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Systems Agriculture: A Paradigm for Sustainability[1]

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INTRODUCTION

A decade ago, C.R.W. Spedding posited that "...as agricultural research and development are generally aimed at the improvement of systems...success depends upon being clear about (1) what constitutes an improvement; and (2) exactly which system is being improved" (Spedding 1979). To many agricultural scientists, these questions bordered on the irreverent. Surely it was obvious: for more than a century, science and technology had enabled farmers consistently to improve the productivity of individual crop and livestock enterprises. Improvements were therefore unquestionably increases in productivity, and the focus for such improvements were specific farm commodities or farming enterprises. Improve the performance of the parts and the whole farm automatically would improve.

To many observers, these assumptions have become increasingly open to question. In the first place, it has become clear that improving the component parts of a farming system does not necessarily result in improvements to the whole system. Furthermore, as systems exist in relationship with their environment, any systemic improvements must also be considered in the higher-order context of the system/environment complex. This complex represents a set of dynamic, interdependent relationships such that changes in one area will induce changes in others. And this is as true for relationships within systems themselves as between systems and their environment.

In addition to these spatial considerations, there are temporal ones. What seems to be an improved state of affairs in the short run may turn out to be less than desirable in the long run.

A narrow obsession with increased productivity has obscured the fact that there has been a high cost to agricultural progress through the degradation of rural environments, both biophysical and sociocultural. This has led in recent years to an increasingly clamorous call for multidimensional research to support the development of farming systems that are sustainable and equitable, as well as stable and productive (Conway 1985).

This shift in foci brings with it many new challenges to both our thinking and our practices as agricultural scientists. We are being drawn into new worlds where concepts are no longer neatly objective and unequivocal. And, as Douglass (1984) has illustrated, none of these new notions is more slippery than that of sustainability.

THE CONCEPT OF SUSTAINABILITY

Sustainability means different things to different people, depending on a variety of factors including worldview and previous experience. Sustainable agriculture is often synonymous with low-input agriculture, which involves maintaining production and profits without the excessive use of purchased inputs. To those with an ecological viewpoint, sustainability refers to the overall imbalance between the use of renewable and nonrenewable resources and the increasing degradation of the physical environment. This calls for the stabilization of yields and homeostasis within agroecosystems. There are also those who take an even wider, sociologi-

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The Association for Farming Systems Research-Extension is an international society organized to promote the development and dissemination of methods and results of participatory on-farm systems research and extension. The objective of such research is the development and adoption through the participation by farm household members—male and female—of improved and appropriate technologies to meet the socioeconomic needs of farm families; adequately supply global food, feed, and fiber requirements; and utilize resources in a sustainable and efficient manner.

cal viewpoint, envisioning agriculture not purely as production but as a way of life for rural people, where sustainability means the maintenance of stable, self-reliant rural communities.

To these differing interpretations can be added the notion that sustainability may have different foci in differing contexts. For instance, while the development of sustainable technologies to substitute for expensive resource inputs is the challenge facing agriculture in the developed world, the growing demands for agricultural commodities for food and foreign exchange in developing economies require new technologies and practices that both sustain and enhance productivity (Ruttan 1988). Such a concept cannot be confined to the farm. As Altieri (1988) has argued, if sustainable agriculture is to be truly equitable, it should consider not only what is produced and how that production is achieved, but also who benefits from this production. Sustainable agriculture must also take into account the environment and its systems, which are subject to both continuous and discontinuous change.

Thus there are many different interpretations of what sustainability means to agriculturalists. It can be argued that if it is to be a useful unifying concept, one that will guide better agricultural practice in a global sense, sustainability should accommodate all of the above viewpoints.

Or is this asking too much? Perhaps there needs to be a different way of thinking about what constitutes improvements in the long-term relationships between people and their environment. This new thinking needs to transcend the idea of farms as homeostatic entities—systems that are capable of restoring their own balance following both short-term perturbations and long-term disruptions. What if the focus is shifted from farms as agricultural systems that are constant victims of adverse environmental forces and that in turn threaten the integrity of those environments, to farms as *learning* systems in constant coevolution with their environments? Like their organismic analogs, such organizations would then be seen as autopoietic (Maturana and Varela 1979), self-organizing and dynamic systems (Prigogine 1980), rather than as constantly threatened, homeostatic systems.

