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The Ecological Knowledge System

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Abstract

Ecologically sound agriculture is not just a question of changing farm practices. It also requires a transformation of a coherent system of learning, its facilitation, institutions and policies. The paper describes the transformation involved on the basis of some country experiences.

A knowledge system (KS) is a mental construct. People develop a KS because they find it useful for effective action. KSs may be described as stable actor networks which support agricultural innovation and learning, comprising, for example, researchers, extensionists and progressive farmers (Roling and Engel, 1991, Engel 1995). But a KS may also be seen as a coherent set of cognitions, cosmologies and practices, as for example, some indigenous knowledge system (Richards, 1985). Combining the two, we may describe any KS as made up of the seven components in Box 1. These seven components occur in unique, internally coherent, combinations, which determine a particular type of knowledge system. We shall contrast pervasive conventional ideas about the knowledge system and then describe the ecological knowledge system that seems to emerge from a number of significant experiences with efforts to transform agriculture.

The conventional knowledge system is described in Box 2. It will be familiar to most readers, but must be briefly presented here to provide a basis for comparison. We also find that many people are not aware of its intricacies. The conventional KS informs decision about investment in agricultural research and other institutions, guides the design of institutions, and is the basis for agricultural training curricula and the management of agricultural development. The conventional KS is supported by powerful actor networks, comprising agricultural scientists, extension officials, and pesticide, fertiliser and seed companies (Roling, 1996). The conventional KS is enhanced by the diffusion of innovations theory (Rogers, 1983) which focuses on autonomous diffusion processes which multiply the effort of extension workers, and by the theory of market-driven technological change (Cochrane's (1958) 'agricultural treadmill') which posits that innovators capture windfall profits while late adopters must adopt to stay even, so that powerful economic mechanisms promote technical change.

An alternative is the ecological KS is described in Box 3. It is as yet uncommon for it to inform practice. Its emergence is actively fought by pesticide companies, agricultural research institutions and others who stand to lose if the actor networks maintaining the conventional KS were to become less important. In many developing countries the failure of the conventional KS to address the potential of diverse, variable and rain dependent agro-ecosystems, and the diminishing returns to the Green Revolution in uniform, irrigated and stable agro-ecosystems, has given rise to a strong movement in the direction of low external input agriculture (Reijntjes, et al, 1992). The search for an appropriate KS through which to execute LEI farming is in progress (e.g., Roling and Wagemakers, (Eds), in press). This search is informed by some crucial country experiences in which the introduction of ecologically sound agriculture at a fairly large scale is attempted.

Box 1: The elements of a Knowledge System

- an epistemology: a belief about the grounds for human knowledge;
- an ecology: a belief about the way people interact with their bio-physical environment;
- a set of practices for managing agro-ecosystems;
- ways of learning about agro-ecosystems;
- ways of facilitating and supporting such learning;
- supportive institutional frameworks and actor networks;
- conducive policy context.

Box 2: The conventional knowledge system

- ecology: the bio-physical environment serves to satisfy human needs. It can be made productive epistemology: positivist, i.e., reality exists independently of human observer, it can be objectively known if discovered or uncovered by scientific methods;
- through inputs which make it yields wanted outputs;
- practices: (new) technologies are applied to enhance the productivity of components of the agro-ecosystem;
- learning: adoption of add-on innovations. Farmer is receiver;
- facilitation: transfer of uniform technology packages developed by science for large recommendation domains;
- institutions: sequence of interlocked institutions along science-practice continuum, input companies;
- policies: subsidies on inputs, public funding of research and extension, coincidence of national interests and those of innovative farmers through technology-propelled productivity enhancement, the benefits of which are passed on to consumers.

In **Indonesia,** pesticide induced pest outbreaks which threaten rice food security and political stability have stimulated policies forbidding broad spectrum pesticides (even through many influential people benefit from distributing them), and the adoption of a national programme for IPM Training. To date some 400,000 farmers have been trained. The programme may be regarded as one of the most advanced efforts to operationalise an ecological KS (e.g., Van de Fliert, 1993). It's innovative features include: Farmer Field Schools using experiential learning methods and processes to strengthen 'ecological literacy' among farmers, specialised highly trained facilitators, decentralised networks of trained farmers and farmer trainers who exchange experience, science linkage through curriculum renewal, etc. Typically, an early effort to use the conventional KS to promote IPM did not work (Matteson et al, 1992).

In **Australia**, the rapid degradation of the productive resource base has given rise to the Landcare movement and to the emergence of successful new methods of facilitating self-discovery learning in land management (Campbell, 1994). One exciting aspect is the scaling up of land use management from the farm to the watershed level through self-discovery learning methods. Such methods have also been successfully applied in Queensland for the large-scale introduction of zero-tillage to enhance water retention in the soil (Hamilton, 1995).

