (the knower) and the object (what is known) scientific.

Defining action research very aptly, Bargal (2008), states that "action research is about undertaking action and studying that action as it takes place". Citing Checkland (1991) and Dickens and Watkins (1999), Bargal also writes that action research is an iterative cycle of problem identification, diagnosis, planning intervention, and evaluation of outcomes to estimate what has been achieved and to plan subsequent interventions (Figure 3).

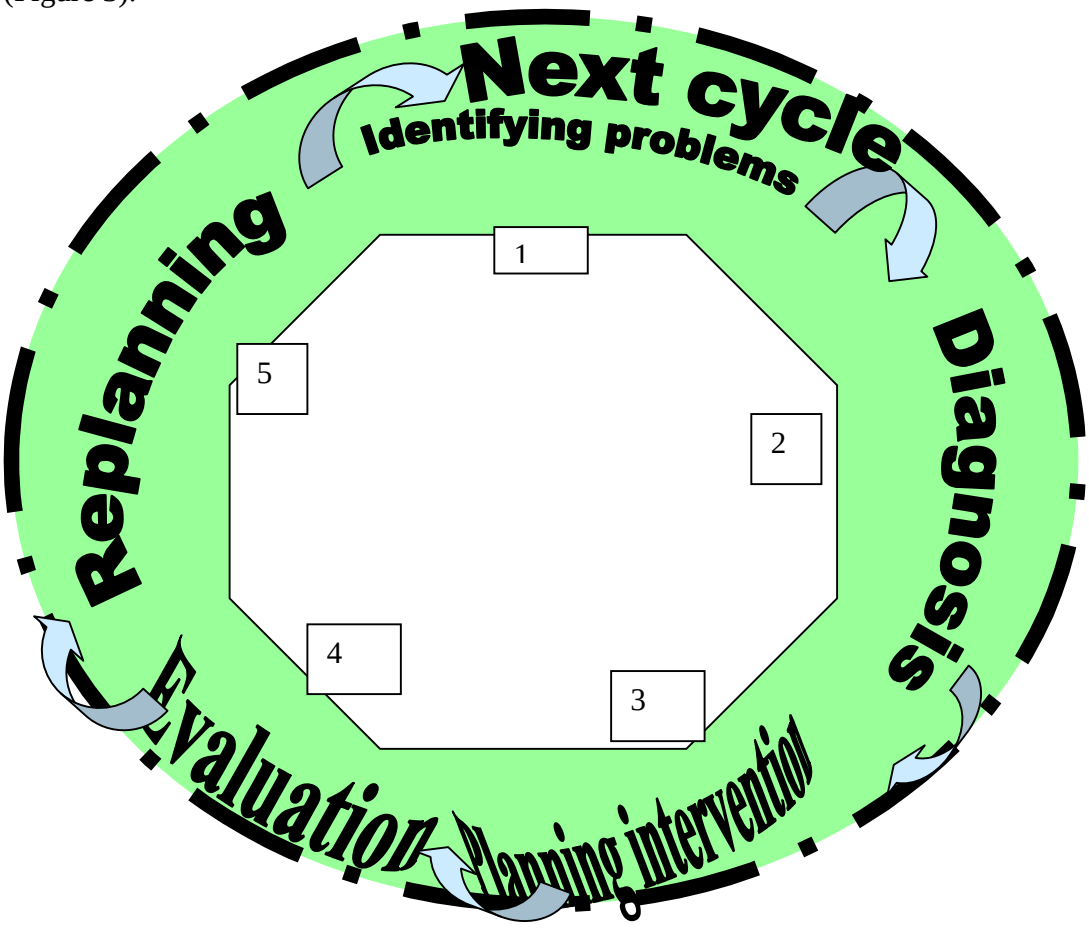

Figure 3: Common Elements of Action Research.

While action research has attracted a diverse group of researchers in the broader domain of social sciences, its philosophical tradition is divided between those who subscribe to

the positivist ontology and epistemology and those who use interpretive and critical social science (Cassell and Johnson 2006).

