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SANREM CRSP

Sustainable Agriculture and Natural Resource Management
Collaborative Research Support Program

SANREM RESEARCH REPORT NO. 1-95

PROCEEDINGS OF THE INDICATORS OF SUSTAINABILITY CONFERENCE AND WORKSHOP
AUGUST 1-5, 1994
Arlington, Virginia

Editor Dr. Barbara Bellows
Washington State University

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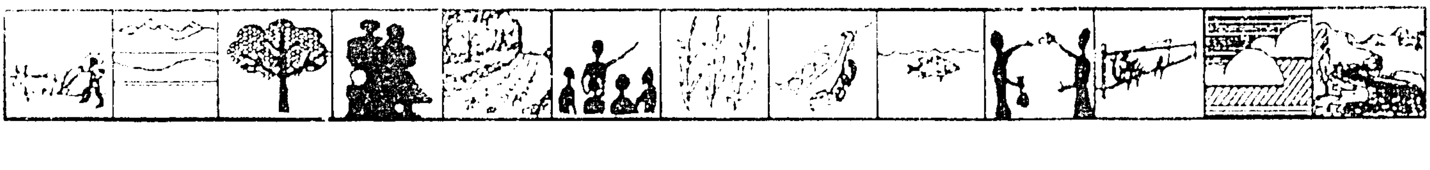

Conference coordination and document development was an effort of the

Department of Agricultural Economics

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And the SANREM CRSP Indicators of Sustainability Cross-Cutting Working Group

Walter Butcher, Chair

Barbara Bellows, Conference Coordinator and Editor of the Proceedings

TABLE OF CONTENTS

FOREWORD

One of the important research goals of the SANREM CRSP is to identify verifiable indicators of sustainability, measurable parameters that will indicate improvements in sustainability. This presents a crucial intellectual challenge for our project, as we consider the hierarchies of scale and focus levels for indicators (individual-household-community-watershed, etc.) and the various user perspectives for indicators (local communities-technical-researcher-management-policy, etc.). The keen interest in indicators of sustainability and in developing a framework for identifying and using appropriate indicators prompted the SANREM CRSP to hold a conference and workshop, 1-5 August, 1994.

We attempted to bring together individuals, from both within and outside the SANREM CRSP, with a wide range of experience and knowledge who could contribute to developing a framework for identifying indicators and their use. The results included formal presentations from a variety of perspectives on the identification and use of indicators and several workshop sessions on developing a framework for indicators.

These proceedings represent a distillation of the current knowledge on this important topic and a compilation of both what we have gleaned from others with more experience than we and what we have to share from our experience. It is our hope that it makes a valuable contribution to the debate and "state of the art" on indicators of sustainability and their use. To all of the contributors, we owe our thanks; to all of the readers, we request your comments and suggestions.

Special thanks go to Dr. Barbara Bellows, Washington State University, for providing the leadership in organizing the conference/workshop and in editing the proceedings.

W. L. Hargrove
Program Director
SANREM CRSP

1 August, 1995

PREFACE AND ACKNOWLEDGEMENTS

Preface

Within the last ten years "sustainability" has become the professed objective for many programs addressing agricultural and natural resource management. Most programs based their objectives on the need to reverse processes they perceived to be responsible for decreasing sustainability. These processes ranged from deforestation and monocropping practices that resulted in decreased biodiversity to top-down management approaches that decreased the level of participation community members had in developing the projects and policies that affect their lives. As programs sought to facilitate changes to enhance sustainability, it became increasingly evident that monitoring the impact of interventions on sustainability required more than an understanding of degradation processes. A clear definition of sustainability as well as indicators that signified incremental progress towards sustainability were also needed.

For the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM-CRSP) the identification and testing of indicators of sustainability is both a program objective and prerequisite for program evaluation. As an international research and development program designed to enhance agroecosystem sustainability through program implementation that is user oriented, has a landscape perspective, and involves inter-disciplinary and intersectoral collaboration, the identification of indicators of sustainability may serve several functions within the SANREM CRSP. These functions include:

1) characterization and monitoring of changes in agroecosystem sustainability,
2) formulation of hypotheses regarding the causes and impacts of these changes,
3) monitoring the impact of program interventions on natural resources,
4) facilitating dialogues among collaborating sectors having different perspectives of sustainability,
5) analyzing the impacts of policies on sustainability, and
6) providing other research and development programs with guidelines for monitoring sustainability.

The SANREM CRSP Conference and Workshop on Indicators of Sustainability was designed to bring together people actively working with programs involved in the identification and assessment of indicators of sustainability. Participants at the meeting included researchers, policymakers, and development workers (from both government and non-government organizations) representing environmental, agricultural, sociological, and economic disciplines. Throughout the four day meeting, participants defined the fundamental principles of sustainability and discussed processes for identifying and using indicators of sustainability. Conference presenters highlighted the breadth of perspectives on sustainability. Workshop members then tried to identify methods for facilitating interactions among these diverse perspectives. Linkages addressed included analytical-participatory interactions, interactions among disciplinary perspectives, and interactions across spacial and temporal hierarchy levels. The insights provided by this conference and workshop are currently being used to guide research development and monitoring within the SANREM CRSP, including forming the basis for the development of a participatory, field-based workbook for the identification of indicators of sustainability.

Acknowledgements

The success of an international and interdisciplinary conference depends on the collaborative interactions, suggestions, and involvement by program coordinators, project members, and invited participants. Hari Eswaran, National Leader of the USDA World Soils Resources Program, provided the original stimulus for this conference. The conference management committee consisted of:

Barbara Bellows	Washington State University
Walter Butcher	Washington State University
Hari Eswaran	USDA World Soils Resources Program
Bill Hargrove	SANREM CRSP Program Director
Robert Hart	INFORUM/Rodale Research Institute
Ralph Montee	PVO/University Center
Irma Silva-Barbeau	Silva Consultant Services

The conference management committee spent many hours identifying conference participants, designing workshop procedures, and refining workshop questions. An e-mail conference, conceived and moderated by Robert Hart, provided initial contacts for several of the invited speakers as well as useful insights into the orientation of the workshop sessions.

Throughout the development of the conference and proceedings, Walter Butcher provided guidance in the identification of conference speakers and designing the conceptual format for the conference and workshop sessions. Cornelia Flora (SANREM CRSP Chair of the Global Technical Committee/Iowa State University) provided invaluable assistance in identifying potential conference speakers and designating a niche for the conference. She also offered the able logistical and intellectual assistance of graduate assistants, Margaret Kroma (Iowa State University) and Alison Meares (Virginia Polytechnic Institute and State University). Margaret and Alison worked tirelessly to provide guidelines for workshop session interactive processes, integrate the participatory and gender perspective into workshop discussion questions, and synthesize information from the conference and workshop sessions. They also followed up on the innumerable hidden details that are required for a successful conference. Christien Ettema, Luc Beorboom, and John Vickery (University of Georgia) assisted in the formation of workshop questions and consolidating information following the workshops.

The SANREM CRSP site facilitators and site coordinators identified program participants, held coordination meetings, arranged for visas, and coordinated the preparation of papers, posters, and discussion guidelines for the conference and workshop. Without their assistance, crucial participatory and site-based insights would not have occurred.

The site facilitators and coordinators are:

Gladys Buenavista	Heifer Project International/SANREM CRSP Philippines Site Coordinator
Mudiyai Ngandu	Tuskeegee University - Burkina Faso Site Facilitator
Laurent Millogo	USAID/Burkina Faso - Burkina Faso Site Coordinator
Kevin McSweeney	University of Wisconsin - Central America
Robert Rhoades	University of Georgia - Ecuador

The Sustainable Agriculture Research and Education (SARE) program of the United States Department of Agriculture provided financial assistance for participation by three U.S. Farm representatives. My appreciation is extended to the following SARE Area Coordinators for their assistance in identifying representatives to this conference:

Paula Ford	University of Georgia - Southern Region
Lisa Jasa	University of Nebraska - North Central Region
V. Philip Rasmussen	Utah State University - Western Region
Steve Waller	University of Nebraska - North Central Region
Fred Magdoff	University of Vermont - Northeastern Region

During the Conference and Workshop, conference moderators and workshop facilitators and rapporteurs stimulated participation and kept the program on schedule. Conference moderators were:

Walter Butcher	Washington State University
Gelia Castillo	University of the Philippines - Los Banos
Hari Eswaran	USDA World Soils Resources Program
Gabriel Hegyes	Sustainable Agricultural Network/Sustainable Agricultural Research and Education
Constance Neely	SANREM CRSP
David Schroder	Agency for International Development - Washington D.C.
Betty Wells	Iowa State University

Workshop facilitators were:

Jerry Aaker	Heifer Project International
William Deutsch	Auburn University
Thomas Forster	NGO Working Group on Sustainable Agriculture
Michael Lee	Zamorano University
Hector Medrano Vaquero	EARTH University
Roger Serrano	Philippine Council for Agriculture and Natural Resource Research and Development (PCARRD)
Irma Silva-Barbeau	Silva Consultant Services
Kimberly Van Wagner	Agency for International Development
Betty Wells	Iowa State University

Rapporteurs were:

Barbara Bellows	Washington State University
Gladys Buenavista	Heifer Project International/SANREM CRSP/Philippines
Elizabeth Kline	Tufts University
Margaret Kroma	Iowa State University
Alison Meares	Virginia Polytechnic Institute and State University
Christien Ettema	University of Georgia
Ralph Montee	PVO/University Center
Jorge Recharte	Facultad Latinoamericana de Ciencias Sociales-Ecuador
Somé Salibo	University of Ougadougou
Jennifer Schumaker	Heifer Project International
B.K. Singh	EARTH University

The SANREM CRSP Management Entity and their Administrative Assistant, Debra Belvin, arranged travel documentation for participants from the SANREM CRSP projects sites. Washington State University staff personnel provided excellent technical support. Nancy Mack (Office of Conferences and Institutes) provided invaluable assistance in conference coordination techniques. Karen Beeson and Karen Jordan (Department of Agricultural Economics) arranged travel schedules and budgets for all invited participants. Deb Schwenson (Department of Agricultural Economics) provided quality logistical and secretarial assistance in preparation for and during the conference and in preparation of the proceedings.

The proceedings were prepared at the Department of Agricultural Economics, Washington State University. Holly Born (M.S. student, Department of Agricultural Economics) proofread and copy edited the proceedings papers. Deb Schwenson finalized word processing and figure layout for all documents.

The task of final review, readying materials for publication, publishing and disseminating these proceedings has been undertaken by staff of the Center for PVO/University Collaboration in Development/Western Carolina University. I would like to acknowledge the work of Ralph B. Montee, William Collins, Mary Lou Surgi and Rashid Hussein in this respect.

Finally, on behalf of the coordinating committee, I would like to extend my sincere appreciation to the all of the participants at the Indicators of Sustainability Conference and Workshop who presented papers, displayed posters, asked insightful questions, and engaged in lively and thoughtful discussions during the workshop sessions. Their participation was critical to the success of this conference and workshop.

Barbara Bellows
Washington State University
Editor

Opening Address: USAID Interest in Indicators

Terrence Brown*

INTRODUCTION

USAID is entering a new era of programming and managing U.S. foreign economic development assistance, including food aid, to promote sustainable development for which food security is an essential precondition.

We are concentrating our financial and human resources on the highest priority areas, reducing the number of countries in which we work and beginning a process to shift from a focus on inputs to a focus on demonstrable development results.

- Continued budget pressures, and in the case of food aid coupled with escalating emergency needs, require us to review carefully all programs to be sure that we are achieving and communicating results.

- The Congress is demanding that we demonstrate clear development results and clear benefits to the American people. The recently enacted Government Performance and Results Act reinforces the commitment of both the executive and congress to this effort.

USAID's sustainable development program has now been named as one of the pilot initiatives under this mandate. Our effectiveness and progress will be closely monitored.

- The administration, with the National Performance Review, is committed to making government more responsive and more effective.

- The administrator has personally committed himself to this effort by designating all of USAID as a "reinvention lab."

USAID is moving to a new consistent programming approach, *managing for results*, based on Best Practices now in use in different parts of the agency.

This morning I want to cover four main points:

(1) What is managing for results?

(2) How does managing for results translate into an overall programming system?

(3) How are missions starting to manage for results through strategic management?

(4) What are the implications for our development partners and, particularly, for PVOs and for NGOs as well?

WHAT DOES MANAGING FOR RESULTS MEAN?

Managing for results means a fundamental shift in thinking:

- From managing inputs...to achieving results.
- From judging the priority USAID and the administration give to a problem on

*USAID (United States Agency for International Development).

the basis of how much funding we put into it.

Managing for results has three main elements:

(1) Planning for results
- identifying objectives
- delineating strategies
- specifying targets

(2) Measuring results
- selecting indicators
- collecting data
- analyzing performance

(3) Using results
- reviewing performance
- reporting performance
- making decisions, including resource allocation decisions

Managing for results means holding every manager fully accountable:

- For vigorously pursing well defined objectives;
- For getting and using information on program performance;
- For understanding why programs are succeeding or failing; and
- For continuously reorienting resources and activities in more effective and productive directions.

Managing for results requires:

- That there is strong top-down leadership for effective bottom-up decision making;
- That policies, priorities and operating principles are clearly articulated and well understood;
- That line managers are trusted to know how best to apply these principles in specific circumstances; and
- That occasional failures are accepted, but that we always learn from our experience.

HOW DOES MANAGING FOR RESULTS TRANSLATE INTO AN OVERALL PROGRAMMING SYSTEM FOR THE AGENCY?

The system includes:

- Setting agency strategic priorities;
- Developing multi-year strategic plans for each USAID mission;
- Defining annual action plans, including resource requests;
- Conducting annual performance reviews; and
- Reviewing and modifying budgets, in part based on performance.

HOW ARE USAID MISSIONS PLANNING AND MANAGING FOR RESULTS?

We are in the early stages of a process that will take several years to be established.

- Not all countries have strategic plans and we know that many of those that do probably will need to be revised.

- In many parts of the agency, the project, which may be a food aid program, is still the primary unit of analysis and managing inputs rather than achieving results is still given priority.

- Many of our central bureaus will face special challenges in putting together strategic plans.

- We know that we still have important institutional incentives which undercut our efforts to focus on results.

- And we know that we are going to learn as we go along that some missteps are inevitable.

But, we are firmly underway and are making progress:

- More than 70 missions have strategic plans.

- 55 Missions have selected performance indicators.

- Over 30 missions are collecting baseline and regional outcome data.

- Dozens have reorganized programs or eliminated activities.

- At least 12 missions are using performance information in program and budget decisions.

  For those 12 missions, it represents at least two years of consistent effort to define objectives, establish benchmark/indicators, put information collection systems in place and assess data collected.

This is what managing for results is all about.

What we need to do to make managing for results work and where are we in that process?

Re-engineering the program process.

- We have initiated an ambitious program to re-engineer our program system.

- These will help us:

  Maximize the impact of scarce development resources

  Improve USAID's stewardship of US Government funds.

  Better manage for results.

Why is this so important to the agency? What will it do for you? It is intended to:

- Significantly simplify our procedures;

- Make it easier to move resources where either human or financial, including food aid, resources can be used most effectively in response to performance information and changing circumstances.

  Or put another way, the new system will empower managers by giving them the authority, tools and information they need to make intelligent decisions.

- Place far less emphasis on detailed ex ante planning and onerous documentation requirements. Instead, the emphasis is on pro-active, information-based program management.

- Clearly state expectations and requirements. In doing so, it should help reduce our audit vulnerability which has been such an issue over the past several years, hogtying our staff and stifling risk taking.

- Make it easier for all of our development partners, PVOs, NGOs, host governments, other USG agencies to participate in strategic planning and program design because requirements will be both simpler and uniform throughout the agency, regardless of the resource or whether one is in Indonesia, Salvador, Poland, Tanzania, Jordan or in an AID/Washington office or in one of the new centers in the Global, Field Support and Research Bureau.

An example of the kind of changes I'm talking about is USAID's new guidance for the use of Title III resources. We have recently issued policy guidance notifying our missions that hereafter the agency will focus these limited food aid resources solely on helping to resolve food security problems related to food consumption and production in the most food needy, least developed countries. This way we hope to make measurable and enduring impact that will eventually lessen or eliminate the need for the food aid in those countries that now seem to need it the most.

The agency is very interested in indicators of sustainbility because:

- Sustainability is a complex concept with multiple, often competing, subgoals. We need to define, promote and monitor progress toward sustainability and ultimately self-reliance. We need to know how we are doing.

- We need to test efficacy and relevancy of the proposed indicators for a number of different environments and farming systems to try to identify "global commonalities" or common themes.

- The agency needs practical indicators for measuring progress towards sustainability in AID projects. Indicators are needed at a variety of levels including the community and grassroots level, the regional and national level (especially for policy analysis purposes) and at an international (global) level.

- Indicators are needed to evaluate A.I.D. projects to ensure they are relevant and appropriate for development.

