The Gatekeeper Series produced by IIED's Sustainable Agriculture and Rural Livelihoods Programme aims to highlight key topics in the field of sustainable agriculture and resource management. Each paper reviews a selected issue of contemporary importance and draws preliminary conclusions for development that are particularly relevant for policymakers, researchers and planners. References are provided to important sources and background material. The Series is published three times a year – in April, August and December – and is supported by the Swedish International Development Cooperation Agency (Sida).

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Executive Summary

The emergence of human disease epidemics can, in many instances, be interpreted as symptoms of serious malfunctions of agriculture and food systems designed to meet food production and economic goals. This paper presents three recent examples of this: bovine spongiform encephalopathy ('mad cow disease') in the UK, cyclosporiasis in Guatemala and North America, and malaria in Honduras. These epidemics illustrate how programmes to achieve laudable, but simplistic goals such as increasing production or improving health, may work through feedback loops across economic, ecological and disease 'domains' to produce unexpected and undesirable 'side-effects'. These side-effects are likely to keep emerging as long as simple, one-perspective changes are made within our increasingly complex agri-food systems.

Disease problems in urban consumers are often signals that there are underlying problems in the complex socio-ecological system in which the food is being produced. Responses to these should take the approach that these are not merely 'food industry' problems, but socio-ecological problems:

- Research and decision-making needs to make a habit of considering the larger context within which particular problems occur, and try to see that context as a system of linked influences. Suggestions are made as to how this can be done.

- Policies need to ensure the maintenance of feedback loops between economic activities and ecological outcomes. In practice this means protecting the integrity of local ecosystems and the communities in them so that farmers and markets may respond in a timely fashion to changes in their social and ecological context.

In several instances, a community-based, participatory, systemic process (Adaptive Methodology for Ecosystem Sustainability and Health, or AMESH), is proving to be useful in helping communities address these issues.

MAD COWS AND BAD BERRIES[1]

David Waltner-Toews

People born after World War II in North America are sometimes referred to as the baby boomers. This is the generation that, faced with looming global starvation, implemented changes in agriculture that mobilised the best science available and harnessed it to the best industrial technology available. While the immediate effects of these practices were the production of large quantities of apparently low-cost food, other effects, many of them surprising and some of them tragic, are only now becoming apparent. Indeed, as the downside of our success, mediated through complex ecological feedback loops, comes to haunt us, the baby boomers may come to be known as the boomerang babies.

Much of the progress in agricultural production has been achieved using methods based on standard experimental techniques and relatively simple linear cause and effect models. Within short time frames and well-defined disciplinary and spatial boundaries, these methods have clearly been successful. Most important questions related to sustainability of human communities, however, are about the much more complex relationships between agricultural productivity, environmental integrity, social equity and public health. When broader questions about these interrelationships are considered, the standard methods are necessary, but insufficient. This is because outcomes viewed as successes at one time or place, or in one domain such as agriculture or health, may be causes of pathology in another time, place or domain. The causal pathways not only become causal loops, but the loops interact in such ways that outcomes are not clearly predictable.

This reality is well illustrated in recent and very worrying experiences with cyclosporiasis, malaria and bovine spongiform encephalopathy (‘mad cow disease’) – three diseases that have emerged or re-emerged at least in part due to agrifood activities. The implications of this for agricultural and health policies are profound.

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Cyclosporiasis[2]

In the spring of 1996, and again in the spring of 1997, government health authorities in Canada and the US received reports of outbreaks of gastrointestinal disease affecting more than 2000 people, in various cities throughout the continent. Clinical signs included long-term (one to three weeks) diarrhoea, loss of appetite, abdominal pain, nausea, vomiting, fever and, not surprisingly given the other symptoms, fatigue and weight loss.