Action research in the context of innovation system – soft system - essentially follows interpretative and critical social science paradigm. Innovation system that aims at improvement of system performance needs to understand the life-world of those involved. This ensures efforts to effectively communicate to understand the meaning of each party that is said to be part of the system. In addition, a critical science perspective is required to empower people so that they can play active roles in their own changes. As indicated by Neuman (1997), critical researchers conduct research to critique and transform social relations. More specifically, social research like any learning should help people to be free from any myths, reducing illusion and ignorance, and help people to change the world for themselves. This is, actually, the root of action orientation in the research process. Positivists normally try to find any plausible explanation to maintain the status quo, whereas the classical interpretive researchers treat equally any explanation about the real world, whether from haves or have-nots, as a mere interpretation of their world (Ibid).

In the context of research, a research team should be able to effectively communicate with practitioners who are interested in the developmental side of the issue, while pursuing a research agenda within the rigor of the action research framework. This phenomenon is well elaborated in the work of Melrose (2001) who writes that "Action research is critical, evaluative, systematic, strategic, participatory, emancipatory, and having theory inform practice and practice inform theory[6]". He also adds that the researcher researches with, not on other people and does not treat the group merely as objects or sources of data. Moreover, it is not a mere classical ethnographic work whereby researchers refrain from disturbing the social ecology of the groups they study. Action research is collaborative and deliberative learning and social change among parties identified to describe the system. To that extent action research requires trust, openness and patience among all involved to respond to unexpected turnout in the interaction of multiple world-views.

4.3 Integration of concepts, approaches and methodologies in innovation system

In the previous sections of this paper, an attempt was made to highlight a range of concepts, approaches and methodological issues that have direct relevance to operationalization of innovation system concepts. Perhaps, the diversity of issues is a testimony of the complexity involved in using the innovation system perspective and also a good indication of why difficulties were inevitable in situations when adequate level of crafting of concepts and methodologies was missing.

[6] Lack of such complementarities between theory and practice is one widespread misconception especially among those people who consider themselves more on the practical side rather than on the theory or academics and research. As this attitude is commonly reflected, I see it as one of the issues we need to overcome in order to ensure development of both theory and practice. Actually, Kurt Lewin sent a permanent message in his days, when he wrote "**There is nothing as practical as a good theory**."

As a phenomenon that is heavily dominated by perceptions and behavior of human beings, institutions and policies, innovation system is a soft system where action research approach (Checkland 1990) can be readily applied to operationalize the system[7]. Relevance of action research in innovation system is not over emphasized as it deals with both research and action (development) where diverse sets of actors from science and technology, development practitioners, government, producers, cooperatives, the private sector and civil societies can jointly form a learning platform for a common goal.

Learning within soft system methodology operates on learning principles where experiential learning takes place through exposure to concrete experience, reflective observation, abstract generalization and active experimentation as the interplay between the real world and systems thinking. Finally, innovation capacity (Hall et al. 2007a) *becomes the learning capacity of the system as a whole.*

With this overview, we can now bring bits and pieces together to explicitly show the holistic learning framework between soft system methodology and action research.

The common stages in action research are (Bargal 2008): 1) problem identification, 2) diagnosis, 3) planning intervention, 4) evaluation of the outcome, and 5) planning the subsequent intervention. In practices, these stages operate as cycle and reiterative patterns rather than linear steps.

Looking at the stages in the action research and that of SSM (seven stages), there is high degree of overlap that inspires integration of the frameworks rather than treating them as separate.

Stage 1 and 2 are more or less similar in both SSM and action research, even though diagnosis of action research in essence goes beyond what SSM does in stage 2. In an ideal situation, one can also expect activities in stage 3 and 4 of SSM as part of the planning process of action research. Even though the common action research also conducts comparison of proposed action with stakeholders and assesses its desirability and feasibility in its own way, stage 5 and 6 of SSM seems rich in addressing those issues. Stage 3 of action research and stage 7 of SSM in principle overlaps. Stage 4 and 5 of action research are subsumed under stage 7 of SSM.