- The development of indicators will be dynamic; indicators developed this week will be the first step and should evolve over time. Just as the definition of sustainability continues to be refined, so will the indicators need to be refined.

In conclusion, USAID is looking to this conference to provide a framework for identifying, testing and evaluating indicators of sustainability.

Indicators of Sustainable Agricultural Development -- Concepts and Illustrations

J. Patrick Madden*

INTRODUCTION

As the sustainable agriculture movement has begun to mature, it has become essential that appropriate indicators of its success or failure be established. I congratulate the organizers of this conference and SANREM in particular for enabling this meeting of minds.

This presentation begins with some illustrations of global indicators of the human and ecological crisis of our times, which are the primary motive force behind the sustainable development movement. A systems framework is proposed for the development and use of indicators of sustainable agricultural development. A tentative typology of indicators is offered. Finally, illustrations from various countries are provided to illustrate the concepts.

EXAMPLES OF CRISIS INDICATORS

Many indicators have been developed to reflect the rapidly emerging ecological crisis on this planet. The following list of crisis indicators adapted from *The Global Ecology Handbook* (Corson, 1990), documents many ominous trends threatening continued life on this planet:

- The world's population is currently about 5.2 billion, and is growing at the rate of almost 90 million (the population of Mexico) each year. If the present trends continue, the population will reach 10 billion by the year 2025. Population pressure is often accompanied by severe environmental degradation such as deforestation, expansion of deserts, and soil erosion.

- Economic development is a threat to sustainability. Third World countries containing more than three-fourth of the world's population, have an average income per person of about $2.00 per day. This is less than 6 percent of the average income in industrial nations. And the gap between rich and poor is rapidly widening. Third World debt owed to the wealthier nations is a significant contributor to this widening disparity. Third World countries owe more than $1.3 trillion; their debt payments (interest and principle) are staggering for these already impoverished nations, imposing pressures to further exploit their land and people, to harvest their forests and fisheries in non-sustainable fashion, and to become even more dependent on non-sustainable technologies.[2]

- Nearly a billion people, 20 percent of the world's population, are chronically hungry: they do not consume enough calories to support an active working life. Decades or even centuries of soil erosions have so seriously degraded the soils that in many areas crop yields are declining even though "green revolution" technologies are being used -- often polluting groundwater and surface water, and threatening the health of people and wildlife.

*World Sustainable Agriculture Association.

· Biological diversity is being rapidly destroyed. Plant and animal species are becoming extinct at the rate of several thousand species per year. One indicator is the prediction that one-fifth of all species could disappear within the next 20 years. Extinct is forever.

· Tropical forests are being destroyed at the rate of at least 11 million hectares per year, an area the size of Pennsylvania. One indicator of this trend is that about half the world's tropical forests are already demolished. Destruction of forests is a complex and far-reaching tragedy: the ability of the forest to absorb and slowly release heavy rainfall is destroyed, thereby exposing downstream areas to a combination of severe flooding followed by drought. Massive soil erosion clogs waterways and dams, inundates farmland, destroys crops, villages. and infrastructure.

· Fisheries are being depleted due to harvesting at nonsustainable rates, compounded by fish kills due to pollution by oil, chemicals, and other wastes.

· Fresh water is becoming a scarce resource. Only about half the people in the world have safe drinking water. The current tragedy in Rwanda and the many refugee camps across its borders is a stark reminder of the crucial role drinking water plays in maintaining health and life itself. More than 10 million deaths per year due to water-borne diseases are caused by impure drinking water, often fouled by human and livestock excrement, agricultural chemicals and other toxic substances.

· Fossil sources of energy are rapidly vanishing. It is estimated that proven world oil reserves are sufficient to last only until about year 2020. That's not far in the future. My grandchildren will be young adults. Proven natural gas reserves may last until year 2050, about the time my grand children reach retirement age. Pollution and destruction of the ozone layer due to non-sustainable rates of combustion of these fuels are a rapidly increasing threat to air quality, climate stability, and the health of people and crops. (Silver and DeFries, 1990).

· Global climate change is accelerating and air quality is rapidly deteriorating. Air pollution is harming plants, animals, and humans. And while scientists are still quarreling over interpretation of global warming data, depletion of the Earth's protective layer of ozone has been depleted by an average of 2 percent worldwide, and has reached nearly 40 percent at times over the Antarctic. Atmospheric carbon dioxide levels, a major concern regarding global warming has increased by an estimated 25 percent since before the industrial revolution, and has increased by 10 percent in just the last 30 years. An increase of only one or two degrees in the earth's temperature could have devastating effects to many nations, particularly in areas with elevation near sea level.

· Hazardous substances are being produced at a non-sustainable rate. Just in the United States, more than one ton per person per year is being generated. It is estimated that the number of pesticide poisonings occurring worldwide each year is between 400,000 and 2 million persons, mostly farmers in developing countries. Perhaps the most disturbing of the hazardous wastes is that being generated by the nuclear power industry. Escalating costs for disposal of these wastes are compounded by concerns for the safety of human and natural populations.

A SYSTEMS FRAMEWORK FOR INDICATORS

Lists of crisis indicators such as these rely on indicator data. Indicators of sustainable agricultural development must be conceived and receive birth and nurturing in an information system that begins with motivation and includes feedback.

Useful indicators do not just happen. There must exist a strong motivation to create and maintain them. The motivation may stem from the decision maker's need for data to aid in understanding complex systems, as a guide to more effective planning and action of intervention programs, or (not exclusive of the foregoing) to support a political agenda. For example, indicators are often used to guide policymakers in setting priorities and in justifying the allocation of funds to meet critical needs.

Indicators ideally evolve in a cyclical manner through eight recurring and interlocking phases of action, as follows:

(1) **Motivate** -- establish a clear need for information about an important condition, trend, or process; a need of sufficient salience to justify investment or resources to create an indicator. Typically motivation occurs only in response to current or persistent crises, as perceived by those in power;

(2) **Conceptualize** -- the process of deciding what must be measured, counted, or described;

(3) **Construct** -- devising ways to gather the needed data to prepare the indicator;

(4) **Maintain** -- establishing continuity in collecting and processing the data needed for the indicator;

(5) **Present** -- preparing and delivering the indicator in effective ways and appropriate locations and times to inform the relevant decision makers;

(6) **Interpret** -- understanding and use of the indicator by the decision maker, normally in the context of many sources of relevant information;

(7) **Action** -- acting upon the information conveyed in the indicator;

(8) **Feedback** -- determining whether the indicator has been useful, whether it should be continued, modified, expanded, or deleted; this feedback may become the new "Motivate" stage of the succeeding cycle of indicator development and utilization.

Most university-trained professionals with whom I have interacted seem to derive great intellectual security in the belief that their work is entirely "objective" rather than "subjective," and that they avoid making value judgements in their professional work. At its root, this position contains a contradiction, since the preference for the objective over the subjective is, in itself, a fundamental value judgement. Subjectivity and the formation of value judgements is both an inevitable and a desirable feature of the enterprise of developing, interpreting, and using indicators of sustainable development. Specifically, all eight phases described here require value judgements. The selection of appropriate indicators of sustainable agriculture is essentially an exercise in making value judgements reflecting one's world view or concept of what constitutes sustainable agricultural development, as well as one's goals regarding attainment of a better future. The underlying concepts stemming from this world view then motivate the data collection, refinement, maintenance, interpretation, and use of the indicators.

The basic concept of sustainable agriculture underlying indicators of sustainable agricultural development will vary from one culture to another. In the United States and most of Western Europe, where agricultural surplus has been the principal farm problem for decades, sustainable agriculture is defined in terms of meeting the food and fiber needs of the present in ways that will enhance environmental quality and ensure that the capacity of future generations to meet their own needs will be enhanced. Reduction or elimination of synthetic chemical pesticides and fertilizers threatening the environment and health of humans and other species is a significant goal of sustainable agriculture in the United States and other industrialized nations.

However, in the so-called developing or Third World nations, where food supplies are often scarce or precarious, elected officials tend to place very high priority on increasing total food production, even if synthetic chemical pesticides and fertilizers known to be harmful to human health and the environment are required, within the precepts of presently known technology.

A TYPOLOGY OF INDICATORS

The central premise underlying efforts to come up with indicators is the belief that the ability of decision makers to reach informed decisions will be enhanced to the extent that they receive and comprehend indicators reflecting relevant conditions and trends, as well as processes that may affect these conditions and trends. Which indicators of sustainability considered will policymakers and others power holders consider "relevant?" This depends largely on their vision of the future, especially their perception of the scarcity or abundance of food. And their choice of strategies to ensure an abundance of food is strongly influenced by beliefs regarding the productivity of more ecologically sound farming methods and systems.

Another premise is that decision makers at many different levels of action (from the national and international to the grass roots, in both the public and private arenas) will find very different kinds of indicators relevant to their decisions. An environmental regulatory agency needs point-source pollution indicators reflecting the performance of individual factories; but for strategic planning and impact assessment, they also need indicators of conditions and trends affecting large geographic or ecological areas. In the economic realm, macroeconomic analysts require aggregate data for entire regions or nations, while decision makers in private firms (such as farms) require data at the operational (farm or field) level of aggregation to help them understand the factors contributing to past and current situations, and to predict outcomes of alternative management decisions intended to improve the situation. These and many more decision scenarios define the need for indicators of sustainable agricultural development.

Indicators of sustainable agricultural development may be arrayed along three interlocking dimensions: time, space, form, and world view (Table 1).

Table 1: Indicator Dimensions, Characteristics and Users.

Indicator Dimensions	Characteristics	Use
Time	Static	Baseline
	Dynamic	Trend data
Space	Geographic expanse	Geographic
	Boundaries	Hierarchies, Systems
Form	Quantitative	Policy making analysis
	Qualitative	Sociological, anthropological, quality of life descriptions
World View	Anthropocentric · Market-oriented · Short-term perspective	
	Ecological world view · Ecologically sound · Economically viable · Socially just · Culturally appropriate · Based on holistic scientific approach	Sustainable agriculture · Enhancement of the quality of life for producers & society while preserving or enhancing environmental quality · Sustainable agriculture model for social & economic organization based on equitable & participatory vision of development ecologically sound

The Time Dimension of Indicators

The time dimension is essential in all kinds of indicators: both baseline and trend data are usually needed for both for quantitative and qualitative indicators. The two broad time dimension categories are static, reflecting conditions at a single point in time, and dynamic, describing trends over time. Dynamic indicators include estimates of the parameters of systems used to prescribe or to predict the outcomes of alternative decision scenarios.

The Space Dimension

The space dimension of indicators reflects the wide range of size and kind of geographic or locational scenario represented by indicators. The space continuum includes a field of corn, a dairy farm, a community, a watershed, a river basin, a continent, planet Earth, and beyond.

Forms of Indicators

Two broad categories of indicators are quantitative and qualitative forms. Quantitative forms of indicators include monetary and non-monetary measurements. Quantitative indicators are most widely preferred by most policy makers and analysts (especially those with a reductionist and mechanistic world view) because quantitative indicators are usually perceived to be simple, clear, accurate and valid. It has been my impression, however, that the users of quantitative indicators rarely if ever understand the assumptions and weaknesses in the indicators they use to guide decisions. And very rarely is the validity of an indicator established (Aaron, 1994; Madden et al., 1976; Gersovitz et al., 1978).

Qualitative indicators are usually presented verbally; when translated into measurable constructs, they become quantitative data, amenable to presentation with numbers. Qualitative indicators have the advantage of providing a richness and intuitive understanding that numerical data alone cannot convey. As a result, they normally require more space on the page and are more effort for the user to internalize. And they often "muddy the waters" by pointing out complexities, exceptions, and weaknesses in quantitative data. The best of both worlds, of course, is an appropriate mixture of both qualitative and quantitative data.

However, busy decision makers (especially those trained in the reductionist tradition of conventional science) often demand succinct answers to their questions, preferably with brief and simple numerical data; and they often express frustration at verbal presentations -- even though the longer presentation may be far more accurate and may lead to different recommendations than the favored succinct numerical reply. Such is the frustration of those who seek to inform the policy process.

Alternative World Views
The Cosmological Dimension

The dominant world view in America and many other nations is inherently anthropocentric, market-oriented, and myopic -- lacking a long-term perspective. According to this dominant cosmological world view, humans are considered separate and apart, and somehow superior to other life forms, including other animals and plants. The various elements of Nature are considered to have value only to the extent that they are utilized or exploited to meet the desires of humans willing and able to pay for their use. Extinction of species not yet found to have commercial value is often trivialized.

Within the anthropocentric world view, it seems somehow acceptable that consumer desires are being magnified by clever marketing campaigns calculated to increase market share and profits of a private firm. By catering to these artificial desires, industrial firms have greatly accelerated the depletion of natural resources, including scarce mineral deposits and fossil fuels, while severely polluting the air, the water, and the soil with chemical wastes.

In the dominate world view, only the desires of the advantaged classes of humans are taken into account, namely those having financial and political power. Their desires for conspicuous or unnecessary consumption take precedence over the survival needs of the disadvantaged now living on earth, as well as future generations. The advantaged classes are, in most societies, predominantly adult males; they are also members of a locally predominant race, creed or religion; and in most countries they are the more literate and educated segments of the population. The impoverished classes, on the other hand, are disproportionately women, children, the elderly, members of minority ethnic or religious groups, the under-educated and illiterate, and the landless who have little hope of upward social mobility (Bird and Ikerd, 1993).

Joanna Macy observes that Third World development strategies based on the dominant capitalistic economic paradigm and the transfer of Western technologies often boomerang, "exacerbating local inequities, creating patterns of dependence, and leaving behind, along with rusting, unused equipment, an increasing sense of frustration and powerlessness. Aid programs have followed blueprints that may be rational in the minds of Western university-trained planners. But too often the only 'growth' they bring to the local population is in the wallets of a small urban elite and in a mounting national debt." (1991, p. 131)

The motivation and concepts underlying prevalent definitions of sustainable agriculture in the United States are strongly anthropocentric in their cosmological perspective. For example, the current agricultural program legislation in the United States (The Food, Agriculture, Conservation and Trade Act (FACTA) of 1990) includes the following definition:

***Sustainable Agriculture** is an integrated system of plant and animal production practices having a site-specific application that will, over the long-term: satisfy human food and fiber needs; enhance environmental quality and the natural resource base upon which the agriculture economy depends; make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls; sustain the economic viability of farm operations; and enhance the quality of life for farmers/ ranchers and society as a whole (Title XVI, Subtitle A, Sec. 1603).*

Inherent in this definition are elements of ecology, economy, and community. Overlaying these elements, however, is a cosmological world view that is strongly anthropocentric, viewing humans at the center of the overall scheme of things.

Contrasting with the predominate anthropocentric world view is the paradigm postulated by deep ecology, ecological economics, Buddhism, and other philosophies based on reverence for Nature and respect for the needs of future generations (Badiner, 1990; Colton, 1963 and 1984; Costanza, 1991; Daly and Cobb, 1989; DeVall, 1993; DeVall and Sessions, 1985; Swimme and Berry, 1992). For example, James Lovelock has proposed what he calls the Gaia hypothesis:

The entire range of living matter on Earth, from whales to viruses, from oaks to algae, could be regarding as constituting a single living entity, capable of manipulating the Earth's atmosphere to suit its overall needs and endowed with faculties and powers far beyond those of its constituent parts. (Lovelock, 1982)

Proponents of ecological alternative world views contend that most of the ominous ecological and demographic catastrophes reflected in the "crisis indicators" summarized above have been fueled by the dominant anthropocentric and market-oriented world view. The world view of a deep ecologist, often rooted in Buddhist or indigenous native culture (Macy, 1991), is that Earth is a living organism of which humanity is a small but integral part, having disproportionate power to create ecological havoc.