Initial reports suggested that the vehicle for the parasite was strawberries from California. But after a July 1996 meeting of US and Canadian experts at the Centers for Disease Control, Guatemalan raspberries were identified as the primary food vehicle in most outbreaks, along with, in a few outbreaks, mesclun (a mixture of various types of baby lettuce).[3]

A basic biomedical description of the disease includes consideration of the etiologic agent, hosts and immediate causes (vehicles for infection). The etiologic agent of cyclosporiasis is a unicellular parasite, *Cyclospora cayetensis*. An infected person may be sick for a month if left untreated, shedding oocysts in his or her faeces. These oocysts take a couple of days to weeks to become infectious for other people, so the infection spreads through environmental contamination, rather than directly from person to person. Related species of cyclospora have been found in rodents and reptiles; the same species has been cultured from one duck in Peru and from a group of Mexican chickens. The first human cases were reported in 1979, and with increasing frequency since then. It is not clear how much of the increase may be a function of improved laboratory diagnostic techniques.

While the medical description of disease behaviour has some immediate diagnostic use, it provides little insight into the larger questions about how and why this disease emerged, and what ought to be done about it. A somewhat better approach can be based on work by the Institute of Medicine (IOM) in the US. The IOM has identified a set of generic categories of causes for the emergence of new infectious diseases such as cyclosporiasis, and re-emergence of old ones such as malaria. These include changes in human demographics and behaviour; technology, industry and commerce; international travel; economic development and land use; the breakdown of public health measures; and microbial adaptation (Lederberg *et al.*, 1992).

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2 For medical information on cyclosporiasis, see the Cyclospora reports at the National Center for Infectious Diseases, Centers for Disease Control and Prevention, <http:// www.cdc.gov/ ncidod/> diseases/cyclospo. Much of the political and social history of the disease is pieced together from newspaper reports, many of which have appeared in Fsnet, a Food Safety news listserv moderated by the Science and Society Project, University of Guelph.

3 Not surprisingly, Guatemalan farmers and their representatives, who were not at the meeting, have accused US scientists of biased judgements intended to protect California strawberry growers.

Taking the best available medical information, combining it with the IOM categories, we might arrive at the following analysis of the emergence of cyclosporiasis:

1. Human demographics and behaviour have changed dramatically in the last few decades in Latin America. Countries are increasingly overpopulated, with migration from the countryside to city slums. International trade agreements, coupled with 'non-traditional' export crops provide one avenue for generating foreign exchange that might be used to finance economic development and, perhaps, to create employment in these countries. At the same time, changing dietary behaviour in US and Canada provides opportunities for marketing some of those export crops.

2. Consolidation and mass distribution in agribusiness is a natural consequence of economic market forces. Improved technology enables these businesses to ship fragile fruits such as raspberries over long distances to take advantage of off season markets.

3. Not only are people travelling to more places, but also, as a result of multinational trade agreements, more food is travelling.

4. Land-use practices in many poor tropical countries reflect a mix of traditional, wealthy, large land-holders and many smaller impoverished farmers. Commitment to economic gains from economies of scale has helped reinforce these conventional land-ownership patterns. The case of cyclosporiasis and raspberries indicates that these land ownership patterns affect public health issues far removed from the farms.

5. Much of the public health infrastructure that was built up in the industrialised world after World War II is now ageing, but less money is being put into the system to rejuvenate it. As a result, food surveillance and inspection in receiving countries as well as in the countries of origin are not keeping pace with the rise in food trade.

6. Bacteria, viruses and parasites can adapt to new ecological conditions as quickly as we can create them, and more quickly than we can devise ways to control them. The raspberry export schemes provided an ecological opportunity for dissemination.

This IOM-based view of the situation is an improvement over the basic biomedical model. At least it acknowledges wider forces at work in the emergence of disease, and identifies some elements of a systemic approach. However, the depiction remains too simple. It does not provide sufficient recognition of the rich, complex interactions among elements to enable anyone to study and manage trade-offs in a sustainable fashion.

One element, for instance, is changing North American dietary habits. The ageing post-war generation now favours more fresh fruits and vegetables (Ministry of Industry, 1995), preferably at low prices, year round. Although this reflects the pursuit of personal interests in maximising disposable income and bodily health, it has unintended and usually negative effects on the public domain. In response to consumer demands, international food consolidation and mass distribution, facilitated by technological innovation and corporate concentration, provide an abundant, low cost food supply in North America. This, in turn, creates ideal conditions for spreading disease-causing organisms to a large, spatially scattered population.