Central to this understanding is the concept of farmers as people constantly engaged in learning more about the characteristics of the environment in which they operate, building and maintaining enduring relationships with other people and with the world around them. From this perspective, it makes more sense to think of sustainability as a measure of the persistence of individual farmers or farm families as learners and "coevolvers" who continuously try to improve the quality of their ecological relationships. "Quality" here is not something that can be judged independently against fixed standards. It is seen as a systemic property emerging from the socio-historical context of the system and judged against ever-changing norms (Checkland and Casar 1986). Thus sustainability as a persistent and intrinsic property of the farm vested in the farmer contrasts with the conventional approach, which presents sustainability as a criterion of an external designer attempting to work out technologies for farms that are both productive and environmentally benign.

IMPLICATIONS FOR AGRICULTURAL EDUCATION, RESEARCH, AND EXTENSION

To move from a production focus that essentially ignores people except as objective components to one that recognizes people and their relationships with the environment as the central concern of agricultural development requires a major shift in the worldview of farmers and of the professionals who help them. Indeed, this is a call for a new type of professional agriculturist, who will in turn need a new style of education—a new paradigm. Technological thinking, often characterized by a reductionist, mechanical perspective, has to be complemented by an ecological, relational, systemic one (Capra 1982). We are arguing for a different ecology and a different type of systemization from the conventional. We are arguing for an approach where "ecology" includes the human actors and where the system is in their minds (Bateson 1972). This is a call for a new social ecology for agricultural and rural development that brings with it the need for a new paradigm of inquiry.

Conventional approaches to agricultural education, research, and extension that reduce and subdivide knowledge into neat compartments and disciplines and then treat such knowledge as a dispersible commodity will need to be modified. The new generation of agricultural professionals will be concerned as much with new, systemic ways of knowing and learning-for-action, as with new knowledge and novel technologies. The focus will not be on the external development of new technologies for more sustainable farming systems per se, but on helping farmers and rural people to create new learning systems—new ways for them to learn how to create new sets of persistent relationships between themselves and the biophysical and sociocultural environments that surround them. The practices needed for designing new learning systems that will encourage colearning relationships between professional agriculturists and their farmer "colleagues" are not capable of recipe; they have to be learned experientially, for each relationship will be unique.

There is much to be gained from shifting the focus of analysis from "real" farming systems to an epistemological approach to generating improvements in relationships. Under these circumstances, education, research, and extension become different facets of a single learning process. Knowledge is not a commodity for transfer from the informed to the uninformed, but the outcome of a dynamic, collaborative process between colearners. This is not to deny the importance of scientific inquiry for the investigation of the biology, economy, sociology, or ecology of the farm. These are vital ways of knowing that generate important new knowledge. But if the knowledge and the ways by which it was generated remain the province of the scientist, then the notion of sustainability as a learning function of the farmer remains unachieved.

The emphasis on the learning process as the key focus for rural and agricultural development is central to the emerging new paradigm that we have termed "Systems Agriculture."

WAYS OF LEARNING

Following Reason and Rowan (1981) we have found it useful to distinguish between three ways of learning: propositional (learning for knowing), practical (learning for doing), and experiential (learning for being). An effective learner is one who is able to use all three modes. Unfortunately, our academic heritage is often such that we emphasize only the first two while virtually ignoring the third. Ironically, it is this latter mode that is most commonly used by farmers as they struggle to make sense of those things that are actually happening to them day by day.

Experiential learning concerns the way we perceive the world and how that perception determines how we behave in the world. In other words, what we experience in the world, how we perceive these experiences, and what meanings, values, and theories we attribute to them will determine what actions we take (Kolb 1984). Learning can be seen as the dynamic process whereby there is a flux between sensory experiences of the world and the mental abstraction of them—between experiencing and making meaning of these experiences. Both are highly personal and idiosyncratic.