A very persuasive alternative world view of sustainable agriculture development has been proposed by the Women, Food and Agriculture Working Group, in their 1994 statement to the United Nations Commission on Sustainable Development:

> *Agriculture is essential to both rural and urban development. Food security is a basic human right that is inextricably tied to sustainable agriculture and is a fundamental prerequisite for human development. Food security is defined in its most basic form as access by all people at all times to the food needed for a healthy life. Food security puts priority on food for domestic consumption over food or products for trade, giving priority to locally produced foods while preserving and protecting cultural food habits and preferences.*
>
> *Sustainable agriculture is a model of social and economic organization based on an equitable and participatory vision of development. Sustainable agriculture is a way of life where communities have access to and control over their resources - specifically land, water and seeds - and processes - specifically marketing. Agriculture is sustainable when it is ecologically sound, economically viable, socially just, culturally appropriate and based on a holistic scientific approach.*
>
> *Sustainable agriculture preserves biodiversity, maintains soil fertility and water purity, conserves and improves chemical, physical and biological qualities of the soil, recycles natural resources and conserves energy. Sustainable agriculture uses locally available renewable resources, appropriate and affordable technologies and minimizes the use of external and purchased inputs, thereby increasing local independence and self sufficiency and insuring a source of stable income for peasant, family and small farmers and rural communities.*
>
> *Women are key agricultural producers as well as experts at all levels of the food, fuel and fibre economy, the long-term sustainability of which cannot be achieved without their active participation in setting and implementing policy, funding and research agendas."* [2]

ILLUSTRATIVE EXAMPLES OF INDICATORS

A principle that has become well established in the sustainable agriculture movement is that a particular technology or farming method cannot be judged as to its sustainability outside a site-specific, whole-farm systems perspective. It is equally true that indicators of sustainable agriculture are most appropriately examined from a holistic perspective as related to a specific geographic, political, and historical context. Different contexts call for radically different concepts and consequently different indicators for measuring progress or deterioration. Indicators that would be considered highly relevant in one decision-making context may be deemed irrelevant in another. Indicators are needed to reflect:

· Trends in the concentration of land holdings, by either domestic or foreign companies, especially multinationals. While traveling in Europe, I have become alarmed at the rate at which foreign investors are flooding into former Soviet republics, buying large holdings of land only recently "liberated" from state-owned collectives. Land transferred to peasants is often purchased at bargain prices by individuals and firms amassing huge amounts of land. Perhaps the seeds of the next Bolshevik Revolution have already been sown.

· The degree of monopoly control of marketing services, such as grain processing and storage, transport and processing of food products, banking, etc.

· Public policies (laws, regulations, enforcement) that are either conducive to or perverse to sustainable agriculture.

· Environmental impact and the short-term and long-term effects of environmental degradation on the productivity of farms, forests and fisheries, and on the health of humans. For example, China has achieved seemingly miraculous increases in agricultural production since the cultural revolution. But this increase in food supply has been attained at an awesome cost to the environment, water quality, and human health. (Cheng Xu et al., 1992 Thiers, 1994) One of the reasons why pesticide use has increased so rapidly and pesticide poisonings have become so prevalent in China is an institutional arrangement which strongly encourages use of pesticides. Starting in 1984, extension agents at the local level began receiving a significant share of their income from commission on the sale of pesticides. This arrangement, often a joint venture with foreign multinational corporations (Thiers, 1994), has been observed in many Third World nations.

In an attempt to counteract this "green revolution" approach in China, a small but growing movement called Chinese Ecological Agriculture (CEA) has been established. CEA is defined as an agricultural system which "utilizes ecological principles and methods of systems science to combine the effectiveness of modern science with traditional agricultural technology to establish an ecologically appropriate and functionally regenerative agricultural system. In accordance with national needs, Chinese Ecological Agriculture combines economic, social, and ecological benefits to achieve low input, high efficiency agricultural production." (Theirs, 1994, p.8)

Cheng (1992), who was one of the founders of Chinese Ecological Agriculture, defines it as embracing five basic components in various degrees, depending on the production situation:

(1) A holistic approach, typically involving a diversity of crops, livestock, aquaculture, and forestry;

(2) Multidimensional use of space and time through a system called "stereo" agriculture development wherein low growing annual field crops or root crops are grown beneath intermediate-sized trees or shrubs (such as

peaches and tea) which in turn grow beneath a canopy of taller trees such as rubber, pears, or species producing timber or firewood. Another type of stereo system involves paddy rice, with *azolla* (nitrogen-fixing aquatic plants) and fish growing in the paddy fields.

(3) An integrated recycling of resources for food, feed, and fuel energy. Organic wastes are recycled through biogas methane generating systems, and the organic residue is returned to the fields as fertilizer.

(4) Environmental management, emphasizing organic fertilizers, biological controls and reduced levels of inorganic fertilizers and (where necessary) pesticides; and

(5) Integration of agriculture with the local community through diversification of commodities produced, value-added enterprises for processing and marketing the products, and other off-farm employment opportunities.

Cheng reports both quantitative and qualitative indicators in his case studies of Chinese Ecological Agriculture. For example, in an 1887 field survey of 30 ecological and conventional farmers, he found that in contrast to conventional farming systems, the ecological farming systems have biogas digesters. They also have additional supplementary enterprises including livestock, higher ratios of organic to inorganic fertilization of crops; more intensive enterprize integration; more intensive use of labor, and emphasis on biological control of pests. Comparing these two groups of farms, Cheng found that crop yields on the ecological farms averaged about 7 percent higher than on conventional farms. He also found that the soil organic matter increased by about 16 percent (from 1.1 to 1.28 percent OM); and total soil nitrogen increased by about 25 percent (from 0.071 to 0.89 percent nitrogen). In contrast, on the conventional farms soil organic matter and nitrogen decreased slightly during the two years of the study. The CEA farms also out performed the conventional farms in economic terms, generating 14 percent more total crop output, 19 percent higher crop profits, and more than doubled the conventional gross value of output from all enterprises, particularly hogs. (Cheng, 1992, pages 1138-1139).

CONCLUDING OBSERVATIONS

The process of creating an indicator of sustainable agricultural development is a reflection of the underlying world view. In this context, specific goals and norms for attainment of a more sustainable agriculture are inherent in the world view. Every indicator is first conceptualized or created through a normative process that involves making value judgements (Aaron, 1994; Tinbergen and Huefing, 1988). And since there is no such thing as a value-free indicator, it is incumbent upon the author or advocate of an indicator to make explicit its underlying value judgements, so the reader's interpretation can be somehow adjusted for the effects of these value positions.

The most widely used indicators of "development" (whether sustainable or not) are the so-called "economic indicators." The most commonly mentioned economic indicator is the quarterly growth rate of the Gross National Product, which is called Gross Domestic Product in many countries. The conceptual and ethical deficiencies of GNP as an indicator of the well-being of people, especially the poor, are well known to many economists,[4] but the value assumptions embedded in these indicators and in widely used analytical techniques are largely unknown and are not acknowledged (Madden, 1986). Certain members of the economics profession continue to develop better indicators (Faeth, 1993). Aaron (1994) observes that "economists trying to confront complex social issues are not asking the right questions. We are not getting the right answers to the questions we do ask because of shortcomings in our analytical approach. And our tools of analysis, highly sophisticated in their own domain, divert us from asking the right questions." The solution he suggests is a major paradigm shift including abandonment of disciplinary chauvinism and professional isolation -- interdisciplinary work keyed to actual (not presumed) behavior in the real world.

Market prices are almost universally accepted indicators of value in exchange. Economists use prices as the multipliers of quantities of goods and services in calculating indicators such as Gross National Product. Paul Hawken, in his book, *The Ecology of Commerce*, observes that "markets are superb at setting prices, but incapable of recognizing costs...we are borrowing if not stealing from the future in order to finance present over consumption...customers and buyers are getting incomplete information, because markets do not convey the true cost of our purchases." (Hawken, 1991, p.75,81)

The reason for bringing up the subject of economic indicators in this closing comment is to sound a warning to those who embark into the uncharted waters of sustainable development in general and sustainable agricultural development in particular. We can and we must avoid repeating the errors made by those who have gone before us. Informed public policy demands it. Humanity deserves it. And continued life on planet Earth may depend on it.

ENDNOTES

1. Paper presented at the SANREM conference on Indicators of Sustainable Agricultural Development in Rosslyn, Virginia, August 1-5, 1994. The views expressed here are consistent with the philosophy of the World Sustainable Agriculture Association, which supports 40% of the author's salary. The views expressed here are those of the author, and may not be shared by the US Department of Agriculture and the SARE program, which provides the other 60% of the author's salary through his employment with the University of California.

2. In his recent E-mail posting to SANREM Table (July 13, 1994), Mark Ritchie proposed some 13 trade-related indicators. They reflect concerns about local food self-sufficiency, food security, ownership (read monopoly control) of genetic resources, etc. I have proposed some slight refinements and extensions beyond his list:

Debt Service (DS) is an indicator computed as the amount of funds flowing out of the country to service debt, in the form of interest and principal payments.

DS/volume of current new loans received is a red flag in many third world nations. Many impoverished nations bear an enormous debt repayment burden, in that they are required to pay creditors much more than they are receiving in new capital funds.

DS/Gross National (or Domestic) Product is another indicator of debt repayment burden on the economy. Upward trends in this indicator may be caused by a rising interest rate, or a stagnant to deteriorating economy.

DS/Population is an indicator reflecting the per capita debt service burden, a measure of the extent that the current generation has borrowed from future generations.

Additional indicators must be developed to monitor changes in the alarming trends toward monopoly control of input and service markets, notably land markets (both rental and purchase), seed and genetic resources, storage and processing facilities, etc.

3. The statement of the Women, Food and Agriculture Working Group continues:

In much of the world, sustainable agriculture emanates primarily from indigenous science and innovation, often developed by women. Rural women and farmers in particular contribute significantly to development of their local and national economies. However, the knowledge, skills and labor of women and indigenous peoples remain invisible, undervalued, largely unpaid and not reflected in economic statistics or the Gross National Product.

Global climate change, loss of biodiversity, misuse of biotechnology, deforestation, soil degradation, desertification, land air and water pollution are seriously degrading the natural resources necessary to sustain life and threatening food security. The increasing use of a wide range of chemicals to destroy pests and weeds in agricultural practice in both developed and developing countries has led to widespread concern about their confirmed and potential ill effects on human health as well as on soils, water, wildlife and entire ecosystems.

Acute poisoning from contaminated food, chemical accidents in industry, and occupational exposure in agriculture, is the primary cause of serious health effects associated with pesticides. Chronic effects include cancer, adverse reproductive outcome, and immunological effects. Women farmers and farm workers and their families are exposed to sprays, contact pesticides by walking barefoot in fields, working near spraying areas, and drinking contaminated water.

Women and children are more likely in many areas of the world to be malnourished. Dehydration and poor nutrition appear to lower the toxicity threshold to pesticides. A major effort is needed to reduce the number of cases of pesticide poisoning, currently estimated to total several million per year. However, the use of chemical pesticides is expected to double in the next ten years in developing countries, and it is likely that the number of cases of acute poisoning will increase accordingly. Unless the use of the most toxic pesticides is reduced, the risks of acute intoxication will increase. With the increased emphasis on cash crops and plantation-style farming in developing countries, the number of individuals in high-risk occupations may increase after the next decade despite a decrease in the proportion of the overall population directly involved in agricultural production. Women constitute a significant proportion of the world's farmers and farmworkers and are often the first to be exposed to the ill effects of pesticides and other agri-chemicals.

4. During a recent televised appearance before a committee of Congress, the Chairman of Federal Reserve, Allen Greenspan, observed that the list of deficiencies in the national economic indicators is depressingly long.

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Development of a Framework for the Derivation of Sustainability Indicators and Application of the Framework in the Río Reventado Watershed in Costa Rica

Sabine Müller*

INTRODUCTION

Economic goals attainable in short and medium terms have been a priority of the political strategies, programs and projects of agricultural and rural development in Latin America in the past. Profitability, at the level of the farm/enterprise, and the general economy, was the clue indicator for success.

The results of this approach showed, in the agricultural and forestry sectors, a production increase in some sub-sectors, especially in cash crops. In other areas, they showed an overuse; that is, degradation and, at times, destruction of natural resources. This situation led to a decrease in productivity in agriculture, deforestation and, finally, impoverishment of the rural population and migration to the urban areas.

In these countries, most of the decision makers are conscious of this vicious circle between poverty and the destruction of the environment, and "sustainable development" has been a declared goal. Many made this declaration even before the Environmental Summit in Rio de Janeiro. However, economic pressures (like the debt crisis), structural adjustment programs, as well as the power structures in the international markets limit the available space for national intervention.

On the other hand, financial cooperation (World Bank, BID, KfW) as well as, in many cases, technical cooperation, are still mainly based on economic indicators. Structural adjustment programs, for instance, were not analyzed regarding their environmental impacts and negative social effects are considered to be inevitable.

Nevertheless, "sustainability," or "sustainable development," is a declared goal in political declarations, in the elaboration of new laws, in the statutes of institutions, in agricultural research, as well as in financial and technical cooperation and they can be found in almost any project document.

But, there is less consensus regarding what is exactly understood as "sustainability" and on what scale sustainability can be measured. In literature, there are many definitions and concepts about "sustainability," but only very few indications of which criteria are available to evaluate if a situation is sustainable or not. Without criteria, or indicators, that facilitate a qualitative and a quantitative assessment of the performance of the system regarding this goal, it is difficult to formulate and achieve activities that will lead to it. The present research activity, described below, attempts to contribute to this task.

The research activity tries to elaborate a methodological framework which helps to identify and select indicators, in order to assess the sustainability of interventions in the agricultural sector of the Central Ameri-

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can tropics. These interventions may consist of policies, programs, projects or they might refer to interventions of the farmers themselves.

The first step has been the analysis of the different concepts of sustainability in order to elaborate a working definition which will lead to the identification of indicators. In the first chapter, the most important of the existing concepts will be discussed. In the second chapter, a methodological approach for the definition of indicators will be proposed. In the third chapter, a case study is presented where the methodological approach is applied in order to assess the sustainability of land-use in a Costa Rican watershed.

DEFINITIONS AND CONCEPTS OF "SUSTAINABILITY"

Under the name of "sustainable development," literature presents us a great variety of definitions and concepts. Several authors, however, criticize that "sustainable development" has become a fashionable statement which can be used by a large number of movements with widely disparate reform agendas (Ruttan, 1992; Lélé, 1991; Goodland and Redcliff, 1991). There is no consensus with regard to what "sustainable development" means and the many interpretations reveal the different disciplines, paradigms and idealogies that are their basis. Lélé (1991), therefore, demands that the goals and implications of "sustainability" have to be more rigorous, systematic and consistent.

The Oxford English Dictionary defines **sustainable** as *"capable of being upheld: maintainable"* and **to sustain** as *"to keep a person, community, etc. from falling or giving way; to keep in being, to maintain at a proper level; to support life in; to support life, nature, etc. with needs."*

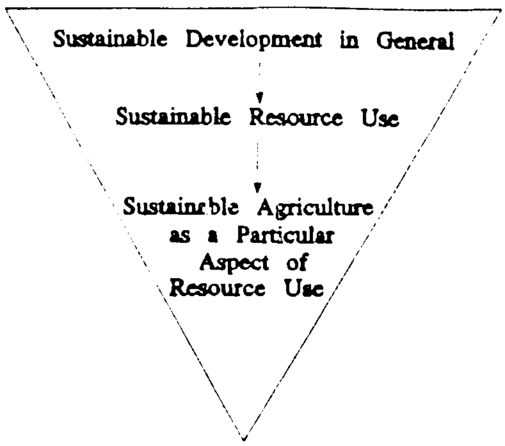
The concept of "sustainability," therefore, has no meaning by itself as it doesn't explain what must be sustained. Nevertheless, "sustainability," many times, is considered to be a synonym for "sustainable development." Using this logic, what must be sustained depends on the meaning of "development." Furthermore, "sustainability" is used at different aggregation levels. It may be used regarding global tendencies of development and when analyzing the effects of agricultural practices in a home garden. The definitions and concepts presented in literature can be classified according to the following criteria:

A hierarchical level: relative to the scope of the definition (world, nation, sector, farm, etc.).

An underlying concept, i.e., the meaning of "sustainable development" varies according to what is understood for "development." Lélé points out that *"...development is a process of directed change and definitions of development thus embody both (a) the objectives of this process and (b) the means of achieving these objectives."* (Lélé, Sh., 1991; p.608).

Regarding the hierarchical classification, three levels have been identified which are directly related to the topic of the present investigation:

The goals and possibilities for sustainable agriculture depend on the development model of a country, which provides the framework wherein the sector may be developed. On the other hand, the production potential, as well as the efficiency of agriculture have an impact on overall eco-



nomic development. Especially in developing countries, where the agricultural sector is of great importance.

According to the underlying development concept, definitions may be classified in three groups:

(1) A significant group of authors equate sustainable growth with sustainable development. Economic and environmental issues have to be considered in order to assure that the overall economic goals and economic growth can be sustained. Since substitubility is assumed between man-made and natural capital (at least for a large part of the natural resources) and since there is strong belief in technical progress that will make up for resource loss, no severe constraints for continuing economic growth are seen. They emphasize, however, the need for adequate resource valuation in order to achieve an efficient allocation of the natural resources. Adjustment of prices, considering environmental costs and environmental accounting require the ability to express most of the environmental functions and properties in economic terms and a complete methodology has been developed for this purpose. The concepts of most resource and environmental economists can be classified within this group, i.e., Solow (1992), Siebert (1992), Dasgupta and Mäler (1991) and Bartelmus (1991).

(2) A second group of authors stresses the importance of the satisfaction of the needs of the present as well as the future population. Economic growth is considered to be an important factor in order to achieve this goal. Economic growth, however, has to respect the limits given by the environment. Some authors view these limits as the conservation of a certain stock and, in some cases, the conservation of the actual stock of natural resources. Some authors point out that not every single resource has to be protected, but a certain (or the actual) production potential has to be sustained. Most of the definitions analyzed in this paper could be classified in this group, for instance, the definitions of the Brundtland Commission, the Food and Agricultural Organization (FAO, 1991) and the International Union for Conservation of Nature IUCN (1990).

