

One Assumption, Two Observations, Some Guiding Questions and a Process for the Investigation and Practice of Agroecosystem Health

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Reference:

David Waltner-Toews, Tamsyn Murray, James Kay, Thomas Gitau, Ernesto Raez-Luna, John McDermott, "Agro-ecosystems, natural resources management and human health related research in East Africa" *Proceedings of an IDRC-ILRI international workshop held at ILRI, Addis Ababa, Ethiopia, 11-15 May, 1998*. Edited by Jabbar, M.A., Peden, D.G., Saleem, M., Li Pub, H. 2000. Published by International Livestock Research Institute, Nairobi. 254 pages pp.7-14

Agricultural activities take place within a complex mess of multi-scalar, multi-dimensional interactions. Researchers using conventional methods have been able to describe and occasionally understand small sub-systems of this larger complexity - human health and disease, nutrient cycling, pasture degradation, livestock production genetics, agricultural economics, and so on - which have enabled farmers in many parts of the world to increase productivity and improve their lives and the lives of urban consumers who depend on them.

More recently, unexpected feedback loops across space and time, and across conventional boundaries of inquiry - urban/rural, economics/ecology, culture/epidemiology - have enhanced some negative outcomes, such as environmental degradation and economic disparity, and undermined some desirable outcomes, such as improved human nutrition. These feedbacks have raised serious doubts about the socio-ecological sustainability of entire agricultural communities. Indeed, the fact that these issues are arising at the very time when agriculture is being rapidly drawn into a process of globalization raises doubts about the global sustainability of current agricultural practices and the human communities who depend on them.

The urgent and multi-dimensional questions we are now asking about agriculture, human well-being and the environment, furthermore, are calling into question the normal way in which we have conducted scholarly research. If we wish to describe

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what is going on in any way that is even remotely realistic, then we shall have to transcend our disciplinary bases of scholarship. If we wish not merely to describe, but to promote sustainable and convivial human communities on this planet, then those people who will make the key decisions and carry them out must somehow be incorporated more fully into the research process itself.

Agroecosystem health is an approach to this complexity which draws on the experience and concepts developed by health practitioners and scholars over many centuries and applies them to the investigation and care of socio-ecological systems (Nielsen 1994; Waltner-Toews 1996). This would seem, at first, to be a logical and relatively straightforward step. The scholarship on which health practices are based draws on a wide variety of disciplines and transcends them in an integrative fashion. The practice of health, which has already been applied to individuals, groups and communities of plant and animal species, combines scientific knowledge, cultural values, and practical experience to make and monitor decisions in a context of uncertainty.

Recently, the practice of agroecosystem health has been described as occurring in five, not necessarily linear, steps, analogous to the practice of herd health management in livestock. The first two steps, which usually occur simultaneously, are:

1) describe the system of interest;

2) identify the owners.

These are followed by

3) set goals, objectives and indicators

4) implement feasible and desirable changes;

5) monitor appropriate indicators and reassess the situation (Waltner-Toews & Nielsen, 1997).

Such a process might be undertaken by an interdisciplinary team of professionals, with a few principal investigators taking the lead in integration.

Despite the seductiveness of the apparent simplicity of the agroecosystem health approach suggested above, initial attempts to apply it have uncovered some serious challenges which must be faced if further progress is to be made along these lines of inquiry (Gitau et al 1997; Rowley et al 1997; Smit et al 1998). These challenges may be summarized in the form of one assumption, two observations, and several questions.

The assumption is this: agroecosystem health research is undertaken in order to help people make better decisions with regard to managing the ecosystems in which they live and grow food. It is thus inherently a value-laden and applied activity. This assumption, which is part of the baggage that comes along with using health approaches, has implications for every step of the research process. As an assumption, this is not open to proof or disproof. If this assumption is not made, then health may well not be the appropriate frame of reference in which to do the research.

What are the implications of phrasing the issues in terms of health? In the first place, One way to clarify this is to distinguish between health and medicine.

Medicine requires its practitioners to analyze a problem, make a diagnosis, and intervene based on the best professional knowledge and practice, as defined by a professional organization. The general approach is thus analytical, implementation depends on compliance with professional authority in a conventional hierarchy, and success, at an individual level, is measured in terms of the cure of specific diseases, and at a population and community level, in terms prevention or eradication of specific diseases. In medicine, the experts make the decisions, the patients suffer the consequences, and the experts learn from those consequences. Many will recognize this as being the traditional approach used in applied research of all sorts. In systems terms, we might say that the purpose of medicine is to keep the system from falling apart. For narrowly defined issues (preventing or treating specific diseases), and in emergency situations – famines, acute massive erosion, car accidents – medical approaches are not only necessary but desirable. When the patient is bleeding to death, it is no time to negotiate.