Experiential learning is triggered when the learner becomes immersed in a concrete experience, in a situation that is "real" and problematic. In trying to obtain a clear picture of the situation, the learner goes through a divergent process of data-gathering by making careful observations across a range of issues and reflecting on them. This is followed by a stage of mentally assimilating divergent knowledge into familiar patterns and framing them into abstract concepts. The generalizations and insights gained are transformed into models to be tested when the learner reaches the stage of active experimentation. Finally, the learner has to accommodate the outcome of action with the reality of the experience. This iterative cycle, in which experiences are transformed into knowledge for action, highlights the synthesis of the concrete with the abstract and reflection with action into what we might term a learning system. In other words, the learner and the issues being investigated are "coupled" (Maturana and Varela 1988) through a vigorous process, combining a number of different, but critically interrelated, learning activities.

To deal with the complex issues of contemporary agriculture and rural development and to focus on the interrelationships between people and their natural and sociocultural environments, we need methods of inquiry that can accommodate the totality of the issues being investigated. A holistic or systemic approach contrasts with the conventional approaches in agricultural science based on reductionism, in which a single crop or crop enterprise is seen to determine the nature of the entire system. Yet these reductionist methodologies can be usefully brought to bear once the overall systemic context has been established and investigated.

SYSTEMS AGRICULTURE FOR LEARNING AND RESEARCHING

Researching is learning with the special intention of adding to public knowledge. In doing research, one attempts to understand the nature of the world and to share one's propositions, thus adding to knowledge. Whether in solving problems or improving human situations through the natural or social sciences, research processes can be seen as a variation in method on the basic theme of experiential learning.

The integration of the learning process along a continuum stretching from holism to reductionism offers us a "hierarchy" of interconnected methods of inquiry. The choice of "level" of inquiry and appropriate methodology by the researcher-learner will be contingent upon the nature of the problematic situation. Exploration of "soft" systems issues (e.g., the management of conflict) may be the entry point of the inquiry, or, at a lower hierarchical level, the concern may be a "hard" systems issue (e.g., the optimization of resource allocation). Further down the scale, the issues may be of a more technical nature, calling for puzzle-solving methodologies of technology and science. The model (Figure 1) depicts at least four levels appropriate to inquiring into a range of issues of decreasing complexity and uncertainty, from paradoxes to performances to puzzles, that may confront those investigating the complex psychosocial and biophysical issues associated with farms existing in coevolution with their environments.

Each level of inquiry provides a perspective and a clearer focus on intent for the subsequent level and each lower level provides insights for the higher levels. By focusing as much on the process of learning and the different methods of inquiry as on the content and context of the issues, personal learning styles can be markedly enhanced. And just as our students learn to master these new ways of knowing, so too do they learn to share them with their farmer collaborators. In this way, working with faculty as well as with field practitioners, students will help to create whole new networks of learners that link academia, rural industries, and rural communities. Each is crucial for the development of the other, but none is primary. The open-ended nature of the model indicates possibilities for new approaches to learning as this dynamic praxis generates new needs.

The similarity of the underlying learning processes in research methods taken from opposing ends of the spiral are illustrated in Figure 2, which compares and contrasts a method employed in a reductionist, scientific experiment with a systemic, participative, action-research method. If, for example, the problem in the former case was low yields of a crop that had signs of nutrient deficiency while the issue in the latter case was sustainability of the