(3) A third group of authors ask for fundamental changes in the prevailing development paradigm. Since these authors are questioning the possibility of unlimited future economic growth, they are pointing out the importance of the distributive aspect (equity) with regard to sustainability. Due to the already extremely advanced destruction of resources and because of the insecurity and risk regarding their life supporting functions, any additional degradation and destruction of the natural resources should be avoided. In this group appear authors such as Goodman and Redcliff (1991), Pearce, Barbier and Markandhya (1991), Costanza et al., (1991) and the group which emphasizes "thermodynamics" (Boulding, 1966; Georgescu-Roegen, 1975; Daly, 1977 and 1989; Victor, 1972 and Perrings, 1987, quoted after Victor, 1991). The latter apply

the laws of thermodynamics[1] to economics, specifically referring to the second law of thermodynamics. From the above, they conclude that growth based on depletion of natural resources leads to absolute scarcity; that is, that from a certain level onward, natural capital cannot be substituted by man-made capital anymore, nor can it be increased. Under these premises, sustainability means a development producing the most efficient utilization of these scarce resources and contrasting with the economic expansion of the last 400 years based upon a growing utilization of resources.

Definitions regarding a sustainable agriculture reveal the different concepts of sustainable development. Nevertheless, the maintenance of the agricultural production potential is a generally recognized condition for sustainable agriculture. The meaning of this production potential, however, is seen in different ways especially regarding the importance of species conservation and the importance of the natural flora and fauna in the production process.

The following conclusions may be drawn from the discussion:

(1) Sustainable development aims for the satisfaction of needs of the present and of future generations. Therefore, equity aspects within and between generations have to be addressed and economic development and economic growth are the means, but not the goal, of sustainable development.

(2) Availability of natural resources is a limiting factor for sustainable development. Therefore, the efficient utilization of the scarce factor "natural resources" is a crucial condition for achieving sustainable development.

Thus, sustainability involves three aspects:

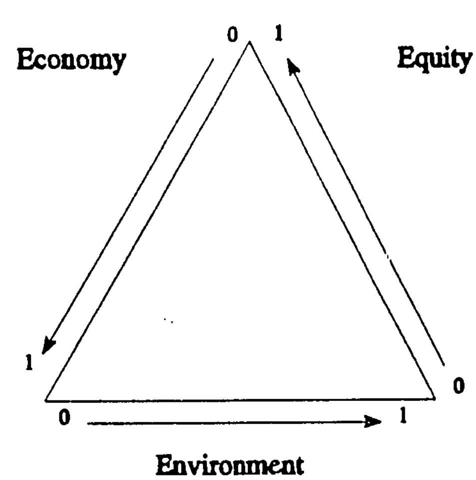
(1) **Ecological sustainability** - the ecosystem maintains its main characteristics which are essential for its survival in the long run;

(2) **Economic sustainability** - the sustainable management of natural resources provides an income sufficient to make its continuation attractive;

(3) **Social sustainability** - the benefits and costs are fairly distributed among the different groups and the social and cultural values of the people affected are respected.

In the short-run, these three dimensions can be considered as conflicting goals, to a certain degree, while in the long run, the interdependencies between the three of them will be realized and the relationship will become more or less complementary. However, it will not be possible to achieve sustainability by maximizing the three goals at the same time, but to reach sustainable development, a balance will have to be found between the three objectives, as shown in Figure 1.

Figure 1: Möbius triangle for three conflicting objectives (Nijkamp, 1990; p. 13).



Using this figure as a reference, if one objective is maximized, then the other two become constraints. A constraint has to be quantified in some way. That is, a certain quantity of the elements that form the constraint has to be defined as the maximum or minimum tolerable level.

One may inquire, however, how these maximum or minimum levels can be identified. What is meant by "fair income distribution," "essential characteristics of the ecosystem" and "sufficient income?" Development goals are defined by the social group in charge of determining them: the society of a country regarding the goals of the society, a community regarding community goals and a singular farmer regarding his own development goals. Goals at a lower hierarchical level, for instance, the farmer's goals have to be adjusted in order to not be in conflict with the community or societal goals. However, frequently these goals have not been defined quantitatively or are not public knowledge. What can be done is to assess the levels to which the different goals have been reached or will be reached and then analyze trade-offs between them. It has to be understood that indicators will not replace the decision, but only contribute to the fact that those decisions are taken with full knowledge of their implications.

As mentioned above, sustainability goals can be defined at different hierarchical levels and, therefore, indicators can be selected at different levels. Toews (1993), Conway (1988) and others propose agroecosystems as a suitable research unit, which Toews defines as follows:

"Agroecosystems are regionally defined entities managed for the purpose of producing food, fibre and other agricultural products comprising domesticated plants and animals, biotic and abiotic elements of the underlying soils, drainage networks and adjacent areas that support natural vegetation and wildlife. Agroecosystems explicitly include people, both as producers and consumers, among the essential elements and, hence, have socio-economic and public health, as well as environmental dimensions" (ibid., p. 3). Thus, the world can be understood as a huge agroecosystem and agroecosystems can be delineated at the regional, national and local levels, as well as at the farm, field or paddock level.

Conway (1988) has argued that ...*the primary goal of an agroecosystem is increased "social value," that is, "the amount of goods and services produced by an agroecosystem, the degree to which they satisfy human needs and their allocation among the human population* (ibid). According to his work, Gutiérrez et al. (1993) propose four properties which describe the sustainability of systems:

(1) **Productivity** - productivity may be defined as *the output of product per unit of resource input."*

(2) **Resilience** - the ability to maintain productivity, whether of a field, a farm or a nation, facing stress or shock. The stress may be growing salinity, erosion or debt that is a frequent, sometimes continuous and relatively small predictable force having a large cumulative effect. A major event such as a new pest, a rare drought or a sudden massive increase in input prices would constitute a shock.

(3) **Stability** - constancy of productivity from month-to-month and from year-to-year, in the face of the normal fluctuations and cycles in the surrounding environment due to such variations as the weather or the

market demand for agricultural products. In contrast to productivity, which refers to a level, stability refers to the variability of the trend.

(4) **Equity** - refers to the manner in which the benefits from the systems production are shared; it may be defined as the even distribution of the productivity of the system among the human beneficiaries (Conway, 1988, p. 653; Gutiérrez et al., 1993, p. 5).

METHODOLOGICAL FRAMEWORK FOR THE DEFINITION OF INDICATORS

As had been mentioned before, the concept of sustainability contains three goals which, in the short term, may compete with each other. Therefore, the ecological, economic and social aspects have to be considered simultaneously. Furthermore, indicators have to be defined according to the specific system or the specific situation to be analyzed. In order to compare different systems, the corresponding indicators should be determined in a local and repeatable process where the basic concept of sustainability and the criteria used for the selection of the indicators are explained. It has to be assured that the choice of the indicators does not occur arbitrarily or purely subjectively and that all the aspects of a system, which are of any significance for its sustainability, are considered.

Next, a proposal for a methodological framework will be presented based on the methodological works of several authors (Avila, 1988; Torquebieau, 1988; Conway, 1988; Weber, 1990; Ferreira, 1991; Bartelmus, 1991; Gutiérrez et al., 1993 and Toews, 1993).

The first step for the determination of indicators should be a clear analysis of the objective of the research and the questions it implies. Are we dealing with a diagnosis in order to elaborate *ex-ante* recommendations for projects, programs or policies? Or, should a monitoring system be elaborated? Do we want to make projections of the sustainability of a given system for the future? Or, is it intended to be *ex-post* analysis to investigate the impacts of a certain intervention?

In order to investigate *ex-post* the sustainability of policies, programs and projects, time series of data are needed. In this case, an important criterion for the selection of indicators is the availability of the corresponding time series.

If the discussion is about an *ex-ante* analysis, the availability of data is also important because a trend has to be forecasted. The forecast has to be based on experiences and proven knowledge about the relationships between different factors that certainly do not always have to be retrieved from the same region. Experiences from outside the research area may be used if they have been obtained in a similar type of system or under similar conditions.

The indicator set for the *ex-ante* analysis does not necessarily have to be identical to the set of indicators used for the monitoring. In the first case, the available information is a limiting factor, whereas additional information can be generated by monitoring. Thus, the set of indicators can be improved step-by-step. However, in order to permit the verification of the assumptions made in the *ex-ante* analysis, the *ex-ante* indicators have to be defined logically in relation to the indicators chosen for monitoring. Table 1 provides three examples showing that the aggregation level, the problems to be analyzed and the kind of intervention determine the type of information to be obtained for indicators.

Considering the objective of the research and the specific problem to be analyzed, the scope of the research can be delineated and the potential users of the information can be determined. The presentation, as well as the degree of detail of the information, should be selected according to the information needs of the potential users, i.e., scientists, consultants, politicians or farmers.

Indicators can be selected for causes of non-sustainability, for factors of pressure on sustainability or for the impacts of these causes and pressure factors. Depending on the problem to be analyzed, sustainability may be determined by the *quality and quantity of resources* of the system and/or by parameters given for the *performance* of the system. The state of the resources always has to be analyzed in the context of the respective system.

According to Conway (1983) and Gutiérrez et al., (1993), the four characteristics of sustainable systems are productivity, stability, resilience and equity. Furthermore, the concept of sustainability possesses three dimensions (the ecological, economic and social). As shown in Figure 2, these criteria could be arranged in the form of a cube so that indicators can be selected according to the characteristics of different square.

Some of the squares may contain the same indicators. For instance, indicators for equity may be repeated in the social dimension. On the other hand, some of the squares may remain empty when no appropriate indicators can be found. The usefulness of the framework consists of helping to include all important aspects in the analysis and to order the process of the selection of indicators.

Agroecosystems at different levels influence each other by contact. The agricultural farm and household system, with its plant and animal production, disturbs its surrounding natural ecosystems. Its self-regulatory mechanism will be partly replaced through human interventions such as the application of fertilizer and products for plant protection. This leads to a weakening of the defense system, toward stress from outside the system (Conway, 1988). The effects that are the result of the agricultural activity, for example, soil and water contamination by pesticides, are relevant to the farm itself and to the local and regional systems surrounding it. As a logical consequence, indicators do not only have to be determined for the level of the system to be investigated, but also for the surrounding systems that are being influenced.

Therefore, the squares can be filled in by using the following four categories:

- The resource base of the system to be investigated.

- The performance of the system to be investigated.

- The resource base of other systems affected by the system under investigation.

- The performance of other systems affected by the system under investigation.

Regarding sustainability, a research category is a significant aspect of a system.

Table 1: Impact of aggregation level, intervention and problem to be analyzed on the type of information to be obtained.

Example 1:

Hierarchical level:	Watershed
Intervention:	Introduction of a gravity irrigation system for small farmers.
Questions to be asked:	What are the expected ecological, economic and social impacts of the irrigation system at the regional level? From experience, name a number of critical factors Ecological factors: Hydrological erosion Soil and water pollution by intensive use of pesticides and fertilizers Inefficient use of water Social factors: Farmers' organization regarding management and maintenance of the system Change of traditional land-use systems Economic factors: Marketing opportunities for the additional production

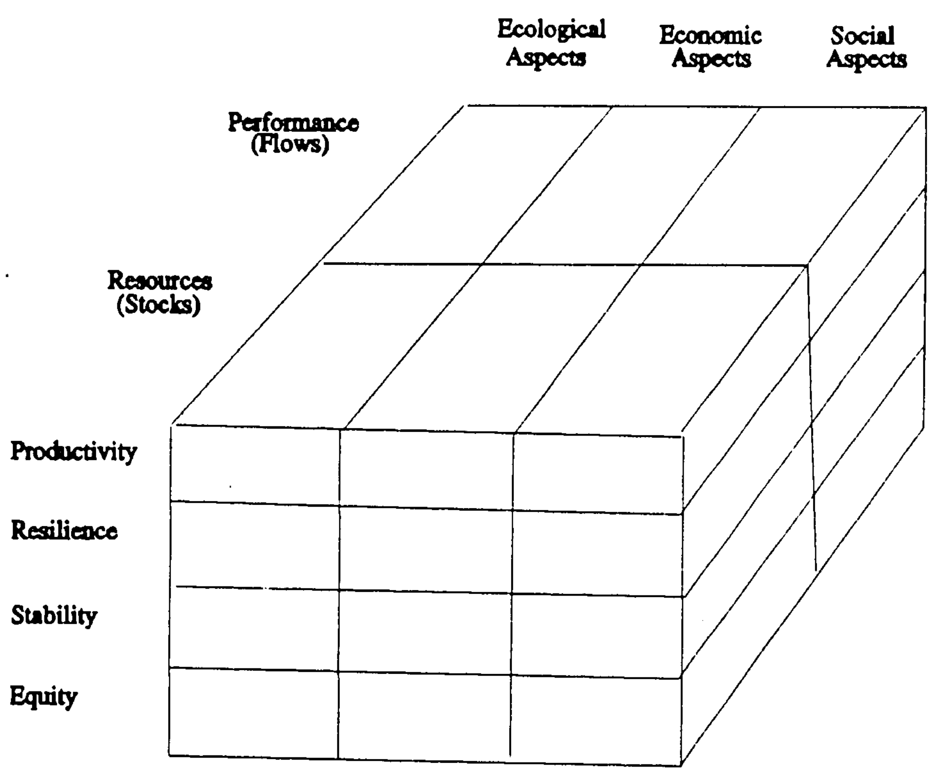
Example 2:

Hierarchical level:	Watershed
Intervention:	Change in land use during the last 20 years from extensive cattle management to intensive production of vegetables.
Questions to be asked:	Ex-post analysis of the ecological, economic and social impacts of the change in land-use with the following critical factors. Ecological factors: Erosion Soil Water contamination Biodiversity Social factors: Changes in the farm size, labor force, farmer's social differentiation between classes ("modern" and "traditional") Dependence on external inputs Health problems created by excessive or imprudent use of pesticides Economic factors: Change in the family income Dependence on external markets

Table 1: Impact of aggregation level, intervention and problem to be analyzed on the type of information to be obtained. (Continued)

Example 3:	
Hierarchical level:	Farm
Intervention:	Introduction of soil conservation measures at the farm level (small farmers).
Questions to be asked:	Expected ecological, economic and social effects caused by the conservation practice at the farm level with the following critical factors. Social factors: The acceptance of conservation practices by the farmers The awareness of erosion as a problem Economic factors: Costs and labor inputs necessary for the conservation practices Ecological factors: Effectiveness in soil protection Ecological impacts that have not been foreseen

Figure 2: Selection of indicators based on characteristics of sustainable systems and dimensions of sustainability.



Each category consists of a number of elements which have to be defined. In the case of the category "resources," for instance, the following elements can be named.

Water
Soil
Flora
Fauna
Air
Human capital and cultural goods
Unique landscapes

An element is a significant part of a research category.

According to Avila (1989), regarding the elements of the performance of the system, the following can be distinguished:

- Management/behavior of the system (i.e., inputs, energy, land use and others.)

- Yield/products of the system (i.e., production, waste and residues, etc.)

Normally, indicators which measure impacts concentrate on the yields and products of the system. Whereas, indicators which analyze causes and factors of pressure will analyze the management of the system and its behavior.

Descriptors and indicators will be determined for each element.

Descriptors are significant characteristics of an element related to the main qualities of the sustainability of a certain system: productivity, stability, resilience and equity.

Thus, a descriptor for the quality "equity" of the element "soil" could be the distribution of land, whereas, its "stability" could be described by the spectrum of species of micro-organisms. Regarding the social dimension, the distribution of income could be a descriptor for the element "yield," the "resilience" of the element "management" could be described by the degree of the diversification of production.

Indicators measure the change of the descriptor. If the system is sustainable, this change is small or positive.

In the case of land or income distribution, for instance, the Gini-coefficient could be defined as an indicator. Each indicator should be represented in a form that provides an answer to the following questions (Torquebieau, 1989):

- How should the significance of the indicator be interpreted?

- What has to be measured with regard to indicators? When? Where?

- What are the necessary inputs for the determination of the indicator?

- What are the indications about the limits of the explanatory power of the indicator?

- What are appropriate instructions for the interpretations of results, taking into account the above mentioned limitations of the indicator and considering other indicators which may be related to the respective indicator?

This can be complemented by:

- A classification regarding the intensity of the positive or negative effect.

- A definition of the extreme values of the indicators.

Figures 3 and 4 show a graphical presentation of the procedure. Table 2 presents an example of how indicators can be derived.

As was stressed before, individual indicators should be analyzed in relation to other indicators. In order to avoid misinterpretations, it should be specified exactly which indicators make a significant explanatory contribution and which indicators must only be used in conjunction with others. If, for instance, the development of soil productivity for the region will be measured using the average yield/hectare, a sufficiently long-term series of data will have to be observed in order to determine the variation of yields caused by annual climate fluctuations. Similarly, changes in input and land use and the respective impacts on yield, have to be taken into account. The average yield/hectare indicator could lead to misinterpretations regarding sustainability if these aspects are not included.