A third approach to explaining the cyclosporiasis epidemic would acknowledge such interactions. One version of such a narrative could unfold as follows:

In the early 1980s, the Reagan administration in the US was in the midst of a war on both military and political fronts to defend American interests in the region. Thus, with help from the US Agency for International Development and the Caribbean Basin Initiative, Guatemalan farmers were lured toward the 'bright future' which the distinctive American version of free enterprise would create for them. Switching from corn and beans, which were good only for local markets and generated no foreign exchange, Guatemalan farmers were persuaded to grow a variety of 'non-traditional' crops, including raspberries, for export in the anticipation of higher incomes.

The Guatemalan initiative was well-timed to take advantage of some radical changes in North American dietary habits, which themselves were the response of an ageing, health-conscious post-World War II generation to epidemiological studies demonstrating the personal health benefits of increased consumption of fresh fruits and vegetables. These dietary changes were already being inserted into a post-war agrifood system whose primary goal was to provide large amounts of food at low cost. This combination opened opportunities for a variety of speciality fruits and vegetables that could be grown in the tropics but were only seasonally available in North America. The Guatemalan entry into the North American raspberry market also coincided with a political atmosphere of deregulation and disinvestment in public health infrastructure, which among other things minimised food inspection. None of these interacting elements offered any incentive to provide training, good pay and good hygiene facilities for field workers in Guatemala.

Between 1992 and 1996 Guatemalans increased their annual raspberry exports to the US from 1800 to 320,000 kg. While this export boom did not eradicate the Guatemalans' own disease problems, it did help them to share their burden with several thousand Americans and Canadians. Some public health officials noticed that the people affected appeared to be mostly wealthy people at business luncheons and weddings, that is, those who could afford to serve raspberries out of season.

To say that any one of these is the 'cause' of the cyclosporiasis emergence is to miss

the point. The various elements are linked in complex patterns with feedback loops, extending over a range of temporal and spatial scales. This is why a framework or checklist like that developed by the IOM has limited value. It helps to identify important elements in the system, but does not show how the elements interrelate. A second case will help to confirm this and illustrate one way of beginning to see things more systematically.

Malaria

In 1993, a brief report in *The Lancet* neatly summarised a hurricane of environmental and disease changes in Honduras over the past 20 years (Almendares *et al.*, 1993). Looking specifically at the context in which human diseases such as malaria, Chagas' Disease (American Trypanosomiasis), and dengue fever, as well as several plant diseases, have emerged, the authors catalogue elements in a complex set of interactions which include road building, deforestation of major watersheds, indiscriminate pesticide use, and large increases in both human and crop diseases. Based on a wide range of indicators, the authors conclude that Honduras has become critically vulnerable to volatile weather patterns in the region.

It is a picture of imminent catastrophe from which much can be learned through clarification of the causal patterns suggested by Almendares' catalogue of the relevant factors. One systematic approach involves recognising that while people are changing their social (including economic, etc.) structures and in turn their social processes, they are also restructuring their environments, thereby altering underlying ecological processes, which in turn affects the ecosystemic context for social activities, leading to more changes in social structure and processes. These interactions are all occurring simultaneously and across scales.[4]

Applying this model to one aspect of the report on Honduras we might create the following plausible narrative for the changing patterns of malaria in Honduras:

In response to regional and global socio-economic and political dynamics, a national elite set some goals for Honduran society, including increasing income through agricultural production for export. Responding to these goals, landowners in the south of the country (Choluteca) intensified cattle grazing, sugarcane and cotton production. This not only accentuated some social changes, and landscape restructuring, but also changed hydrological cycles and thermodynamic processes, resulting in a large increase in ambient temperatures. The Los Encuentros station in the Department of

4 This is an application of a model of socio-ecological interaction designed by James Kay and his colleagues at University of Waterloo for use by the Ontario Ministry of Natural Resources (Boyle et al., 1996).