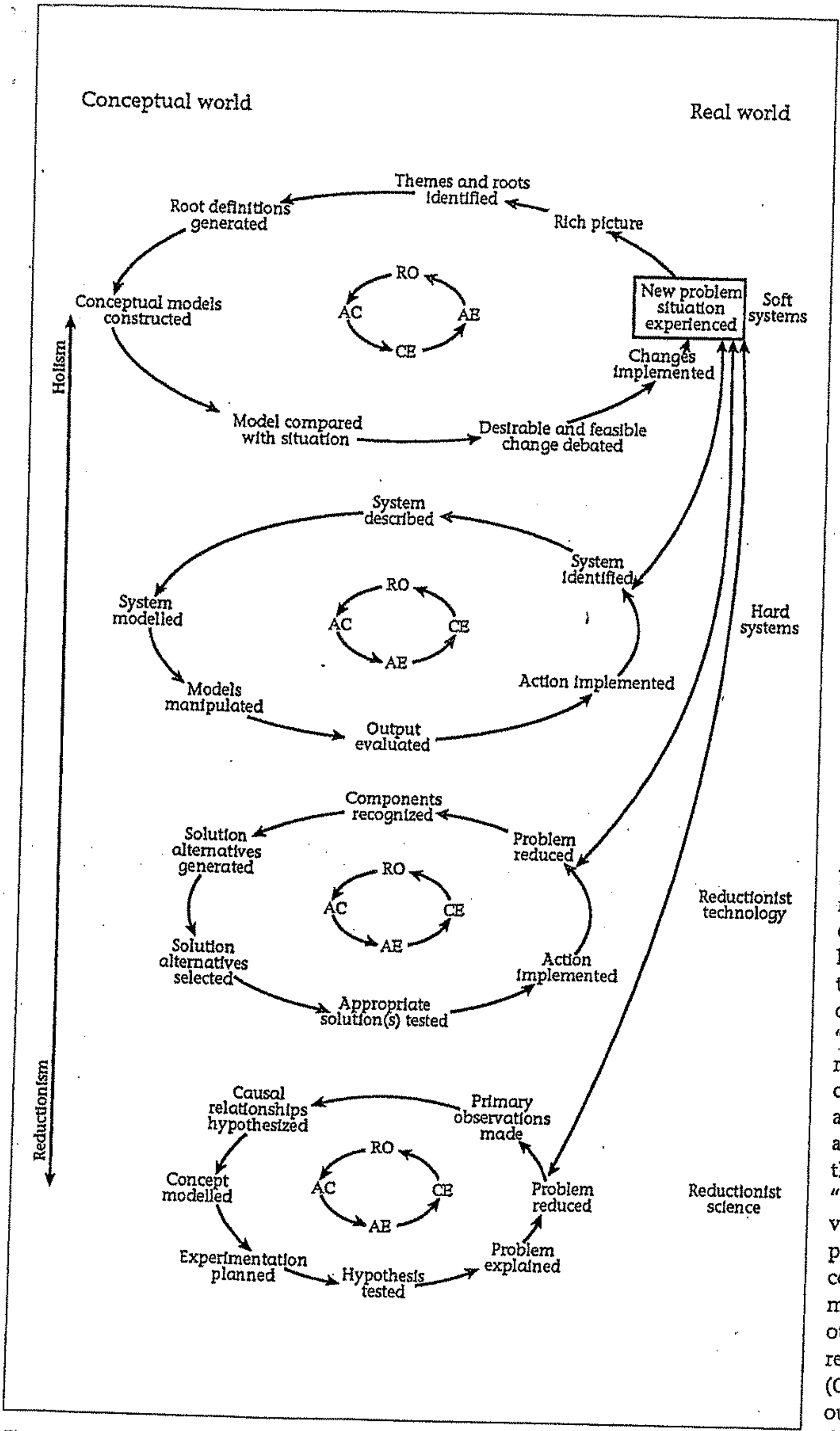

Figure 1. Nested hierarchy of interconnected learning subsystems. Key: CE—Concrete Experience; RO—Reflective Observation; AC—Abstract Conceptualization; and AE—Active Experimentation. Source: Bawden and Ison 1988; Kolb et al. 1983.

future of a rural community, in both cases the inquiry would start with the experience of a problem situation. This would lead to observations being made, concepts drawn, and action taken. The process moves from the real world into the conceptual world and emerges back in the real world in the action phase.

The reductionist experiment must be conducted under controlled conditions, and the researcher often must make observations away from the site of the real problem. On the other hand, the method of the researcher who wants to actively explore the rural community necessarily would be participative and systemic. The outcomes of the two methods would be learning and knowledge on the one hand and improvement in the problem situation on the other. The nature of reality and the way it is organized and the nature of knowledge and knowing are profoundly different between the two methods. The purpose of research, the impact of its outcomes, and the worldview of the researchers using the respective methods will also be different.

ACTION-RESEARCHING SYSTEMS

If the mission is to help people to become persistent learners as a basis for more successful coevolution with their environments—to create sustainable learning systems—then there is a need to be explicit in sharing different ways of "seeing" the world as a prelude to "doing" new things in it. Ways of researching need to be developed that combine "finding out" about complex and dynamic situations with "taking action" to improve them, in such a way that the actors and beneficiaries of the "action research" are intimately involved as participants in the whole process. Given that this aims to be a collaborative and democratic process, we must learn how to learn from each other. This means more than just respecting "indigenous knowledge" (Chambers 1983), but actually sharing our respective ways of knowing. This is the essence of what is being termed participatory development: of researching in active ways *with* farmers and