Indicators, therefore, have to pass through a selection process where they are confronted with a series of selection criteria. Thus, their number will diminish significantly:

- Indicators should be relatively easy to measure and their definition should be cost-efficient;
- Indicators should correspond to the aggregation level of the system under consideration;
- Indicators should be elaborated in such a way that they also allow the participation of the local population with regard to their definition;
- It must be possible to repeat the measurements over certain periods of time;
- Indicators should give a significant explanation of the sustainability of the observed system;
- Indicators should fit the specific problem to be analyzed and the needs of the users of the information;
- Indicators should be sensitive to changes in the system;
- Indicators have to be placed in relation to each other;
- Indicators should give basic information in order to allow for the assessment of trade-offs between the different dimensions of sustainability.

The last points are decisive for the interpretation of the results.

The question, however, is given that indicators are different according to the respective system and given that they cannot easily be aggregated without making value judgements, how can different systems be compared and how can the performance of a system be evaluated? Indicators have to be compared with reference values which permit the determination of the degree to which sustainability has been reached. According to Adrianse (1993) and OECD (1993), several alternatives to define reference values exist:

The Use of Historical Values which are supposed to represent a sustainable situation. The Dutch Government, for instance, is using the year 1930 as a reference value for water quality of the North Sea.

Figure 3: Plan for the Definition of a System of Indicators.

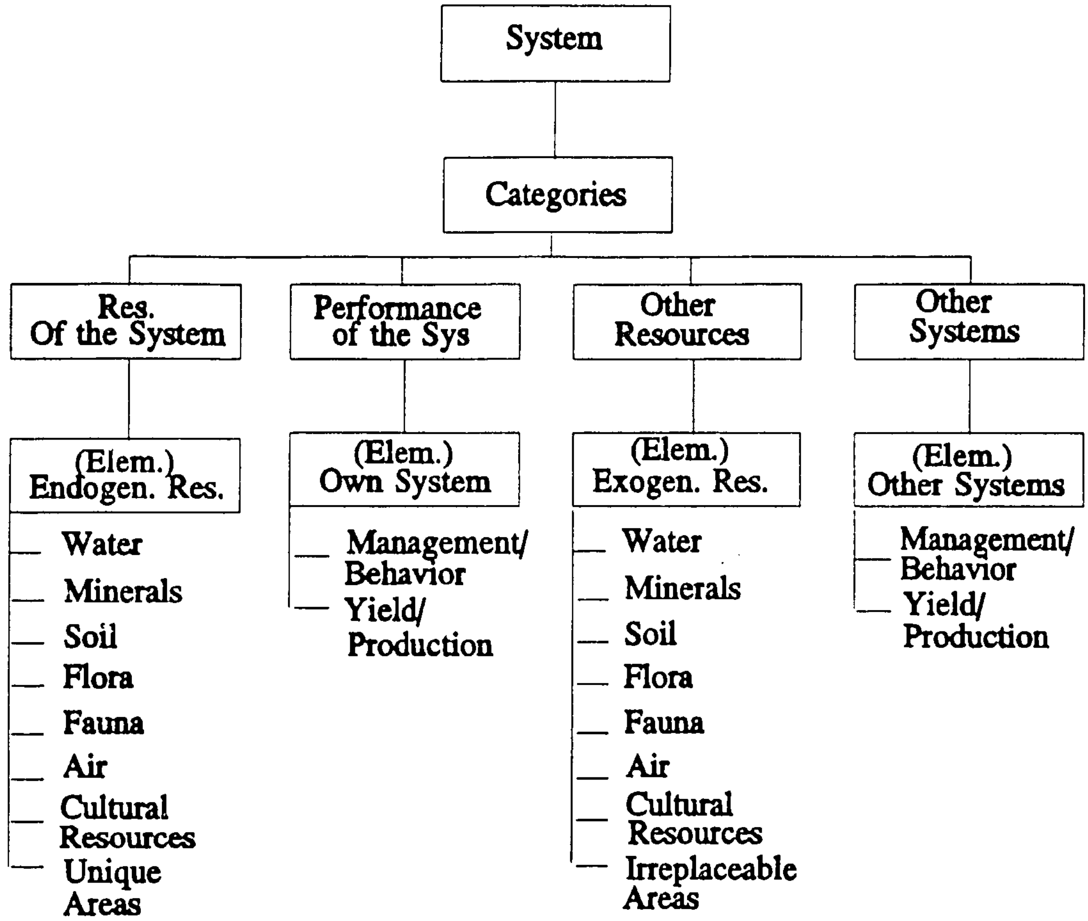
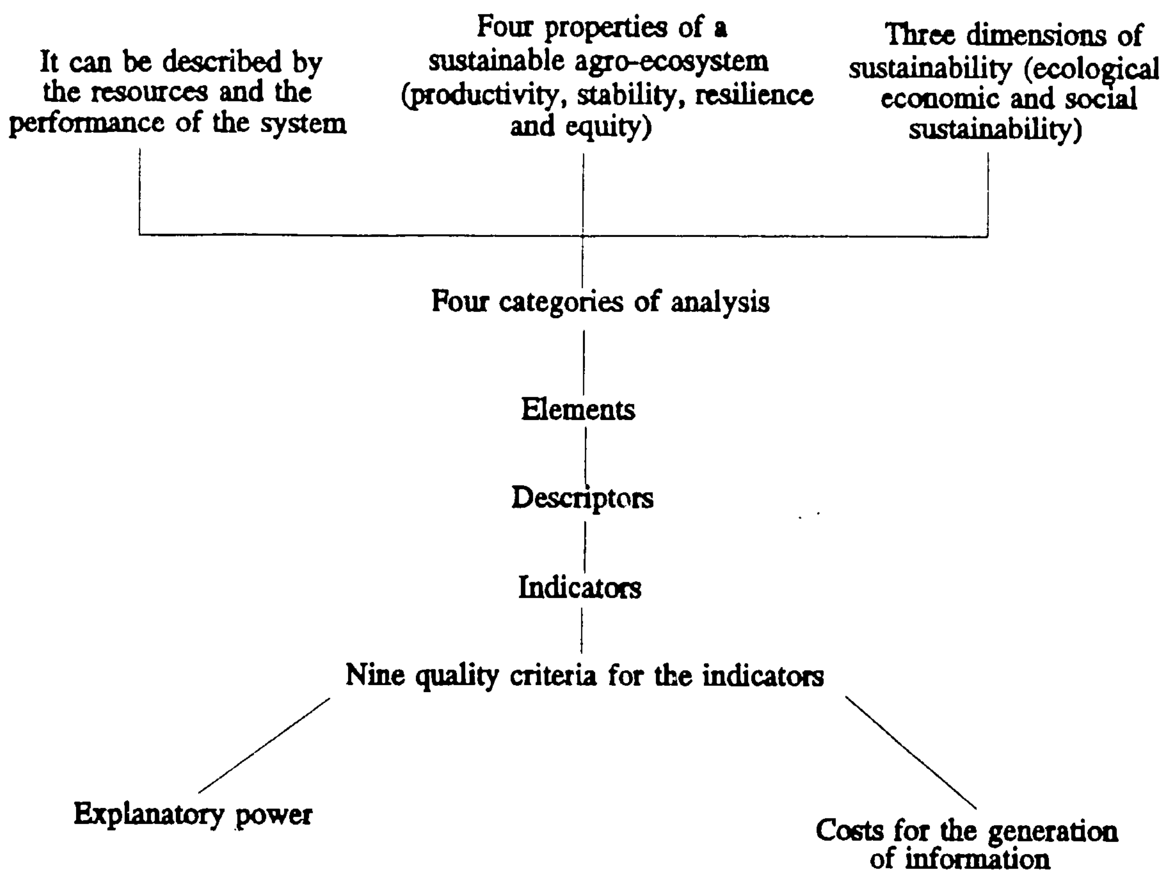


Table 2: A hierarchical procedure for deriving indicators.

System:	Watershed of river x
Category:	Resources of the system
Element:	Water
Dimension:	Ecological
Property:	Productivity
Descriptor:	Quality of water
Indicator:	Residues of pesticides which have been measured in the main outflow of the watershed (mg/l)
System:	Farming system x
Category:	Performance of the system
Dimension:	Economic
Element:	Management
Property	Resilience
Descriptor:	Degree of diversification of production
Indicator:	% of contribution of the main crop to the family income

Figure 4: Interactions Among Sustainability Properties, Dimensions and Components at the Agroecosystem Research Unit Level.



Target Values such as certain water quality standards set by the government. Target values and, to a certain degree, historical values are subjective values and some kind of consensus in the affected society is necessary for their implementation.

Threshold Values or critical values of indicators. An amount higher than the critical value of an indicator may be expected to have significant negative impacts. Threshold values are supposed to be defined scientifically and to be, therefore, less subjective.

Tendencies in the development of the value of an indicator such as tendencies in soil loss, tendencies in income levels and distribution, etc.

Average Values of similar systems as when comparing Costa Rica with the average values of Central America.

The last two reference values do not permit any evaluation concerning whether or not a system is sustainable, but they give a rough idea of its relative position regarding the past development and similar systems.

Different systems may be compared by weighing the respective indicators compared to their distance to the correspondent reference values. A system where most of the indicators are close to achieving the level of the reference value (i.e., a target value) may be considered more sustainable than systems where the values of the indicators are distant. In the case of threshold values, where we normally assume that they should not be surpassed, a system may be assessed as more sustainable when the values of its indicators are relatively far beyond or below the threshold values (if there are minimum or maximum thresholds, respectively).

In order to be able to assess a certain degree of sustainability, or at least to rank different alternatives according to their sustainability, several authors have tried to form a "sustainability index." Socio-economic and ecological indicators, however, cannot just be aggregated without difficulty because a common denominator is necessary. Thus, it is proposed that economic evaluation of non-economic indicators should provide this denominator. Even considering the significant number of concepts and methods for the economic evaluation of the ecological impacts, the aggregation cannot always be obtained through an economic evaluation of indicators.

If it is assumed, in the short run, that the three dimensions of sustainability may partly represent a competitive relationship, trade-offs are between the economic, ecological and social aspects and the respective indicators can be expected. As mentioned before, sustainable development represents a multi-objective goal function; one possible approach to achieve this goal function is to maximize one of the goals under the condition of respecting maximum or minimum standards of the remaining goals. For certain indicators, which are already in use, well-founded thresholds can be a helpful measure. Ecological standards, such as the extreme values for the tolerable resource degradation, could partly be deduced from the natural sciences. Social and economic thresholds do not exist. For instance, there is not an equity threshold beyond which social unrest may occur. Minimum wages which reflect the satisfaction of basic needs may be considered as threshold values which, if surpassed, may cause health problems, but they normally fall in the category of target values since the concept of basic needs varies from country-to-country and, very often, reflects value judgement.

Therefore, it may be useful to try to estimate the costs implied by the respect of these thresholds or target values. As a rule for decision making, an adjusted form of the "safe-minimum-standard rule" (see Bishop, 1978) can be used: the standard is being maintained if the social costs caused are not unacceptably high.

CASE STUDIES

The case studies are the central part of the research. We will not find out what kind of indicators fit situations typical for Central America and which indicators can be determined and assessed with a reasonable effort if we do not define indicators in real cases. The question whether there are trade-offs among different indicators and how they can be assessed, can be answered only after the determination of a set of indicators for a specific case. Answers have to be found for several questions including:

- Is the proposed procedure feasible with a reasonable effort?
- Is it useful? That is, does it lead to indicators that provide information about sustainability and are helpful in the decision making process?
- What are the costs for the generation of information?
- Where are the weak points of the concept?

Any process of gathering and analyzing information implies costs and it has to be carefully evaluated as to whether the additional acquisition of information justifies the costs.

Considering the fact that the current research requires a multi-disciplinary approach, the case studies are carried out in collaboration with IICA (Interamerican Institute for Cooperation on Agriculture) and the Tropical Agricultural Research and Training Center (CATIE) specifically with the departments of "Watershed Management" and "Production Systems of the Tropics."

The methodological approach of the case studies follows the scheme presented in Section II. The first case study tries to assess the sustainability of land use in the Río Reventado Watershed in Costa Rica. Indicators will be defined at the farm and at the regional (watershed) level.

The participating institutions selected the research site according to criteria including the "importance of its agricultural production potential," the fact that "there are, at least, two different farming systems," and the "available information, logistics and infrastructure as well as relevance of suspected environmental problems."

Methodological Procedure and Preliminary Results

(1) In order to orient the definition of the indicators according to the objective of the analysis, the first step consisted of a short diagnosis of the situation which should give a rough idea of the socio-economic and environmental situation of the region. This involved the collection of secondary data regarding natural resources, soil, climate, vegetation, farming and production systems, crops, prices, markets, the social organization, institutions and their activities, infrastructure and extra-agricultural activities.

(2) The original idea was to use this information to prepare a "Rapid Rural Appraisal,"[2] in order to compare secondary data with reality.

For practical reasons, no "perfect" RRA was conducted, but a multidisciplinary team visited the region on several occasions, talked to some of the farmers and obtained a general understanding of the area and its problems. Afterwards, a pre-survey, with individual interviews, was carried out with 75 farmers in order to broaden the knowledge about the predominant farming systems, the problems the farmers are facing and their opinions and needs. Additionally, meetings were held with the cooperatives and projects working in the region and with the respective persons of the Ministry of Agriculture.

Farmers have also been questioned regarding their disposition to participate in research regarding land use and sustainability. Most of them were very open, but emphasized that they wished to be integrated in the work and informed about the results. They also wanted to be sure that the cooperatives and, in some cases, the Ministry of Agriculture were also informed. There was a general complaint about lack of technical assistance and they were very well aware that some of their techniques, especially fertilizer and pesticide application, could be improved.

The Río Reventado Watershed is located in Cartago, Costa Rica and has an area of 2,152 ha, which consist of volcanic soils, sharply sloping banks and unstable slopes. The principal river bed is 12 km long and is a typical mountain river, one or two meters wide and 15 cm deep during the dry season.

The spring of the river is located 2 km southeast of the principal crater of the Irazú Volcano at an altitude of 3,432 m. Annual precipitation is about 1,700 mm with a dry season from December to April. Average temperature is 13 degrees C and it varies according to altitude and season. The Río Reventado is one of the affluents of the Río Reventazó River where a hydroelectric power plant is located.

Most of the upper part of the watershed is covered with secondary forest and a few spots with primary forests belonging to the "Prusia" National Park. Areas outside the park are used for extensive cattle ranching. The middle and lower parts of the watershed are mostly cultivated with annual crops, even on steep slopes. There are still some cattle farmers who are temporarily using some areas as paddocks in order to recover productivity of exhausted soils.

The majority of the farmers own their land and they cultivate an average of 3 ha (however, variations range from 0.25 ha to 50 ha) with horticultural crops (potato, onions, carrots, cabbage, beans, etc.). Land use is very intensive with two or sometimes three harvests in one year. A significant percentage of the farmers use irrigation during the dry season. Fertilizer and pesticide use are relatively high and most of the farmers are partly mechanized (they rent a tractor for ploughing). Very few farmers apply soil conservation measures.

In the three districts of the watershed, the population has been estimated at 8,900. Infrastructure permits access to markets and the whole region has access to electricity and potable water.

Natural vegetation was removed a long time ago and water and soil seem to be the most affected resources by the actual land use. Decrease in soil productivity and significant damage caused by pests have been reported by the farmers.

(3) The information gathered has been used to formulate some hypothesis with regard to the suspected problem or the positive contributions to sustainability:

- The quality of soil and water resources are affected by actual land use;

- Soil productivity has decreased in areas with high soil degradation;

- Intensive land use with few rotations and high pesticide use have affected system's resilience and stability which manifests itself in high pest and disease pressure and resistances;

- High pesticide use leads, in some cases, to residues in crops and health problems for workers applying the chemicals;

- At the regional level, inadequate land use leads to a considerable sediment load which is being transported to the Rio Reventazón and contributes to the sedimentation problems of the Cachí Dam.

(4) For practical reasons it was decided to start with the analysis at the farm level and a preliminary set of indicators has been defined according to the results of the pre-survey and the analysis of secondary data (the indicators are presented in more detail in Appendix 1). A questionnaire has been prepared which is being filled out in a multi-visit survey. Multi-visit surveys are good contacts with the farmer and have the advantages of usually involving short visits which do not require too much time during working hours and do not overload the farmer's (and the interviewer's) concentration capacity. Additionally, a multi-visit survey

permits a better assessment of land management practices and pesticide and fertilizer applications. The intensive survey will only cover the middle part of the watershed where most of the intensive production takes place due to limited resources and the fact that soils at the lower and the upper part are quite different. The lower and the upper part will be considered in the regional analysis.