Box 3: The Ecological Knowledge System

- epistemology: reality is socially constructed, acceptance of multiple perspectives;
- ecology: people are part of the bio-physical environment. They can amplify the human biotope by knowledgeable use of natural processes and cycles;
- practices: applying general principles to the low-input management of locality specific, diverse and variable eco-systems;
- learning: farmer is expert on his/her own farm and takes decisions based on knowledgeable inference from observation and analysis, and relies on his/her ability to anticipate;
- facilitation: creating conditions for discovery learning (through agro-ecosystem analysis, resource flow mapping, etc.), training in observation, experimentation and collective decision making;
- institutions: decentralised self-learning network of farmers and facilitators with access to scientific knowledge;
- policies: financial support for facilitation, network activities, such as farmer meetings, the development of curricula for discovery learning, etc. Regulation of environmental pollution, poisoning and destroying bio-diversity and thus making it harder to externalise environmental costs.

In **the Netherlands** pollution of air, soil, surface and subterranean water and the destruction of biotopes and landscapes by input intensive agriculture has led to restrictive environmental legislation with respect to pesticides, minerals, and bio-diversity. The new regulations are applied in the context of a strongly entrenched conventional KS. Add-on adoption of technologies which farmers expected to allow them to adhere to the new regulations has proven to be inadequate for realising a significant reduction in pesticide use. Small pilot projects with other approaches which involve intensive facilitation of learning and active participation by farmers seem to be more successful and adhere more closely to what has been learned in other countries about the adaptation of the KS in the direction we have called ‘ecological’.

In **Germany** consumer demand for clean and healthy food has given rise to rapid expansion of the scope for biological farming practices which, in turn, is giving rise to the emergence of a KS which is marked by decentralised networks of facilitators, groups of farmer-learners, and consumers, which are typical for the institutional frameworks characterising the ecological knowledge system (Gerber and Hoffman, in press).

From these and other examples, we learn that the process accompanying the transition of a conventional to an ecological KS has the characteristics described in Box 4.

Box 4: The transition to the ecological KS

- introduction of support for farmer/community-based learning;
- linkage of farmer networks to research institutions and non-traditional sources of knowledge and expertise;
- introduction of policies and administrative support which recognise farmers and communities as agro-ecosystem managers;
- increased emphasis on development of science-informed curricula and technologies for discovery learning which are cheap and easy to use;
- increased involvement of research and development grant makers as active stakeholders in the iterative learning process with concomitant adjustments to budgeting and planning cycles;
- acceptance of sustainability as an emergent property of stakeholder interaction (rather than as an objective attribute of an eco-system);
- stimulation of markets for ecologically produced products, establishment of alternative processing and distribution chains;
- wider use of participatory methodologies;
- explicit support of ‘consensual approaches to conflict resolution’ in recognition of the contested advance of sustainability concerns.

References

Campbell, A. (1994) Landcare. St Leonards (NSW): Allan and Unwin;

Cochrane, W.W. (1958) Farm Prices, Myth and Reality. Minneapolis University Press, Chapter 5.

Engel, P. (1995) Facilitating Innovation: An Action-Oriented Approach and Participatory Methodology to Improve Innovative Social Practice in Agriculture. Wageningen: WAU, published doctoral dissertation.

Gerber, A. and Hoffmann, V. (in press) The Diffusion of Eco-Farming in Germany and the Concomitant Development of the Knowledge System to Support it. In: Roling and Wagemakers (eds.), chapter 8.

Hamilton, N.A. (1995) Learning to Learn with Farmers. Case Study: Queensland, Australia 1990-1995. Wageningen: WAU, published doctoral dissertation.

Matteson, P., K. Gallagher and P. Kenmore (1992) Extension and Integrated Pest Management for Plant hoppers in Asian Integrated Rice. In: Denno, R. and Perfect, T. (eds.): Ecology and Management of Plant Hoppers. London: Chapman and Hall, pp 57.

Reijntjes, C., Haverkort, A. and Waters-Bayer, A. (1992) Farming for the Future. An Introduction to Low External Input and Sustainable Agriculture. London: MacMillan and Leusden:ILEIA.

Richards, P. (1985) Indigenous Agrarian Revolution. London and Boulder: Hutchinson and Westview.

Rogers, E.M. (1983) Diffusion of Innovation. New York: Free Press.

Roling, N. and Engel, P. (1991) The Development of the Concept of the Agricultural Knowledge and Information System (AKIS): Implications for Extension. In: Rivera, W.M. and Gustafson, D.J. (eds.): Agricultural Extension. Amsterdam: Elsevier Science Publishers.

Roling, N. and Wagemakers, A. (eds.) (in press). Learning Sustainable Farming: facilitation, institutions and policies. Cambridge: Cambridge University Press.

Roling, N. (1996). Towards an Interactive Agricultural Science. European Journal of Agricultural Education and Extension, Vol 2 (4): 35-48.

Van de Fliert, E. (1993) Integrated Pest Management. Farmer Field Schools Generate Sustainable Practices: A case Study in Central Java Evaluating IPM Training. Wageningen: WAU, published doctoral dissertation.