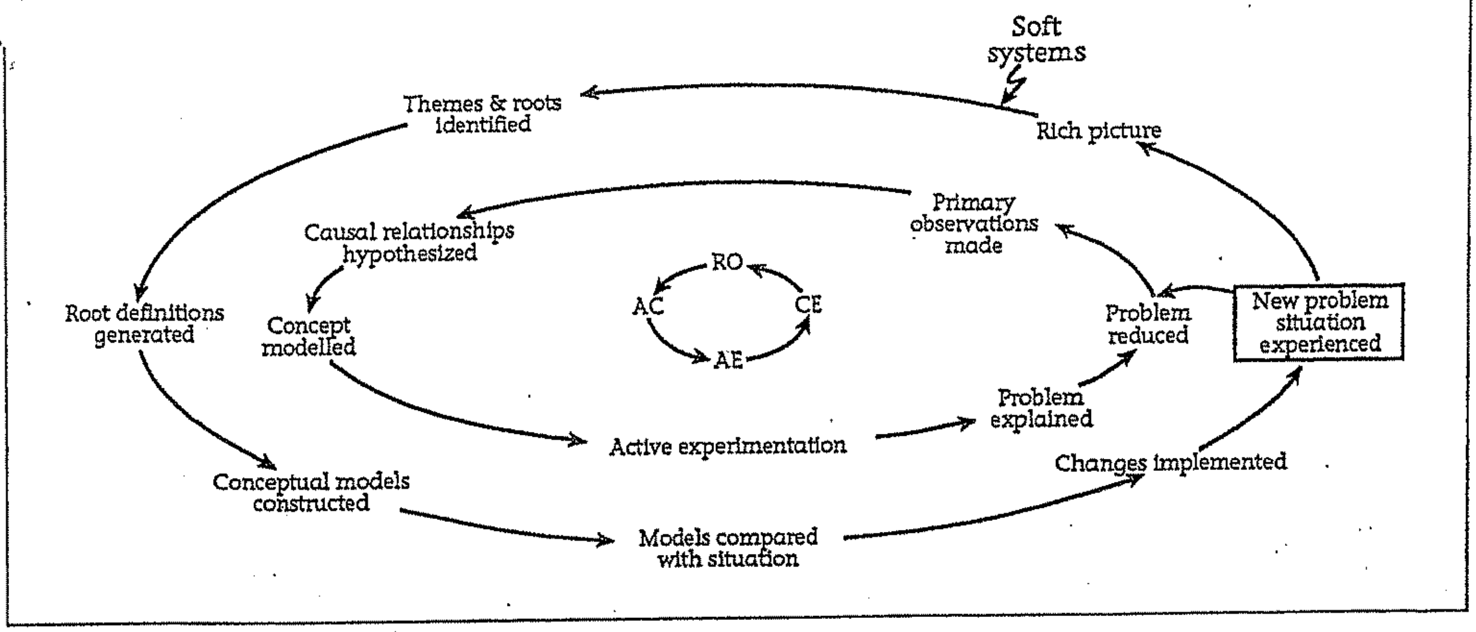

Figure 2. Two research methods compared. Source: Bawden 1989a.

others in rural communities, rather than for them or on them (Levi and Litwin 1986).

There is an important distinction to be made here between researching with farmers on issues that were identified as important through a participative process and performing research that the researcher considers important and which the researcher happens to conduct on the farmers' fields. These two approaches reflect very significant differences in beliefs about the nature and purpose of research as well as fundamental epistemological differences concerning the nature of knowing and of knowledge (Bawden 1989a,b).

CONCLUSION

Farmer participatory research has been proposed by Farrington and Martin (1988) as an approach that complements farming systems research in the process of technology development for resource-poor farmers. The partnership between researchers and farmers is seen as the critical component of participation that enables cost-effective design and implementation and dissemination of technology and that builds on indigenous technical knowledge—new technology-developing systems. What we are suggesting through our paradigm of Systems Agriculture is a further shift towards the creation of new learning systems. Here, agricultural professionals will be engaged in the process of collaborative inquiry with farmers, in action-oriented research towards the establishment of sustainable relationships between people and their environment. Given the understandings presented in this paper, new learning systems offer an important perspective on sustainable agricultural or rural development.

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