Choluteca reported a dramatic increase of 7.5° C in the median ambient temperature between 1972 and 1990.

One result was a large reduction in malaria in the region, which has become too hot for anopheline mosquitoes. On the negative side, soil desiccation and reductions in productivity, along with social changes, resulted in the departure of large numbers of people, many of whom migrated into the north-eastern tropical rainforests.

The migrants were still subject to the national goals as set by the country's elite. The growing of bananas, melons and pineapples in the north was accompanied by massive doses of pesticides (which will no doubt have long-term effects, including among North American consumers of the fruit). The surviving anopheline mosquitoes in this part of Honduras were thus selected, by the agricultural management techniques used, to be resistant to a wide variety of pesticides. The mosquitoes were also supplied with a large population of human blood sources in the form of the migrants from the south. These people, coming from an area where malaria had disappeared, were not immune to the disease. In 1987, there were 20,000 cases of malaria reported from Honduras. By 1993, about 90,000 cases were reported, 85 per cent of them in the northern areas.

This narrative points to no single 'cause' of the disease emergence. The resurgence of malaria in Honduras is apparently the product of a host of interacting factors from local pesticide practices to US political and economic policy in Latin America. While conventional research methodologies can identify many of these causes, they are not well equipped for revealing and assisting understanding of the interrelations among factors. Consequently they cannot describe the systematic context in which solutions might be found.

A third case study, from the United Kingdom, will show that this is not a 'Third World' problem. It will also show that, while the particular disease manifestations will depend on local context, the type of problem I am describing is systemic. Modern agrifood systems impose unprecedented selection pressures on micro-organisms, while providing these micro-organisms with unique opportunities to be redistributed. Which particular organisms will avail themselves of these opportunities depends on the local ecological history and cultural context.

Mad Cow Disease

One of the consequences of an agrifood system whose underlying rationale is production of large volumes of cheap food, is the widespread pursuit of economies of scale. This has occurred at various points in the food web, from the farm to the processor to the distributor, and in slightly different ways in each commodity-based

industry (see Winson, 1992 and Nell, 1998, for discussions on aspects of the agri-food system). Animal-related farming typifies this. Globally, 43 per cent of the world's combined poultry, pork and ruminant meat production, and two-thirds of the global egg supply, are now provided by industrial-type farms, which are increasingly concentrated into fewer and fewer corporate hands.

Consumers, most of whom don't live on farms, benefit in a variety of ways from cheap food. Indeed, one can argue that we have built a whole economy around the provision of cheap food, which frees up income for spending on other things, ranging from cars and television sets to schools and hospitals.

While most farmers may not like this, most farmers are driven out of business. The very few farmers who survive are now more essential than ever. Several studies have suggested that as the number of individual farms dwindles, the ability of local communities to provide hospitals, schools, churches and sports clubs dwindles[5] and life in the country gets a little more isolated. Money is being siphoned out of local communities and ecosystems into the pockets of urban investors. Meanwhile, fewer and fewer people in society actually understand what farmers do, isolating them even further.

In contrast, many bacteria, parasites and viruses thrive in this restructured ecosystem, because they can now come from all over the country, congregate, interbreed, and redisseminate themselves all over the country (and into export markets as well) in new and creative ways.

One way to keep down the price of meat products is to recycle all the non-edible parts of slaughtered animals and feed them back to the livestock as protein supplements. This creates a new pathway for opportunistic viruses or bacteria, and was well-established as a mechanism for amplification of salmonella contamination before the recent epidemic of bovine spongiform encephalopathy. Recycling of dead animals back into the animal food chain – by converting animal offal into fat (tallow) and defatted meat and bone meal used in animal feeds – is done by what are called 'rendering plants'. Until the late 1970s, rendering plants in the UK used energy-hungry processes that used mixing, steam-heating, milling and extraction of fat using hydrocarbon organic products. In the 1970s, fuel prices increased, some animal production managers preferred more energy (ie., fat) in the feed, and industries expressed greater concern about worker health and safety while using the old processes. So the processes were changed: hydrocarbon extraction was dropped, as were processing temperatures.