Even though from the ontological and epistemological points of view soft system methodology and action research are the same, particularly when those involved are explicit about these philosophical issues in their practices; it may create a common ground and promote soft system methodology if implementation modality of innovation system is popularized in the framework of action research that is widely known. Therefore, more emphasis should be given to philosophical issues and principles behind frameworks rather than to the stages followed in their implementation.

[7] In this respect, Fodder Innovation Project in India and Nigeria (2007-2009): Reframing Technical Change: Livestock Fodder Scarcity Revisited as Innovation Capacity Scarcity is one typical example to show the use of action research for innovation system in agriculture (Hall et al. 2007a).

5. Conclusion

Research and development are value-laden which are guided by a particular strand of paradigm that informs the whole gamut of operations in research and development, from design to evaluation. Owing to this, the positivist social science paradigm adheres to the value-free and quantitative approach where the researcher and the researched are detached from each other in the interest of objectivity. On the contrary, the constructivist paradigm follows an interpretative-critical approach where relevant parties put their value system on the table for negotiation and accommodation through a direct interaction rather than in isolation. Based on this argument, the paper identified a relevant methodological route for an innovation system perspective, which is the constructivist paradigm.

Concepts and theories from innovation, learning and system thinking were reviewed to shed light on the innovation system in agriculture and rural development. It was argued that learning should be systematic by using a well-developed framework such as experiential learning with its level of learning, rather than a mere description as "lessons learned." Facilitation of learning contributes to innovation capacity of the system that needs to be recognized in all organizations and networks.

Regarding system thinking, the paper emphasized prominent contributions in system thinking that make a clear distinction between the hard and soft system that adds value to our understanding of the world around us.

Owing to the nature of innovation, which is complex, the innovation system is posited as a soft system where qualitative methodology is more appropriate with a possibility to use quantitative methodology in a complementary way. Hence, the innovation system is better operationalized through an action research framework, which accommodates both qualitative and quantitative approaches.

References

Bargal D. 2008. Action Research: A paradigm for achieving social change. Small Group Research, Vol. 39. No. 1:7-27.

Bawden R. 1995. Systemic Development: A Learning Approach to Change. Occasional paper # 1, March. Hawkesbury: Center for Systemic Development, University of Western Sydney.

Capra F. 1997. The Web of Life. A New Synthesis of Mind and Matter. London: Flamingo.

Cassell C and **Johnson P.** 2006. Action Research: Explaining the diversity. Human Relations. 59 (6):783-814.

Chambers R, Pacey A and **Thrupp LA,** eds. 1989. Farmer First: Farmer innovation and agricultural research. Intermediate Technology Publications. Exeter, Great Britain: Short Run Press.

Checkland P. 1993. System Thinking System, System Practice. John Wiley & Sons Ltd., New York, Toronto.

Checkland P and **Scholes J.** 1990. Soft Sytems Methodology in Action. John Wiley & Sons. Chichester, New York, Brisbane, Toronto and Singapore.

Clark N. 2002. Innovation Systems, Institutional Change and the New Knowledge Market: Implications for Third World Agricultural Development. Economics of Innovation and New Technology, 11:4, 353-368.

Engel PGH. 1997. The Social Organization of Innovation: A focus on stakeholder interaction. Amsterdam: KIT.

Engel PGH. 1995. Facilitation of Innovation: An action-oriented approach and participatory methodology to improve innovative social practice in agriculture. PhD thesis, Wageningen University, The Netherlands.

FAO/World Bank. 2000. Agricultural knowledge and information systems for rural development (AKIS/RD). Strategic vision and guiding principles. Rome, Italy: FAO/ World Bank.