Health, is generally defined in terms of current overall functioning and the capability to deal with future stresses (Waltner-Toews & Wall, 1998). The goal of health is flourishing, that is, the creative expression of a group or individual 's genetic and social potential (Haworth et al 1998). Those who wish to have health need to be able to synthesize information from a variety of sources to respond to a changing environment. The general approach to promote health involves recognition of mutual interdependence, negotiation, and resolution of conflicting or competing goals within an overall holarchic structure (see observation #2 below for an explanation of this term). In health, decisions are made by stakeholders collectively, in consultation with experts, and stakeholders learn from their own mistakes. In research terms, this requires that participation by stakeholders is required in both the definition of the problems and the selection of solutions. In systems terms the purpose of health practice is to foster self-organization. Health promotion, then, is best suited to dealing with questions of long term, complex sustainability.

The two general observations are with regard to the nature of the reality to which we are proposing to apply this health approach:

1. Agroecosystems, like all complex realities, can be viewed and interpreted from a variety of non-equivalent perspectives. (cf Funtowicz & Ravetz 1994). For instance, a systemic description of agroecosystems from an economic perspective might look quite different than that reflecting an ecological perspective. Even within a broad economic perspective, women, children, men and government institutions are likely to identify different elements of importance and draw different systemic diagrams. Furthermore, although they are linked in various important ways, there is no obvious equivalence between these systemic descriptions. This means that different health indicators are likely to be used, and different conclusions drawn, by different

researchers and stakeholders. That is, the third axis of the so-called AESH cube (see Smit et al, 1998 p 20), will vary with different interest groups and hence raise conflicts.

2. Within each perspective, agroecosystems can be viewed and understood at a range of spatial and temporal scales. (Allen & Hoekstra 1992). Even if we take the smallest coherently managed unit to be the farm, we can see that farms occur within rural communities and watersheds, which are parts of larger ecological and socio-political regions, and so on. Socially, culturally and ecologically, this multi-scalar reality is often best understood in the form of a nested hierarchy - what has been referred to in the systems literature as a holarchy. A holarchy is a nested hierarchy, a structure in which whole individuals, each with their own unique characteristics and needs, are parts of greater wholes (families, neighbourhoods, communities), which also have unique characteristics and needs which are greater than, or at least different from, the sum of the members' needs and characteristics. Each level is a holon, that is, it is simultaneously a whole with its own emergent properties, comprised of smaller wholes, while itself being part of something greater. Politically, the way we govern this multi-scalar world is most often in the form of a more conventional hierarchy. While the distinction is less clear at the global level of the United Nations or World Trade Organization, within countries, local levels of government most often take their orders from higher levels of government without having any organic stake in those higher levels. National governments, for instance, are not usually comprised of state or provincial government leaders, which are not comprised of local leaders.

Each of these two observations generate questions which must be answered as we develop and implement agroecosystem health projects.

Whose perspectives are reflected in the research process? What are the implications of this for the results? How do we incorporate multiple perspectives into the research process?

Conventional research assumes that outside experts can fully describe a system, diagnose its ills, and prescribe solutions. This is simply false, even at a given scale. A woman's economic view of a farm agroecosystem may be quite different from a man's economic view, and both are likely to create different conceptual models of the system from what a child, an ecologist or a public health epidemiologist would create. One person's problem may well be another's solution. A shift from small mixed farms, for instance, to larger industrial farms, may improve nutrition, while at the same time representing a shift in power and income from women to men, and from the local economy to the regional economy. There is no obvious "right or wrong" from a research point of view. Each model is correct and each is insufficient to describe the system. Furthermore, any decision about what constitutes a desirable or healthy agroecosystem must, by definition, be negotiated, not prescribed, since empowerment is a key component of health. Some indicators of health, especially those related to effectiveness (does the local system produce what the larger

systems wants/ needs), can be suggested at the research design stage. One may even – through economic incentives, political coercion and/or technological intervention – prod farmers and local communities to move toward these goals. However, unless we know for sure that they reflect the goals of the internal stakeholders, they will give no indication of sustainability or health. Therefore indicators cannot be fully defined or prioritized *a priori*.