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5 An excellent discussion of the "Goldschmidt hypothesis" and other explanations of the relationships between rural communities and agriculture can be found in Ramsey, 1997.

The UK has a large sheep population, many of which die before the food system can kill them. Before the emergence of mad cow disease, the remains of these sheep were rendered into feed for other animals. Scrapie, a mysterious disease associated with malformed proteins in the brain called prions, is endemic in the UK sheep population at about two per cent. In the 1970s, two accepted facts about scrapie were that:

1. prions could not be causing the disease because they didn't have any DNA- or RNA-like bacteria or viruses; and

2. diseases like scrapie would not jump between species.

In 1997, Stanley Prusiner, who suggested that malformed prions do indeed cause a range of diseases by transforming normal proteins into which they came in contact, received a Nobel Prize. The facts, then, appear to be changing. In 1986, a new neurological disease was recognised in British cattle, characterised by slow onset, changed behaviour (fear or aggression), inco-ordination, falling, tremors, and abnormal responses to touch and sound (for summaries see Wilesmith, *et al.*, 1991; and Nathanson et al., 1997).

The epidemic of this disease peaked at several thousand cases per month in the early 1990s, after which some government initiatives to stop the recycling of dead sheep parts began to have their effects. The brains of the diseased cattle looked like sponges. They also looked like brains of sheep that had died of scrapie, people who had died from Creuzfeldt-Jakob disease and kuru, and mink that had died from transmissible mink encephalopathy.

The point to pursue in this context is not so much the biology of these diseases and the reasons for jumps between species, nor the really bad job the British government did of discussing this epidemic in public, nor why a disease, which appears to have killed a few dozen Europeans, is a cause for panic while diseases like malaria and tuberculosis, which kill millions of non-whites, elicit a shrug. These have been covered in detail by other authors. My central concern here is the complex systemic nature of the causes of this epidemic. A lot of good intentions interacted with some dubious ones to produce a 'surprising' result that is understandable only as a product of many factors whose interrelations were not immediately obvious.

Diseases and Systems

The three stories presented above are not exceptional. In the much larger collection of agriculture-health cases that I have examined so far, every one has involved the unintended consequences of many contributing factors in highly complex systems. In every case the relevant elements and effects are linked in complex patterns including feedback loops operating over a range of temporal scales and at many levels. For instance, individual farmers making production decisions, national and other authorities setting economic and political incentives, and regional or global market pressures reflecting transnational corporate initiatives as well as consumer choices. In every case the complexity also includes participants with different priorities (e.g., increased farm incomes or more healthful diets) and consequently different perspectives on the situation.

These patterns represent more or less self-organising systems. While conscious human choices play important roles in these systems, the consciousness is usually focused on immediate considerations and does not recognise many secondary implications, much less overall system effects. No one controls the patterns formed when these choices and their effects combine. Few people are even aware of the patterns.

Not surprisingly, unintended consequences are both common and difficult to trace. Typically they occur at one scale and from one perspective (eg., that of an individual raspberry eater who gets sick) but as the result of decisions made from another perspective and at another scale (eg., by government officials drafting regional economic policy). Moreover, the usual solutions developed for one set of sectorally or discipline-defined problems (eg., food production, food availability or personal health) often create the sufficient conditions for another set of problems to emerge (eg., ecological degradation and the emergence of infectious diseases).

In this context, an appropriate agenda would focus on the patterns of self-organisation and, in the case of agrifood systems, look for interactions that will better achieve the multiple goals related to food availability, agricultural production, economic viability and public health. There is no easy way to do this. However, it is not difficult to identify openings for improvement – in research, policy making and community action. Certainly we can make a habit of considering the larger context within which particular problems occur, and try to see that context as a system of linked influences. That is what I have tried to do here by taking a conventional list of relevant factors (the IOM categories of causes of infectious disease emergence) and linking them in plausible narratives. This is routinely done as the final step in foodborne disease outbreaks and enables one to create story ‘types’ (particular combinations of activities) that are more likely to result in disease. Although more difficult to achieve for multi-perspective, multi-scalar systems such as those we are talking about, it is clear that narrative patterns can be identified which reveal risks to sustainable and healthy human communities, and that policy lessons can be learned from those.