Guba EG and **Lincon YS.** 1989. Fourth Generation Evaluation. Sage Publications, Newbury, London and New Delhi

Hall A, Sulaiman R and **Bezkorowajnyj P.** 2007a. Reframing Technical Change: Livestock Fodder Scarcity Revisited as Innovation Capacity Scarcity: Conceptual Framework

Hall A, Clark N and **Naik G.** 2007b. Institutional Change and Innovation Capacity: Contrasting experiences of promoting small scale irrigation technology in South Asia. International Journal of Technology Management and Sustainable Development. 6:92)77-101. Intellect Ltd.

Hall AJ, Yoganand B, Sulaiman VR, Raina R, Prasad S, Niak G and **Clark NG.** 2004 Innovations in Innovation: reflections on partnership and learning. Introductory chapter *in* Innovations in Innovation: reflections on partnership and learning (Hall, AJ, Yoganand B, Sulaiman R, Raina V, Prasad SR, Niak G and Clark NG, eds). Patancheru 502324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics and New Delhi, India: National Centre for Agricultural Economics and Policy. 238pp.

Hall AJ, Clark NG, Rasheed Sulaiman V and **Taylor S.** 2002. Institutional learning in technical projects: horticultural technology R&D systems in India. Pages 21-39 *in* International Journal of Technology Management and Sustainable Development. Vol. 1, Issue 1.

Hall AJ, Clark NG, Sulaiman VR, Sivamohan MVK and **Yoganand B.** 2000. New agendas for agricultural research in developing countries: policy analysis and institutional implications. Pages 70-91 *in* Knowledge, Policy and Technology. Vol. 13, No 1.

Kolb D. 1984. Experiential Learning: Experience as The Source of Learning and Development. Englewood Cliffs, New Hersey: Prentice-Hall, Inc.

Lundvall B-Å, ed. 1992. National Innovation Systems: Towards a Theory of Innovation and Interactive Learning. London: Pinter Publishers.

Leeuwis C. 2002. Making Explicit the Social Dimensions of Cognition. *In* Wheelbarrows Full of Frogs: Social learning in rural resources management (Leeuwis C and Pyburn R, eds). Assen, The Netherlands: Koninklijke Van Gorcum BV.

Leeuwis C. 2004. Communication for Rural Innovation: Rethinking agricultural extension. Third Edition. India: Blackwell Publishing.

Little Daniel. 1991. Varieties of Social Explanation: An introduction to the philosophy of social science. Boulder, San Francisco and Oxford: Westview Press.

Melrose MJ. 2001. Maximizing the Rigor of Action Research: Why would you want to? How could you? Field Methods, Vol. 13, No. 2:160-180.

Muchie M, Gammeltoft P and **Lundvall B-A,** eds. 2003. Putting Africa First: The making of African Innovation System. Denmark: Aalborg University Press.

Neuman WL. 1997. Social Research Methods: Qualitative and Quantitative Approaches. London: Allyn and Bacon.

Pickel A. 2007. Rethinking Systems Theory: A programmatic Introduction. Pages 391-407 *in* Philosophy of the Social Sciences. Volume 37 Number 4.

Pretty JN. 1995. Regenerating Agriculture: Policies and Practices for Sustainability and Self-reliance. London: Earthscan Publications, Ltd.

Rivera W, Wamar MK and **Mwandemere HK.** 2005. Enhancing Coordination Among AKIS/RD Actors: An analytical and comparative review of country studies on agricultural knowledge and information systems for rural development (AKIS/RD). Rome: FAO.

Rogers EM. 1983. Diffusion of Innovations. Third Edition. New York: The Free University Press.

Rogers EM. 1995. Diffusion of Innovations. Fourth Edition. New York: The Free University Press.

Roling N. 2006. Conceptual and Methodological Developments in Innovation. Keynote for Innovation Africa Symposium, Kampala, 21-23 November 2006.

Röling N. 2002. Beyond the Aggregation of Individual Preferences: Moving from multiple to distributed cognition in resources dilemmas. *In* Wheelbarrows full of frogs: social learning in rural resource management (Leeuwis Cees and Pyburn Rhiannon, eds.). International research and reflections. Assen, The Netherlands: Koninklijke van Gorcum.