What this means for the research is that the process must incorporate a strong element of stakeholder analysis: Who has power? Who is making the real decisions? Who is marginalized? It also means involving those stakeholders in the process of defining issues, constraints, options and opportunities for action, and indicators of success. The selection of indicators will reflect the different perspectives incorporated into the work. Indicators of agroecosystem health which reflect the interests and perspectives of one group may in fact dis-empower other groups. For instance, it is possible to select indicators in such a way that livestock appear to be villainous, or to be heroic. Researchers may choose indicators which are precise and quantifiable, but which require sophisticated laboratory equipment to measure and can only be interpreted by professional experts. This may actually reduce agroecosystem health, since farmers will either become more dependent on outside professional elites, or will ignore the professionals and act on the basis of personally selected but perhaps unverified and unreliable indicators. This is further complicated when we move across scales.

At which scale should we focus our work on agroecosystem health? Is there an appropriate scale at which to study agroecosystem health? What are the implications of focusing at any particular scale?

If we look across all scales, we may note that there are tensions or even outright conflicts. Slash and burn agriculture requires destruction of particular localities within a larger context. It is sustainable if that larger context remains intact so that the local settings can be rejuvenated with seeds, fertilizer, money, social support and the like. Globally, a multinational company might sustain itself through using up local communities and then moving on to new communities. A herd of animals can only remain healthy if some of its members die (naturally, or through deliberate culling or slaughter) and are replaced by newborns or outsiders, who bring in new genetic information. Thus, what is good for the herd is not necessarily good for the individual. Similarly, a local farmer may want to keep all her profits at the household level, in which case the neighbourhood, community and nation cannot survive. A national government may want to take all the farmers' profits to maintain national infrastructures, pay off foreign debts, and so on, but in this case the farmers will not survive. In looking at these examples, it seems clear that, while it is important to have some death and replacement, and to have some profit removed from the farm into community infrastructure, it is in everyone's best interest to ensure that the system is locally sustainable. If all the farmers go bankrupt, the whole system may collapse. It is for this reason that local participatory research is so important.

Indicators of agroecosystem health which reflect the economic interests of the national government (that is, one perspective at one scale) may actually be used to promote unsustainable, poor agroecosystem health at local scales. Similarly, indicators which are only local may lead to social fragmentation and national disintegration.

There are nevertheless good practical reasons for focusing research into agroecosystem health at the farm and local community or watershed level. This is the most "human" end of the scale, where the immediate impacts of decisions and actions are felt, and where there may be the greatest opportunity for progress in the near future. There are also important reasons for taking into account the larger context within which farms and geographically-based communities exist; at the very least, we should be able to identify the routes of information flow and feedback across levels, both formally and through informal communities of interest. Thus studies focused at various scales should be structured in such a way that they complement each other and the participants learn from each other.

What might a research process look like which incorporates these considerations? Checkland (Checkland & Scholes 1991) has proposed a general sequence of activities for studying human activity systems in the context of organizational management. This has recently been extended to research in multi-stakeholder communities (Rowley et al 1997). Variations of this process are currently being applied in agroecosystem projects in Kenya, Honduras and Peru. The process builds on a rich historical exposition of the site being studied, and a socio-cultural study/ stakeholder analysis. These are necessary to identify a set of perspectives which are likely to capture the main issues of interest in defining system sustainability and health.

An initial synthesis of these perspectives may give a general picture of the overall system. This then leads to systems analysis, to identify causal relationships and feedback loops within subsystems (water, nutrients, disease patterns, labour use), and systems synthesis, to identify linkages within a particular perspective (nutrient and water interactions; labour and economic interactions). Once researchers are reasonably comfortable with their systems descriptions, they can move to synthesis across perspectives, in order to identify options and trade-offs across the full range from male and female economic, crop and livestock, to social and environmental systems views. Both analysis and synthesis are likely to involve a plurality of research tools. Those currently being explored include signed digraphs, qualitative loop analysis, complex systems models such as catastrophe folds, chaotic attractors and the like, and various forms of Geographic Information Systems (Flood and Carson 1993; Kay & Schneider 1994; Rapport et al 1998).

While researchers may identify trade-offs, however, conflicts and resolutions which lead to management choices, if they are to be effective and sustainable, must be done by the stakeholders who identified the issues in the first place. Therefore, if given a choice between an esoteric analytic method and one that is more transparent

to lay people, one should always choose the latter. We have found, for instance, that influence diagrams are useful for both scholarly researchers and local participants. The process and the research methodologies used are likely to be subject to debate and experimentation for many years to come. The process has already been modified several times since this work was first undertaken. It will no doubt continue to be modified as the research progresses; nevertheless, we would recommend it as a good starting place for anyone wishing to pursue agroecosystem health research.

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