Depicting Systems Through Research

Efforts to depict systems inevitably run against the impossibility of paying attention to everything or of knowing for sure how to simplify in a way that minimises surprises. One option is to begin with the single perspective, multiscale approach used in 'farm to fork' or 'stable to table' studies that trace the biological pathways taken by infectious agents from animal reservoirs, through the slaughtering system, and on to the consumer. These studies are excellent for identifying where, along the food chain, an organism might be controlled or eliminated, but they do not look broadly enough to capture possible consequences across perspectives.

The necessary next step is to incorporate a variety of systems models from different perspectives – not just different research disciplines (biomedicine, farm economics, etc.) but also different community interests (food consumers, farm workers, etc.). This means adopting methods that integrate scientific and other studies into a broadly participative framework in which people with different perspectives (male, female, economic, ecological, biomedical, etc.) create models of the problem's context. The results can then be combined to reveal important interactions and implications.

A major unresolved issue in such work centres on how to deal with conflicting visions of the system, both within scale (commercial versus ecological, for instance, or indigenous people versus migrants) and across scales (multinational businesses, national government, farmers). Even here, however, considerable headway has been made, and a variety of methodologies are being field-tested (Daniels and Walker, 1996; Gunderson et al., 1995). What is encouraging is that the nature of the complexity inherent in agrifood system problems is increasingly being recognised by researchers in a variety of disciplines, and transdisciplinary solutions are being sought with the direct involvement of the people who are affected. What is also being recognised is that sustainability in this context is something that participants ("stakeholders") negotiate in relation to goals within the constraints of the ecosystem in which they live (Röling and Wagemakers, 1998).

Addressing Economic and Political Feedback Loops Through Resilient Rural Communities

If we are talking about sustainability, our aim is not merely to try to understand or describe complexity, but to work with it in such ways that our collective lives on this planet are improved. How can we make the systems both more resilient in the face of inevitable changes, as well as providing the kinds of services which make life enjoyable? The kind of strengthening that is needed is suggested by the cyclosporiasis, re-emergent malaria and mad cow cases. These diseases are not just problems in themselves. They are also unanticipated feedbacks that current agrifood systems and larg-

er politico-economic systems are ill-equipped to address. In these systems the main intentional decisions work mostly in one direction; indeed the very way in which I have described the problematique reflects part of the problem.

For instance, the Guatemalan raspberry situation appears quite different from a poor Guatemalan farmer's point of view. Such a farmer might identify the following elements as being important: a third to two-thirds of the children in the country are malnourished, about three-quarters of the population lives in extreme poverty, the country has a foreign debt of over $2.5 billion (US) and about 78% of the farms are marginalised by wealthy landowners to 10% of the land (Barrett 1995, PAHO 1994). From this point of view, the problem is not one of parasites on raspberries, which are a trivial issue in the global context of serious diseases; indeed probably half the cases of cyclosporiasis in the US are not related to imported raspberries, and many tons of raspberries were shipped to the US (especially those during the autumn harvest peak) which did not cause problems (Sterling and Ortega, 1999).

The problem from the point of view of poor Guatemalan farmers is how to create sustainable livelihoods from a very small land base that is rapidly degrading. Without major land distribution or social reorganisation, it appears that the necessary cash to buy enough food for these marginalised farmers to eat can come only from exports. Hence these farmers (as those in Honduras) have responded fairly quickly (with help from the US government) to regional markets, producing such items as snow peas, broccoli, and raspberries. Because agriculture is as profoundly ecological as it is economic in nature, production decisions have local biological effects. These are often environmentally destructive, but the farmers can seldom make changes to avoid such environmental damage without losing the sources of their income. No satisfactory mechanism is in place to change or overrule the market influence so that the local farming practices can be corrected. The necessary feedback loops of economy and policy are missing. What we get instead are biological feedbacks of an unpleasant kind; for instance, parasites on raspberries at the consumer end, and land degradation and hundreds of cases of pesticide poisoning among Guatemalan farmers every year (Barrett, 1995).