Several stratification criteria have been tested which are supposed to have an impact on soil degradation and productivity:

Farm size
Time horizons of growing vegetables (period since they shifted from cattle ranching to horticulture)
Slope
Mechanization
Access to irrigation
Use of soil conservation measures

Since there are no time series for some indicators, for instance soil quality, the original idea was to generate these by a cross-section analysis. During the last forty years, an expansion of the vegetable production to the detriment of cattle production has occurred within area covered by this research study. This expansion results in there being farms that are growing vegetables with different time horizons. Therefore, well-selected soil tests could provide an indication regarding the medium- or long-term changes in the soil conditions as a consequence of the change in land use. In addition, there is a small proportion of farms which are using soil-protection measures and the comparisons of these with the farms that are not protecting their soils could provide interesting information.

Unfortunately, the information regarding time horizon of horticultural production has not been very reliable due to changes in land tenure. Very few farmers were found to be applying conservation measures and of those that are, technical preparation is not at a very high level. As a result, management practices do not vary significantly in order to be able to group farmers.

It has been observed, however, that degradation symptoms strongly vary according to the slope. Therefore, soil and productivity analysis will be carried out in samples which have been delimited according to the different types of slopes predominant in the region (0-10%, 11-30 and more than 30). Different slopes can be found in the same farm or in the same field. Therefore, yield measurements cannot be carried out per field. Instead, yields have to be estimated per area having a given slope. Considering the variance of yields and the number of factors which may have an influence, the sample size should not be less than 100. The number of farms, however, could be less.

The depth of topsoil, apparent density and percentage of organic mass have been selected as indicators for the soil quality in order to detect changes caused by the actual land-use practices.

The success of the research depends on the goodwill and the participation of the farmers. Farmers particularly are interested in fertility analysis in order to be able to adjust the fertilizer application. Therefore, fertility analysis has been included even when no significant results are expected regarding the degradation caused by intensive land use. It must be recognized that the chemical analysis of soils may produce higher values in extensive use areas that in the reference sample due to the high fertilizer application. Since fertilizers are applied several times per year, there is almost no time when its influence can be eliminated and the accumulative effect also has to be considered.

Additionally, fertilizer information may be used to calculate potential fertilizer leaching where a relatively simple approach like the "nitrogen balance" concept can be used (Jarosch, 1990).

Reference samples are collected in the few areas which are not cultivated or which have been under pasture for a long time. Reference samples have to reflect the different slopes which are analyzed.

(5) Based on the information collected, farming systems will be modeled including their requirements of fixed and variable production factors, farm budgets and family incomes. Additionally, as far as possible, ecological impacts will be quantified and economically evaluated. The objective of this analysis is the assessment of the actual situation from the point of view of sustainability and the projection of future developments given the actual management of natural resources. It is not intended, however, to identify alternatives and to look for an optimum solution. Therefore, optimization models, such as the linear programmation, do not necessarily have to be used. However, they may provide some valuable information about the shadow prices of environmental and socio-economic restrictions, in other words, the costs of respecting these restrictions or standards and the trade-offs between socio-economic and ecological indicators.

Additionally, the farmers expect some recommendations regarding land management and how to deal with the problems they are reporting. Therefore, the information will be evaluated in this sense and, together with the Ministry of Agriculture, recommendations will be elaborated. The results will be presented at a meeting with the members of the cooperative. In addition, farmers' interests in the survey process are enhanced by asking them about diseases they do not know how to combat or other agronomic problems during the multi-visit surveys. The interviewer then takes a sample that will be analyzed in a laboratory, even if it is not part of our indicator set. On the next visit, the farmer will receive the result.

(6) At the regional level, the farming systems in the upper and lower parts of the watershed will also be investigated, but in less detail. The water analysis is part of the regional analysis. Ten sample points have been selected which cover the course of the Río Reventado and some of its affluents. Samples are taken every 15 days in order to assure a representative sample which is not altered by precipitation and other factors. Water analysis will concentrate on effects which may be being produced by high fertilizer and pesticide use.

Ecological-biophysical data and economic and social data will be processed by using a geographic information system. IDRISI has been selected because it is widely used and it needs less time (than other systems) for one to become familiar with it, such as ARCINFO. The first step of the analysis will be the assessment of <u>potential land use</u> (a maximum intensity of land use, taking into account the ecological limits). The <u>potential land use</u> will be compared to <u>the actual land use</u>. An actual land use, which is much more intensive than the potential land use and where no mitigating measures are applied (i.e., soil conservation measures) may serve as an indicator of unsustainable land use. Furthermore, it is intended to assess the areas that are showing visible signs of degradation.

Erosion, which is of extreme importance in the research region, could be assessed by using the "Universal Soil Loss Equation" (USLE), proposed by Wischmeyer and Smith (Wischmeyer, 1976). This equation has been calibrated for the United States and for slopes up to 15% and it seems to overestimate the soil erosion in the tropics and at steep slopes. Additionally, it is considered that not all the soil eroded is lost, but instead, a part may be transported to the lower parts, enriching the soil there. It still has to be discussed whether it is possible to adjust the results provided by the USLE or if the use of alternative models is feasible. In the negative case, a different indicator has to be found which assesses regional impacts of land use on soil resources.

PRELIMINARY CONCLUSIONS

The research at the Río Reventado Watershed is still continuing and, therefore, no final conclusions can be drawn. However, it can be said that:

- The framework has been useful in the process of definition of the indicators and the identification of information needs;

- Indicators had to be adjusted several times due to reasons of feasibility and costs;

- Farmers were not very interested in soil erosion measurement, but in fertility analysis and recommendations regarding pest management. That is because fertilizers and pesticides are a significant part of production costs, whereas, the costs of erosion are not perceived;

- The preliminary results stress the need to provide economic indicators for physical impacts, i.e., productivity;

- Farmers are aware of soil erosion, but soil conservation measures proposed by a FAO project have not been adopted. Farmers complained that they have not participated in the elaboration of the project and that the proposed measures are not compatible with their management practices;

- Since it is not feasible to measure yields during a sufficiently long period (5-10 years) in order to analyze impacts of soil degradation on productivity, there has been an attempt to overcome these shortcomings by amplifying the sample in one year. Considering that the region is relatively small, weather conditions can be considered to be equal in the same year for the whole sample. In order to avoid problems which may be unique for one year (i.e., infected seed material), the yields of two years (four harvests) will be measured. The results will show if this is feasible.

- At the regional level, some kind of erosion measurement is necessary in order to be able to assess its economic impact. Decision makers will react when a significant contribution to the reported problems of the Cachí Dam can be proven. On the other hand, the impacts of mining activities in the region may be farm more important than land use.

ENDNOTES

1. "All states of matter and all forms of energy do not have equal potential for use. Though we neither create nor destroy matter energy in production and consumption, we do transform it (first law of thermodynamics). Specifically, we transform matter from organized, structured, concentrated, low-entropy states (raw materials) into still more highly structured commodities and then, through use, into dispersed, randomized, high-entropy states (waste) (second law of thermodynamics). In the production of commodities, energy is transformed from high-temperature energy with a potential to do work into a low-temperature energy whose capacity to do work is lost

when the temperature reaches equilibrium with the general environment.

2. Rapid Rural Appraisal: A multi-disciplinary team visits farms, cooperatives, women's groups, etc., interviewing individuals and groups and making field visits in order to get to know the different land use systems and the socio-economic conditions in the research area. The team tries to obtain, through observation, as much information as possible. Standardized questionnaires are not used and a statistically-based representativeness is not obligatory. The experience of the participants for a correct interpretation of the results is decisive.

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APPENDIX I

SYSTEM: Vegetable growing (potato, onion, carrot)

Category: Resources of the system

Element: Soil

Dimension: Ecological (physical quality and quantity of the resources)

Property: Productivity

Descriptor: Soil fertility

Indicators: % Organic matter (organic carbon)
Inventory nutrients/area unit (kg/ha)

Property: Stability (constancy of productivity in the face of normal fluctuations and cycles in the surrounding environment due to such variations as climate)

Descriptor: Soil structure

Indicators: Water infiltration rate (mm/time unit)
% Organic matter
Apparent density

If the information is available and reliable, the variation of the productivity indicators from year-to-year can also be used as indicators for stability.

Property: Resilience (Capability of facing lengthy stress or shock)

Descriptor: Erosion

Indicator: Depth of topsoil (cm A horizon)

Property: Equity

No descriptors have been found for the ecological dimension

Dimension: Economic (economic value of the resource)

Property: Productivity

Descriptor: Land price (for agricultural and forestry use)

Indicator: US $/ha agricultural land

Dimension: Social (Access to and distribution of resources, considering the different qualities)

Property: Resilience

Descriptor: Importance of degraded land

Indicator: Percentage of agricultural area with marginal or deteriorated soils/farm

Category: Performance of the system

Element: Management/behavior of the system

Dimension: Ecological (physical performance of the system, regarding ecological goals)

Property: Productivity

Descriptor: Productivity

Indicator: Yield/nutrient input

APPENDIX I (Continued)

Property:	Stability
Descriptor:	Variation of productivity indicators
Indicator:	Variation yields/nutrient input from year-to-year
Property:	Resilience
Descriptor:	Crop loss caused by pests and frequency of crop loss
Indicator:	Crop loss kg/ha
Dimension: Economic (economic performance of the system regarding economic goals)	
Property:	Productivity
Descriptor:	Profitability
Indicators:	Total factor productivity Partial factor productivity Gross margin/ha
Property:	Stability
Descriptor:	Variation of profitability indicators
Indicator:	Variation coefficient of gross margins
Property:	Resilience
Descriptor:	Pest and disease pressure
Indicators:	Costs of pest management Value of production loss
Descriptor:	Dependence on external inputs
Indicator:	Costs as % of total factor costs and as % of economic yields
Dimension: Social	
Property:	Resilience
Descriptor:	Health expenses
Indicator:	Frequency of intoxications due to fertilizer application
Element:	Products of the system
Dimension: Economic	
Property:	Productivity
Descriptor:	Capital accumulation
Indicator:	Farm equipment, means of transportation
Dimension: Social	
Property:	Productivity
Descriptor:	Satisfaction of needs
Indicator:	Ratio of household expenses to income Frequency of the need for consumer credits

APPENDIX I (Continued)

Property:	Stability
Descriptor:	Variation of net farm income
Indicator:	Difference between the lowest and the highest income in the last 10 years
SYSTEM:	Río Reventado Watershed
Category:	Resources of the system
Dimension:	Ecological
Element:	Soil
Property:	Resilience
Descriptor:	Erosion
Indicator:	Area with physical erosion feature according to severity Sediment load measures (MT)
Property:	Equity
Descriptor:	Land tenure
Indicator:	Gini-coefficient

No indicators have been defined yet for the economic and social dimension

Element:	Water
Property:	Productivity and Resilience
Descriptor:	Water quality of the Río Reventado and its affluents
Indicators:	Conductivity Oxygen soluble Turbidity Fecal coliforms
Descriptor:	Fertilizer contamination
Indicators:	Nitrate, ammonia and phosphate
Descriptor:	Pesticide contamination
Indicators:	Organophosphates and organochlorates
Property:	Equity
Descriptor:	Access to irrigation water
Indicator:	% of farmers with access to irrigation water

No indicators have been defined yet for the economic and social dimension

Category:	Performance of the system
Element:	Management/behavior of the system

Dimension: Ecological

Descriptor:	Regional crop yields
Indicator:	Yield kg/ha of the different crops
Descriptor:	Variation of average productivity
Indicator:	Variation coefficient of crop yields

APPENDIX I (Continued)

Property:	Resilience
Descriptor:	Rationality of land use
Indicator:	Relation between potential and actual land use
Descriptor:	Long-term productivity
Indicator:	Long-term regional yields
Descriptor:	Vegetative land cover
Indicator:	% of denuded land during parts of the rainy season
Descriptor:	Use of conservation measures
Indicator:	% of farmer on steep land with soil conservation measures
Element:	Products of the system
Property:	Productivity
Descriptor:	Crop production
Indicator:	Regional production (MT)
Property:	Stability
Descriptor:	Variation of regional crop production
Indicator:	Variation coefficient of crop production
Property:	Resilience
Descriptor:	Long-term crop production
Indicator:	Long-term crop production (MT)

No indicators have been defined yet for the economic and social dimension

Development and Application of A Framework for Evaluation of Sustainable Land Management (FESLM)

J. Dumanski*

INTRODUCTION

Rising populations competing for limited land resources have focused attention on the need for increasing food production, while preserving the resource base and decreasing land degradation. This has prompted discussion on the sustainability of current land management systems.

Sustainable land management (SLM) has emerged as a global issue in securing enhanced productivity and performance of land resources, consistent with minimising adverse effects on the environment. To achieve this, there is an urgent need to develop and implement appropriate technologies and policies for more effective land management which are sustainable over time. Significantly, SLM was high on the priority list of AGENDA 21 of the United Nations Conference on the Environment and Development, held in Rio de Janeiro, June, 1992. Also, Osten-Sacken (1992) has recently reported that the Consultative Group on International Agricultural Research (CGIAR) must address sustainable land use management as a matter of priority in the coming years.

DEVELOPMENT OF THE FRAMEWORK

The Need for a Framework

Decisions as to whether or not a particular type of land use is sustainable in a given environment over a stated period of time can potentially be assessed using a framework approach. With this in mind, the International Board for Soil Research and Management (IBSRAM) brought together a group of international agencies to develop a structured methodology for evaluating the sustainability of land management. The work was initiated through an international workshop held at Chang Rai, Thailand, in 1991 (Dumanski et al., 1991a; Dumanski et al., 1991b). The second international workshop in this series was held in Lethbridge, Canada, in 1993, and focused specifically on development of indicators for SLM (Dumanski, 1993; Wood and Dumanski, 1993).

An international working group has been established to develop a Framework for Evaluation of Sustainable Land Management (FESLM). Membership in this working group consists of representatives from:

- International Board for Soil Research and Management;
- Food and Agriculture Organization of the United Nations;
- International Fertilizer Development Centre;
- International Society of Soil Science;
- Soil Management Support Services, USDA-SCS;

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Table 1: The levels of the Framework are summarized as follows:

Level 1:	OBJECTIVE - identification of the land use system(s) to be evaluated.
Level 2:	MEANS - specification of the land management practices employed in the land use system(s).
(Collectively the OBJECTIVE and MEANS statements describe WHAT will be evaluated)	
Level 3:	EVALUATION FACTORS - identifcation of all physical, biological, social and economic factors which potentially bear on the sustainability of the system.
Level 4:	DIAGNOSTIC CRITERIA - establishment of cause and effect relationships between factors; collecting evidence of trends in these relationships on the site; projecting a pattern of these future trends. These are attained through analyses of available information, including modeling and expert systems, but experimentation may also be involved.
Level 5:	INDICATORS AND THRESHOLDS - measurable or observable attributes which describe the rate and direction of change in one or more of the pillars of SLM and identify the status or condition of sustainability; measures beyond which the system can be judged to be unsustainable.
(The three lower levels of the Framework describe HOW the evaluation will be carried out).	

- Centre for Land and Biological Resources Research, Agriculture and Agri-Food Canada.

- International Centre for Research in Agroforestry;

- The Tropical Soils, Biology and Fertility Program.