Röling N and **Jiggins J.** 2001. Agents in Adaptive Collaborative Management: The Logic of Collective Cognition. *In* Biological Diversity: Balancing interests through adaptive collaborative management (Buck LE, Geisler Charles C, Schelhas John and Wollenberg Eva, eds.). Florida, USA: CRC Press.

Röling N and **J Jiggins.** 1998. The Ecological Knowledge System. *In* Facilitating Sustainable Agriculture. Participatory and Adaptive Management in Time of Environmental Uncertainty (Ling NR and Wagemakers MAE, eds.). Cambridge: Cambridge University Press.

Röling N. 1997. The Soft-side of Land. Pages 248-263 *in* ITC Journal, Special Issue on Geo Information for Sustainable Land Management. Vol 1997, No. 3/ 4.

Röling N. 1997. The Soft Side of Land: Socio-economic Sustainability of Land Use Systems. Invited Paper for Theme: 'Land-Use Systems Approach to Sustainable Land Management' at the Conference on Geo-information for sustainable land management held at ITC, Enschede, The Netherlands, 17-21 August 1997.

Röling N. 1996. Towards an Interactive Agricultural Sciences. Pages 35-48 *in* European Journal of Agricultural Education and Extension. Vol. 2, No. 4.

Röling N. 1994. Platforms for Decision-making about Ecosystem. *In* The Future of the Land: Mobilizing and Integrating Knowledge for Land Use Options (Fresco LO,

Stroosnijder L, Bouma J and van Keulen H, eds.). New York: John Willey & Sons Ltd.

Röling N. 1992. The Emergence of Knowledge Systems Thinking: A changing perception of relationships among innovation, knowledge process and configuration. Knowledge and Policy: International Journal of Transfer and Utilisation 5(1):42-64.

Röling N. 1990. The Agricultural Research-Technology Transfer Interface: A Knowledge System Perspective. *In* Making the Link: Agricultural Research and Technology Transfer in Developing Countries (Kaimowitz David, ed.). Published in Cooperation with the International Service for National Agricultural Research (ISNAR). Boulder, San Francisco and London: Westview Special Studies in Agricultural Science and Policy.

Röling N. 1988. Extension Science: Information systems in agricultural development. Cambridge: Cambridge University Press.

Salomon M and **Engle Paul GH.** 1997. Networking for Innovation. A participatory actor-oriented methodology. The Netherlands: Royal Tropical Institute.

Sarantakos S. 1998. Social Research. Second Edition. Australia: Charles Sturt University.

Senge P, Kleiner A, Roberts C, Ross C and **Smith B.** 1994. The Fifth Discipline Fieldbook: Strategies and tools for building a learning organization. New York, London, Toronto: A Currency Book, Doubleday, Random House, Inc.

Smits R. 2002. Innovation Studies in the 21st Century: Questions from a user's perspective. Technological Forecasting and Social Change 69 (2002) 861-883.

Spielman D, Ekboir J and **Davis K.** 2006. Developing the Art and Science of Innovation System Inquiry: Alternative Tools and Methods and Applications to Sub-Saharan African Agriculture. Paper prepared for the Innovation African Symposium. Kampala, Uganda, 21-23 November 2006.

Walby S. 2007. Complexity Theory, Systems Theory, and Multiple Intersecting Social Inequalities. Philosophy of the Social Sciences, Vol. 37 No.4:449-470.

Wals AEJ, ed. 2007. Social Learning: Towards a sustainable world. The Netherlands: Wageningen Academic Publishers.

Wilson K and **Morren GEB.** 1990. Systems Approaches for Improvement in Agriculture and Resource Management. Macmillan: New York.

World Bank. 2007. Enhancing Agricultural Innovation: How to go beyond the strengthening of research systems. Washington DC, USA: World Bank.