The existing institutional mechanisms, designed to protect North American consumers, responded initially by blocking Guatemalan raspberry imports. Since this occurred only after the imports seemed to be giving California growers some stiff competition, it is no wonder that one Guatemalan farmer informed me that talking about raspberries was like talking about religion, by which he meant that it had to do with emotions, perceptions, and beliefs manipulated for competitive advantage, and not with health at all. The second response has been to force a few selected producers to institute new hazard control methods – hazards being defined as those which affect North Americans. One recommendation, for instance, has been for the farmers to use potable water as a vehicle for spraying pesticides. That is, pesticide toxicity and environmental damage are not relevant hazards, only the parasite.

An ecologically and socially sustainable solution must incorporate the goals of all the major stakeholders; in all three of these cases that means that the legitimate livelihood needs of the farmers must be addressed systemically, without allowing the desires of urban consumers to be the primary driving force. The latter results in a global slash-and-burn kind of sustainability, where wealthy urban consumers satisfy their wants by selectively using up (destroying) local communities and ecosystems around the world. A more appropriate approach would include working with the rural Guatemalan agricultural communities to help them find appropriate ecologically and socio-economically adaptive solutions (Box 1).

Box 1. Developing ecologically and socio-economically adaptive solutions

An Adaptive Methodology for Ecosystem Sustainability and Health (AMESH) has been developed in collaborative projects in Peru and Kenya (Murray et al; Gitau et al). It is also being tested in Nepal and Honduras. Using this approach, we have worked to identify the complex system of stakeholders, issues and relationships in which the disease (malnutrition, deforestation, disease, underemployment) is embedded. It seems to work best initially at a combination of household, community and local ecoregional scales, since this is large enough that the complex interactions are apparent, but small enough that people can face each other and argue about goals, opportunities and constraints. This works differently in each setting.

In Kenya, rural villagers working with researchers were able to identify a complex set of interacting health, agricultural, environmental and socio-economic goals within a year, and have moved ahead to try to achieve them within a complex, systemic world view. In the Peruvian Amazonian frontier, our research group took the better part of three years to even identify and recruit appropriate stakeholders (relating to agriculture, health/nutrition, fisheries, Amerindian communities, and so on). A process to address simultaneously issues of health, biodiversity and natural resource management has now been initiated. In Guatemala, the biggest problem would not likely be identification of legitimate stakeholders, but finding a way to bring large wealthy landowners to the table with impoverished *campesinos* to talk about a collective future. One possibility would involve initially working separately with farm workers and landowners/exporters to create systems descriptions and establish goals from two broad perspectives. Within each of these groups, it would be important to tease apart economic, social, ecological and biomedical elements of importance, and translate goals directly into indicators of progress. Then, one can look at how changes in elements in the system as perceived by the landowners interact with those of the farm workers, and what the effects of those interactions are on health and disease.

A regional policy which ensured that, for instance, North Americans would only import from those rural communities through a co-operative of stakeholder groups from those communities would force the beginnings of strengthening local relationships. This would not immediately address the lopsided power relationships within Guatemala, or alter things in the countless other communities with similar problems. But if combined with many other such initiatives it could begin to establish pathways for more systematic responses to human and ecological health problems.

More information on these and similar projects will become available later this year through the website of the Network for Ecosystem Sustainability and Health (NESH) (http://www.ecologistics.com/nesh/)

Conclusions

In general, even in the absence of obvious diseases, policies are needed which ensure the maintenance of feedback loops between economic activities and ecological outcomes. In practice this means protecting the integrity of local ecosystems and the communities in them so that the feedbacks can take place in a timely fashion. Ecosystems and communities need to have these boundaries (however leaky) in order to be sustainable; otherwise there is nothing to sustain.