- The World Bank

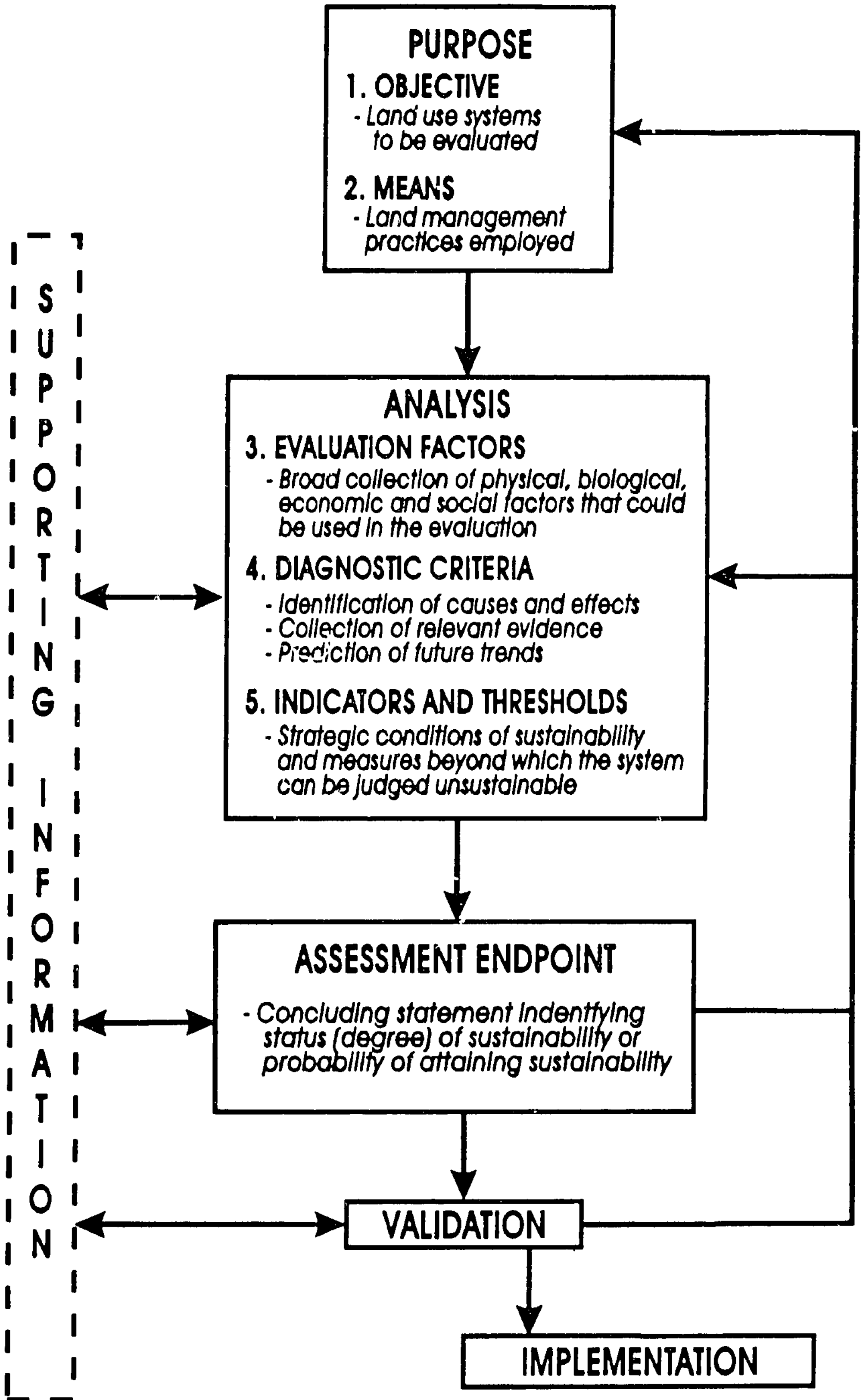
The international working group has developed the following definition of SLM:

Sustainable land management combines technologies, policies and activities aimed at integrating socio-economic principles with environmental concerns so as to simultaneously:

- *maintain or enhance production/services (productivity);*

- *reduce the level of production risk (stability);*

Figure 1: The Framework for Evaluation of Sustainable Land Management (FESLM).



- *protect the potential of natural resources and prevent degradation of soil and water quality (protection);*
- *be economically viable (viability);*
- *be socially acceptable (acceptability).*

These five objectives of SLM - productivity, stability, protection, viability and acceptability are the basic pillars and the foundation on which the Framework is being built.

What is the Framework

The FESLM is designed to function as a logical pathway for analysis of the probability of sustainability. The pathway seeks to connect the form of land use under investigation with the multitude of environmental, economic and social conditions that collectively determine whether that form of land management is sustainable or will lead to sustainability. The Framework enables the evaluation of sustainability in a scientifically sound, logical, stepwise fashion, so as to develop a solution (assessment end point) in which one can have confidence.

The proposed Framework is designed as a hierarchy, consisting of five levels, which collectively lead one through the process of assessment, but in a manner that ensures that the most important (controlling) processes or constraints to sustainability are considered along the way. The land uses and the land management factors to be considered are defined in the first two levels of the Framework, whereas the diagnostic criteria to be used in the assessment - the causes and effects of these factors, and the indicators and thresholds for evaluating sustainability - are defined in the lower three levels.

Rigorous and systematic implementation of the Framework will serve to develop conclusions on the probable sustainability of the land use system being evaluated. However, this should still be validated. Validation is achieved by double-checking all steps used in the analysis to ensure consistency of application, but more importantly by comparing the trend (direction and rate of change) of each indicator used in the analyses against the objectives of the five pillars of sustainable land management. Where necessary, additional field investigations, including experimentation may be undertaken. Only through thorough validation can one be reasonably certain that the assessment end-point is reliable.

Application and Uses of the Framework

The FESLM will be used to evaluate the sustainability of current systems of land management in specific environments, and to evaluate the probabilities that improved systems of land management will enhance the likelihood of achieving sustainability. This will identify how new technologies of land management, including biotechnology, can be applied in resolving the global problems of increasing agricultural production while preserving the environment. It will also contribute significantly to the development of innovative agricultural policies and programs in support of sustainable land use. The Framework will be a useful planning tool for donor agencies to assist in setting project priorities and in guiding investments into locations of best return. The Framework will have application in developing as well as developed countries.

The FESLM was applied in the recent international workshop held in Lethbridge, Canada (Dumanski, 1993). This workshop identified the issues of SLM, developed a strategy for dealing with these issues, and developed some preliminary indicators of SLM to be applied in the Framework and used for future reporting on the status of natural resources. Twelve focus groups from 36 countries developed indicators for specific land uses in five of the major climatic regions of the world. The major conclusions from this workshop were as follows:

- The groups recommended 3-5 indicators for each of the agronomic, environmental, economic and social dimensions of SLM. The significance of this is that no single, comprehensive indicator of SLM could be developed with our current knowledge. Therefore, a collection of indicators for each pillar is the preferred approach, and these will have to be integrated in developing the final assessment.

- The indicators recommended by the focus groups reflected the performance of a specified land use using particular management practices in a defined environmental setting. This indicates that indicators cannot be separated from current land management pratices, land uses and local environmental conditions.

- The above notwithstanding, a number of indicators consistently reappeared from several of the focus groups. These were the following:

  Crop yield (trend and variability)
  Nutrient balance
  Maintenance of soil cover
  Soil quality/quantity
  Water quality/quantity
  Net farm profitability
  Participation in conservation
  practice and programs

Although incomplete, these indicators possibly preview a set of generic indicators that could be developed as international standards for the evaluation and monitoring of SLM. Further work is required to determine if this is possible.

The FESLM has been used in a preliminary case study in Alberta, Canada, to assess the sustainability of cereal-livestock land use systems, using conventional and conservation technologies (Gameda and Dumanski, 1994). Farmer-based indicators were used for the study, supplementd with data from field studies and research findings. This application demonstrated the relative unsustainability of conventional farming systems (in the absence of financial support programs), and the superior performance of conservation-based systems if properly designed and applied. Similarly, the Framework is being used by IBSRAM and its collaborators to assess the comparative sustainability of land management practices on Vertisols in Zimbabwe and Queensland, Australia, and on acid, sloping lands in the Phillipines and in Queensland, Australia.

In addition, a series of other case studies are being started and others are being planned in both developed and developing countries to test the concepts of SLM in the field and make improvements as necessary. The results of these case studies will be reported at international workshops that are currently under discussion. However, additional case studies and other related research on SLM will still be needed to fully research all the required indicators of SLM and develop procedures for their integration.

THE WAY AHEAD

Work on the FESLM was initiated only three years ago, but already much has been achieved. The international working group is in place, and it has developed the basis for investigation and research in SLM, as well as a definition and a prototype structure for the Framework. A discussion paper for application of the FESLM has been prepared and published (Smyth and Dumanski, 1993). A symposium on the FESLM has been organised as part of the International Society of Soil Science XV[th] Congress, Acapulco, Mexico, 1994.

Although the international working group is leading the way, the search for sustainable systems of land management is everyone's responsibility. Sustainable land management involves harmonising environmental and ecological concerns with the economic realities of food and fibre production. The simple economic criteria of the past can no longer be used as yardsticks for future success. Although agriculture is producing more food on less land with fewer producers than ever before, there are few that would claim that our current production systems are sustainable. For example, government support payments in many developed countries currently account for about 50 percent of net farm income. Both consumers and producers are wondering if current support systems are the right approach. There is increasing evidence that society is demanding more from agriculture than simply putting food on the table (Grossi, 1993). Increasingly, it is demanding that farmers become the custodians of rural resources, particularly soil, water, and habitat.

The attainment of the objectives of SLM and the transition to a sustainable agriculture will require a long-term commitment, and there are no universal solutions. Technological and scientific advances will be instrumental in this, but political, economic and institutional structures will also have to be a part of the solution.

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Seeking Sustainability Results: Choosing and Applying Indicators in Communities

Elizabeth Kline*

ABSTRACT

Indicators are tools to help people in communities articulate their values, establish desired pathways (e.g. sense of direction/framework to guide actions), develop appropriate responses (e.g. policies, laws, regulations, market signals), and evaluate progress. Sustainability indicators need to reflect the needs, culture, roots, values of the distinct voices within and affecting communities. They also need to embody the paradigm shifts so that results measure progress towards a new way of thinking (e.g. integration of environment and economic development).

INTRODUCTION

Many terms are used to set a course and evaluate progress: indicators, benchmarks, milestones, and vital signs. Sometimes, these terms are interchangeable. Other times, they have distinctive meanings: value-driven objectives (e.g. indicators); points of progress (e.g. benchmarks or milestones); and key symbols of accomplishment (e.g. vital signs).

The choice of measurement instrument depends, sometimes, on issues such as ease of understanding, availability of data, and reliability of information. For example, some people seek to measure items, such as amount of acreage of wetlands lost or amount of existing parkland and open space as surrogates of environmental sustainability. Yet, these figures do not adequately convey the notion of the functioning capacity of the wetlands remaining or the functional value of the connected or disconnected open spaces.

Another difficulty in identifying useful things to measure stems from the lack of preciseness of the concepts "sustainable development" and "sustainable community". How do we measure such a complex, dynamic system where pieces are intertwined with each other and flows in, around, and outside of the community affect its short and long-term well being?

I believe that an approach to measuring *community sustainability* (versus measuring progress on particular actions or on specific objectives or principles) is to (1) rely on a definition of a sustainable community (the four characteristics are proposed: economic security, ecological integrity, quality of life, and empowerment with responsibility) as a starting point from which (2) categories are derived that focus on what to measure within each characteristic, followed by (3) some examples or clues on how to measure progress within that category.

CHARACTERISTICS, PATHWAYS AND INDICATORS TOWARDS A SUSTAINABLE COMMUNITY[1]

The concepts of "community" and "sustainability" are illusive. *Community* often

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refers to geographical areas defined by political boundaries, such as towns, cities, and villages. It also can apply to ecological addresses, such as watersheds, riverbasins, lakes, ponds, and valleys. At its essence, community defines a sense of place and belonging, however many ways that fits an individual or a group. For example, you can be part of a household, a neighborhood, a municipality, an ecosystem, an ethic/religious/racial/economic group. People can belong to communities within communities.

This paper presents the generic characteristics which apply to communities of any of these types. This understanding evolved through an applied policy research project concluded in the fall of 1993. Seven case studies were conducted, using various definitions of community, in order to draw out common elements.

A sustainable community could take many different forms. There is no one type of community that these four characteristics describe. However, people need to recognize the importance of all of the characteristics. For instance, moving towards economic security alone does not guarantee an improved quality of life for everyone or healthy natural ecosystems (e.g. clean air and water). In fact, current methods of achieving economic security may hinder realization of the other three characteristics (e.g. the current nature of businesses and the incentives for their profitability often undermine environmental quality).

In addition, it is important to realize that each attribute within a characteristic contributes to sustainability, but alone may not be sustainable. For example, the characteristic *economic security* includes the attribute of financial viability for businesses. A business may be financially stable, but not ecologically sound. The reverse can also be true. A company that is environmentally sound and socially responsible may not be sufficiently profitable.

ECONOMIC SECURITY

A more sustainable community includes a variety of businesses, industries, and institutions which are environmentally sound (in all aspects), financially viable, provide training, education, and other forms of assistance to adjust to future needs, provide jobs and spend money within a community, and enable employees to have a voice in decisions which affect them. A more sustainable community also is one in which residents' money remains in the community.

Economic security is different from economic growth or economic development. Progress towards economic security is not measured by quantitative increases, such as more jobs, or by financial indicators alone. Rather, this term implies a change in the very nature of business so that economic opportunities contribute to the improvement of the environment and serve as vehicles for economic equity and long-term satisfaction.

Relevant indicators for evaluating a community's economic security can be derived from an analysis of four categories of what to measure: disparities; environmental soundness; local wealth; and mutual assistance.

Disparities

Disparities deal with relative comparisons. For example, diversity of employers seems to be more important over the long term for a community's economic well-being than having many people employed by a few industries, businesses, or institutions. Communities dependent on one major employer, such as a military base or a mine, or reliant on one major type of employment, such as fishing or timber harvesting, are vulnerable when these sources fail. Military base closures, over-harvesting of George's Bank off New England, and the battles over the Northwestern and Northeastern forest lands are examples of such fragility.

Disparities cover a broad range of issues. It is important to evaluate disparities in income, in lending, in dollars that remain in a community as compared with those that leave, in employment salary ranges among employees, and in how dollars are spent. The ranges between items measured and the trends over time tell a lot about the community's long-term stability and the fluctuations it faces over time. For example, a trend of out-migration among young adults and a concentration of young children and older people affect the economic base of a community. An assumption is made that the more diversity, in general, the more sustainable a community is likely to be.

Indicators which help measure disparity try to elicit comparisons, ranges, and gaps. In some cases, a larger distance (e.g. greater number of employers versus fewer businesses) are positive indicators. In other instances, a larger gap (e.g. the range of incomes of the highest paid employee as compared with the lowest one) indicates a negative assessment. Still other indicators try to reveal information which then has to be analyzed for its consequences. For example, the percentage of dollars spent on infrastructure maintenance as compared with new capital improvements may or may not demonstrate a lack of investment in basic foundations while favoring new start-up facilities.

ENVIRONMENTAL SOUNDNESS

Environmental soundness means that economic actors (including individuals) need to apply environmental values and practices. The approach towards implementing environmental soundness means understanding and living within the functional capacity thresholds of natural ecosystems. From an economic perspective, this means producing no toxic wastes, converting other wastes into beneficial uses, and resource efficiencies. Energy and water conservation projects are preliminary steps along this pathway. However, more important are actions which take the by-products within processes and as the outcome of processes and convert them to other, economically viable purposes. For example, fertilizer pellets are being distributed and sold by the Massachusetts Water Resources Authority which are the end-product of their wastewater treatment facility. Other examples, include the use of recycled tires to make sandals or patio flooring; the use of stream from a electrical power plant for residential heating; and the Kalunborg, Denmark illustration where exchanges are made involving an electric power-generating plant, an oil refinery, a biotechnology production plant, a plasterboard factory, a sulfuric acid producer, cement producers, local agriculture and horticulture, and district heating.

Indicators to measure environmental soundness are not easy to imagine. Many frequently used indicators rely on the degree to which environmental standards are met or the amount of acreage of land/water/wetlands lost or preserved. These type of indicators are not appropriate. Rather, you need to measure things such as the percentage of energy used in a community generated by local facilities using renewable energy sources; the percentage and volume of waste material converted into beneficial uses; and replacement of virgin materials by recycled products used in businesses, industries, and public institutions; the number of hazardous waste superfund sites which have been cleaned up and then used for some beneficial purpose; and the number of vehicle miles traveled per person per year in fossil-fuel powered single occupancy vehicles.

Local Wealth

Local wealth includes many aspects of wealth, both monetary and non-monetary. It considers investments residents and business people have and make in their community and the extent to which people in the community support each other. Exchanges and investments can be measured in dollars as well as in bartered trades. An assumption is made that the more a community retains its wealth, the more sustainable it is. However, like all systems some resources come from outside the community and others flow from the community to the ou.side. Sustainability, therefore, is not synonymous with self-sufficiency.

Indicators measuring local wealth deal with different ways of evaluating a community's commitment and support of itself -- direct dollars invested and retained, infrastructure inducements provided, financial viability of individual businesses, industries, and institutions, and the stake of employees in their work. It is important to measure not only how much comes into and stays within a community, but also how much wealth is generated from a community. For example, a community loan to a micro-entrepreneur can produce a multiplier effect by nurturing the establishment of a small business which hires some local people, purchases local products, and pays local taxes.

Mutual Assistance

Mutual assistance implies that people who work together, cooperate, and share resources benefit themselves as does the community as a whole. The notion of mutual assistance goes beyond businesses purchasing from within the community to include a wide variety of joint enterprises. In some communities, especially in Europe, mutual assistance means the purposeful collaboration of independent businesses to respond to particular product requirements. Instead of having binding associations or subcontracting agreements, these businesses come together and separate depending on the nature of the business deal.

Indicators for mutual assistance can include the percentage of firms/institutions that market together; that purchase items together; that share equipment and/or personnel. Enterprises encouraged by the group "Working Capital" (New England organization patterned after the Grameen Bank in Bangladesh and other similar places) rate high using these indicators.

ECOLOGICAL INTEGRITY

A more sustainable community is in harmony with natural systems by reducing and converting waste into non-harmful and beneficial products and by utilizing the natural ability of environmental resources for human needs without undermining their ability to function over time.