One specific approach to this has been to recognise community ownership of land in such a way that non-community members must negotiate with the community, rather than only individuals in the community, to sell or purchase land or make major changes in production activities. Note that this means protection of agricultural communities, rather than focusing on protecting small family farms per se. Elements of this have been in place in Mexico since the 1912 revolution (though are under some threat since 1992, under the North American Free Trade Agreement). If Guatemala´s new constitution is passed later this year, it will also make some allowances for this. This particular approach seems to work best for cohesive indigenous groups with relatively clear land bases, but could be adapted for conditions elsewhere with some ingenuity and political will.

Disease problems in urban consumers are often signals that there are underlying problems in the complex socio-ecological system in which the food is being produced. Responses to these should take the approach that these are not merely 'food industry' problems, but socio-ecological problems. Hence the responses need to be systemic, participatory and community-based if they are to be sustainable.

The needs of the producer community ecosystem should take precedence over that of consumer communities, since it is the former that ultimately determine the sustainability of the whole virtual edifice built over them.

References

Almendares, J., Sierra, M., Anderson, P. and Epstein, P. 1993. Critical regions: a profile of Honduras. *The Lancet*, 342: 1400-02.

Barrett, B. 1995. Commentary: plants, pesticides and production in Guatemala; nutrition, health and nontraditional agriculture. *Ecology of Food and Production* 33: 293-309.

Boyle, M., Kay, JJ. and Pond, B. 1996. *State of the Landscape Reporting: The Development of Indicators for the Provincial Policy Statement Under the Planning Act.* Ontario Ministry of Natural Resources, Maple, Ontario, Canada.

Daniels, SE. and Walker, GB. 1996. Collaborative learning: improving public deliberation in ecosystem-based management. *Environmental Impact Assessment Review* 16: 71-102

Gitau, T., McDermott, J. and Waltner-Toews, D. 1997. Design and implementation of a program to assess the health of an intensively farmed tropical highlands agroecosystem in Kenya. *Epidemiologie et Sante Animale* 31-32: 02.07.

Gunderson, LH., Holling, CS. and Light, SS. (eds.). 1995. *Barriers and Bridges to the Renewal of Ecosystems and Institutions.* Columbia University Press, New York.

Lederberg, J., Shope, RE. and Oaks, SC. (eds.) 1992. *Emerging Infections: Microbial Threats to Health in United States.* National Academy Press, Washington, DC.

Ministry of Industry. 1995. *Apparent per Capita Food Consumption in Canada.* Statistics Canada, Ottawa.

Murray, T., Kay, J., Waltner-Toews, D. and Raez-Luna, E. 1999. Adaptive methodology for ecosystem sustainability and health: development and application in the Western Amazon Lowlands. Presented at a workshop on *Conservation Medicine* at White Oak Conservation Center, Jacksonville, Florida. Center for Conservation Medicine, Tufts University, 200 Westboro Road, N. Grafton, Mass 01536, USA.

Nathanson, N., Wilesmith, J. and Griot, C. 1997. Bovine Spongiform Encephalopathy (BSE): causes and consequences of a common source epidemic. *American Journal of Epidemiology* 145: 959-69.

Nell, AJ. (ed). 1998. *Livestock and the Environment,* proceedings of an international conference. International Agriculture Centre, Wageningen, The Netherlands.

PAHO (Pan American Health Organization). 1994. *Health Conditions in the Americas.* Vol II. PAHO, Washington, DC.

Ramsey, RD. 1997. *Understanding Changes in Rural Community Well-being: A Case of the Tobacco Belt, Southern Ontario*. PhD Thesis, Department of Geography, University of Guelph, Guelph, Canada.

Sterling, C. and Ortega, Y. 1999. Cyclospora: an enigma worth unraveling. *Emerging Infectious Diseases.* 5(1): 1-8.

Wilesmith, J., Ryan, JBM. and Atkinson, MJ. 1991. Bovine Spongiform Encephalopathy: epidemiological studies on the origin. *Veterinary Record* 128: 199-203.

Winson, A. 1992. *The Intimate Commodity: Food and the Development of the Agro-Industrial Complex in Canada.* Garamond Press, Toronto, Canada.

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