Effectiveness of Natural Systems to Function

Ecological integrity is very different from environmental protection. It seeks to understand and live within the functional capacity of natural systems rather than to reduce the risks to those systems. Emphasis is, thereby, placed on gaining scientific understanding of ecological thresholds and anticipating and enhancing their well-being. Much of the current U.S. environmental structure is aimed, instead, at the sources which affect resources and establishing regulatory controls and/or market incentives to minimize environmental impacts.

An ecological integrity approach means, for example, that no more water is withdrawn from a river than can be naturally replenished to meet in and out of stream uses. The implementation tool to meet this objective is maintaining reasonable streamflows.

Identifying appropriate and practical indicators for ensuring ecological integrity is challenging for several reasons. Unlike measurements relating to environmental protection, those dealing with ecological integrity are not simply achieved through meeting environmental standards. Environmental standards may not be comprehensive enough nor strict enough to protect the systems' environmental health. Moreover, often we do not know what a threshold is until the natural resource fails to function in some way because certain qualities are impaired, harmed, or destroyed. It is then difficult to diagnose what happened and why and to deduce threshold levels.

Possible indicators include, the number or percentage of exotic (e.g. non-native) plants and animals in a given area; the loss of natural predators; accelerated eutrophication of surface water bodies as compared with predicted natural succession rates; percentage change in volume of first tropic level (i.e. producers); and the percentage of fragmentation of habitats.

Environmentally Sound Utilization of Natural Resources

This topic has already been described under the section dealing with Economic Security.

QUALITY OF LIFE

A more sustainable community recognizes and supports peoples' evolving sense of well-being which includes a sense of belonging, a sense of place, a sense of self-worth, a sense of safety, and a sense of connection with nature, and provides goods and services which meet peoples' needs both as they define them and as can be accommodated within the ecological integrity of natural systems.

Respect for Self and Others

A sense of personal and communal self-worth is a critical qualitative aspect of a sustainable community. People gain and feel such a sense when they are proud of their accomplishments, feel satisfaction and enjoyment with their lives, believe in themselves, feel a part of a group, and accept and respect the differences in other peoples.

Although a sense of respect is difficult to measure, there are clues which can, in a quantitative and qualitative way, help identify people's beliefs, values, and sense of themselves and others. For example, surveys can ask questions about people's participation in multicultural events, in neighborhood block parties; their friendships with people from different backgrounds; their familiarity with their neighbors; and their sense of public interest in the way they take responsibility for the maintenance and operations of public places and spaces.

Basic Coverage

Basic coverage implies essential survival needs such as shelter, food, water, and clothing. Without these basic needs provided people cannot think about other concerns. However, basic coverage in a sustainable community includes additional needs such as appropriate housing, child care, safety, health care, and education.

Some relevant indicators measure availability and access to these basic needs; others try to evaluate people's feelings (i.e. their sense of comfort, satisfaction, or happiness) about their coverage. For example, location and distribution of public services and facilities in relationship to concentration of people with needs is a critical indicator. As important, however, is the ability of people to gain use of the available services. If someone does not speak English or has cultural inhibitions asking for assistance, then the local health care center may not be sufficiently inviting to induce that person to get assistance.

Other possible sustainability indicators for measuring basic coverage include: percentage of parents who have their preferred child care arrangements; percentage of people who have health care coverage (availability and access); number of public employees who live within the community; number of homeless families; percentage of low income housing with severe problems, using HUD or state standards; impact of fear of crime on behavior whether based on crime statistics, experience, or awareness from another source such as media (e.g. willingness to go out after dark in your neighborhood alone/in a group); ratio of public funds spent on drug and alcohol prevention and treatments as compared with funds spent on incarceration for drug and alcohol related crimes; teacher/student ratio; location of services (e.g. child care facilities, English as a Second Language facilities, food stores) in relationship to concentration of needs.

Connectedness

Connectedness (in time, place, and with nature) is another integral part of quality of life. When people know each other, they are more likely to feel a part of a community and, then, are more likely to taken an interest in what affects their community. The notion here, however, is broader. It assumes that individuals who have a sense of place, i.e. knowledge of the history and/or understanding of the natural systems where they live, will have a stronger identification with their community. It also assumes that people want a sense of belonging to extend to the natural world as well as the physical place.

Possible sustainability indicators to measure connectedness are: number of neighbors each individual knows by name; rank on scale of importance the value of connecting to nature via actions and desires (e.g. grow plants in gardens, window boxes, decks, or roof gardens; recreate outdoors; sit in the sunlight to read and/or eat); number of residents who know what watershed they live in; number of parks and streets named for some historical person or place; and number of participants at public events, such as a local parade.

Caring

The final aspect of quality of life in a community is caring. Like respect for self and others, this quality measures the degree to which people translate concern into action for the improvement in the lives of living things. It means more than awareness and empathy. Caring implies an ability to respond to the needs of others because of an emotional tie and sense of responsibility.

Indicators for measuring a sense of caring may include: the number of hours volunteered or the percentage of the population that volunteers. It can be more sophisticated a measurement by analyzing the percentage of people in businesses, institutions, and neighborhoods where people returned to help others in situations similar to what they overcame (e.g. successful businessperson mentors start-up entrepreneur; once abused person volunteers to help victims of abuse; financially successful (once poor) person stays in the community or reaches back to help neighborhood residents; students that participate in a mentor program who later become mentors.

EMPOWERMENT WITH RESPONSIBILITY

A more sustainable community enables people to feel empowered and take responsibility based on a shared vision, equal opportunity, ability to access expertise and knowledge for their own needs, and a capacity to affect the outcome of decisions which affect them.

An authoritarian community is not assumed to be a sustainable one because, eventually, people seem to be driven by a desire and need for self expression, self-determination, and an ability to influence decisions which affect their lives.

Empowerment with responsibility is comprised of four components: reaching in, equity/fair playing field, accountability, and capacity.

Reaching In

Reaching in is a term I coined to describe the idea of broadening the base of participation by tapping into the diverse voices of a community, connecting to its roots, and engaging people in a dialogue whereby they express their concerns, interests, and ideas and help shape implementation actions. The more common term, "reaching out" implies a base from which overtures are made; whereas, the concept of "reaching in" connotes the bridges and linkages made continuously to bring more and more people into discussions and enable their diverse viewpoints to be heard and respected. Strategies to engage people in this reaching in process often include going to where people are most comfortable, i.e. their churches, associations, meeting houses, apartments, board meetings and asking them to define their concerns and interests rather than seeking their reaction to a predetermined agenda or outcome. Another strategy is to begin intellectually where people are rather than try to force them to imagine what is unfamiliar. Visioning, for example, is a step which is less effective done earlier in an engagement process rather than as a evolutionary result of an ongoing dialogue.

Like many other sustainability indicators, the ones to measure reaching in are not easy to identify, especially since the evaluation needs to focus on outcomes rather than processes. For example, an appropriate indicator may be the number of new participants involved over a time period rather than the number of invitations distributed. Another possible indicator, the sources of ideas and recommendations, can distinguish those thoughts which were generated by affected persons rather than by project leaders. A third type of indicator evaluates the outcome of participation, such as the number of community gardens created over a specified time period. This particular activity was chosen because the evolution of a community garden usually necessitates an engagement process involving many people from diverse cultures, economic statuses, ages, and professions coming together to work on a common project.

Equity/Fair Playing Field

Benefits for a few at the expense of some people does not generate community wealth, improve quality of life for everyone, or ensure ecological integrity of natural resources. Equity does not mean that everything is equal; rather, it entail equal opportunity and equal access.

Equity affects people's sense of empowerment and the degree to which they take responsibility for themselves and for others. Denial of resources, whether financial or technical, whether physical or emotional, impairs people's abilities to understand and assert their interests, to take initiatives, and to be held accountable for their actions.

Indicators to measure equity seek to disclose inequities, but are not intended to presume certain responses. Like similar language in describing economic disparities, these indicators reveal the gaps. How people respond to this knowledge depends on community values, priorities, and interests. There is an implication, however, that significant gaps are not healthy for a community. There is no assumption, though, that absolute equivalency is desired. Possible indicators are: percentage of students accepted to higher education who cannot afford to go; percentage of people of color compared with percentage of whites of the same economic status who received home mortgages during a specified time period; percentage of community political leaders and appointed professional managers who are people of color/women as compared with the community's breakdown; and ratio of ethnic and gender diversity of teachers/administrators/support staff to equivalent student body figures.

Accountability

This third aspect of empowerment with responsibility is of increasing concern to people in the United States who reject the attitude that either blames others for problems not resolved or absolves victims of taking responsibility for their lives. It stems from a belief that everyone has responsibilities and can be held accountable. No sector (i.e. government), no group (i.e. elected and appointed officials), no individual has the burden to act on behalf of everyone's interests.

Appropriate indicators attempt to determine to what extent people and institutions are actively working to make their communities better places and to what extent they are meeting their obligations and held accountable for their actions. Some indicators are quantitative, such as the percentage of community-based loans from local banks which are repaid; the percentage of people in a defined area, such as a neighborhood or street, who act on behalf of a specific change (e.g. to host a street closing for a street fair or in support or opposition to a particular land use on a site; and the number of people who pay taxes and/or traffic violations. Others are qualitative, such as the percentage of the population that rates government responsiveness as good or excellent for both administrative effectiveness and delivery of services.

Capacity

The last aspect deals with personal and institutional capacity. Like some of the economic indicators, these measures evaluate both the skills and knowledge type of capacity (e.g. English and environmental literacy) as well as people's ability to affect an outcome which requires capacity-building tools (e.g. passage of a zoning amendment which necessitates organizing a town meeting or city council vote).

In order to be appropriate to a wide diversity of people's backgrounds, capacity indicators need to measure a variety of opportunities and not presume that there are limited possible responses. For example, percentage of adults involved in an organized learning program is a more useful indicator than the percentage involved in an educational program. Some people are involved in sports programs, such as soccer, baseball, or basketball leagues; other people are involved in cultural activities, such as music groups; and still others indicate their capacities through psychologically oriented activities, such as peer support groups and peer training programs. All of these responses are appropriate to evaluating the ability of people to become engaged in some activity.

CONCLUSION

Identifying and applying sustainability indicators can be a useful, though challenging, exercise. Used strategically, indicators can help reveal to people where their (collective, i.e. public and private) investments are made and the intended and unintended consequences from such decisions. By so doing, people can evaluate whether the results are desirable to them or whether they may want to seek changes.

I believe that, ultimately, sustainability indicators can serve as a practical tool in challenging society's basic rules -- its policies, laws, regulations, and market signals. Once people realize that they are not getting what they want and understand that the results are tied to the rules of the game, they will be less likely to blame others and take more responsibility in changing the rules. The paradigm shifts needed to move towards sustainable communities depend on this awareness and the actions resulting from that knowledge. People create and people can change.

ENDNOTE

1. These characteristics are described and illustrated in detail in a document titled Defining a Sustainable Community by Elizabeth Kline. A copy can be purchased for $15 (check made out to Trustees of Tufts College) and sent to her at Tufts University, Curtis Hall, 474 Boston Avenue, Medford, MA 02155.

Leading Indicators of Sustainability: Searching for the Coal Miner's Canary's "Canary"[1]

Stephen A. Vosti*

INTRODUCTION[2]

Researchers concerned with merging the issues and objectives associated with environmental change with traditional economic growth and poverty alleviation goals are being called upon by the donor community and policymakers to generate demonstrable development results, and to provide a series of indicators (leading indicators of sustainability (LIS)) that signal when environmental change is reaching critical and perhaps irreversible thresholds, and guidance as to what actions should be taken if and when such circumstances arise. Indeed, if sustainability research cannot deliver on these two issues, it will not survive the test of time (Ruttan, 1993).

Surviving the test of time will require not only that all three development objectives be met, but that these successes be empirically (and convincingly) documented, and the routes to successful outcomes be clearly identified and replicable. To meet these challenges, more and sharper measurements of environmental change (both environmental degradation and environmental improvements) are needed, and alongside these, improved measurements of other development objectives will be required. To make successes replicable, improved analytical methods are needed to identify the interrelationships among all three development objectives, and to link changes in these objectives to the policy and other variables known to influence resource use decisions. The sustainability indicators literature has, in my view, already made contributions in the areas of measurement and analytical methods, and it is hoped that this paper will suggest ways to broaden and strengthen these contributions.

In beginning the search for tools for identifying and evaluating different leading indicators (of any kind), it occurred to me that the coal miners' canary was a good place to begin.[3] The canary was a great leading indicator because it was:

Dichotomous in nature, and therefore very easy to interpret;

Reliable;

Cheap;

Provided sufficient lead time for action;

Suggested clearly identified action; and

Saved lives.[4]

Upon reviewing the characteristics of this particular leading indicator, I noticed that they mapped very neatly into the desired characteristics generally mentioned for leading indicators of sustainability. (See, for example, Harrington et al., 1994.) In addition, and perhaps more importantly for this paper, the same characteristics also

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mapped into the literature focusing on leading economic indicators (LEI). This literature, begun in the 1940s by Burns and Mitchell (1946), has clearly survived the test of time, and along the way has generated some very sophisticated (as well as some very simple) tools for identifying LEIs and evaluating their performances. This paper sets out the general issues and foci of LEI research, provides a quick overview of the analytical methods employed and an assessment of the extent to which "cross-pollination" between LEI research and LIS research might be possible.

Section II briefly assesses the *ex ante* potential for cross-pollination. Section III examines the leading economic indicators literature, with particular emphasis on issues, focus, and methods. Section IV concludes the paper by highlighting what researchers working on LIS might learn from the LEI literature, and some potential pitfalls.

POTENTIAL FOR CROSS-POLLINATION

Before extolling the benefits of linking LEI and LIS research, it might be useful to "pre-assess" the scope for cross-pollination. There are, from the outset, some good reasons why one might not want to pursue such a link. First, LEI research is, after all, based on business cycles -- recurring upswings and downswings in economic activity. Environmentally fragile areas (the foci of sustainability research) might not survive one, let along several, "swings." Second, LEI research has been undertaken principally in developed countries, where there are vast amounts of data available for model estimation and prediction -- the same is not true of sustainability research in developing countries. Third, LEI research focuses principally on prediction and subsequent reaction, rather than prediction with an eye towards prevention -- sustainability research needs to predict unsustainable patterns and suggest action for altering such patterns in beneficial ways. Finally, LEI research has been challenged almost from its inception as being "measurement without theory" (Auerbach, 1994) -- what good are correlations without causation, either in economics or sustainability research?

While all these potential obstacles to cross-pollination are quite valid, it might turn out (under closer scrutiny) that the foci and objectives of LEI research are not all that different from those of LIS research. First, it is not clear that the examination of multiple business cycles (within an ever-changing economy) is conceptually any different from examining the degradation of adjacent watersheds occurring at different points in time. While it is true that every watershed is different, the same can also be said about every business cycle, and the economy (set not only in space, but in time) that generates it. Second, LEI research was not always based on a rich data sources. In fact, much of the data that currently exist and are being utilized (by LEI researchers and others) owes its existence, at least in part, to innovations in LEI methods and the data these methods require. Third, the prediction/reaction focus that characterized the early development of LEI research, has given way to an increasing focus on prediction/prevention -- principally due to links with other sub-disciplines within economics. Finally, it is not clear that some measurement without theory is necessarily a bad thing -- at least at the initial stages of the search for indicators of sustainability. Indeed, to the extent that aerodynamics owes much more to airplanes than vice-versa,[5] theories of sustainability may in the long run owe more to leading indicators of sustainability, than vice-versa.[6] (Auerbach, 1982).

LEADING ECONOMIC INDICATORS THE BUSINESS OF PREDICTING BUSINESS CYCLES

Issues and Focus[7]

Traditional LEI research focused on predicting inflection points in aggregate economic activity (say, the Gross National Product (GNP)), and its correlates. To do so, this research had to grapple with a number of difficult issues, all of which the LIS research will have to deal with sooner or later, in one way or another.

First, targets had to be established. Concerns regarding what *the* appropriate target was (or what *a* target might be, for that matter) had to be addressed (McNees, 1991). Initially, turning points in aggregate economic activity were the focus -- upturns as well as downturns. More recently, the speed and depth of economic recession (and expansion) as well as the time that passed between consecutive economic recessions (or expansions) has gained importance. (See, for example, Diebold and Rudebusch, 1991.)

Once the target (or targets) was selected, leading indicators (or predictors) of these indicators had to be identified and their performance assessed -- both within and outside the data samples from which they were derived. Notions of forecast error, reliability, and lead time had to be made rigorous and applied to each of the alternative potential leading indicators. (See, for example, Moore, 1991.)

Next, the benefits associated with being correct, and the costs associated with being wrong, had to be assessed for each indicator -- taking into consideration the asymmetry of costs/benefits associated with each type of forecasting error. This is quite important since the cost associated with missing an "upswing" might be very different from the cost of missing a "downswing." (See Zellner and Hong, 1991.)

Finally, since information (and its processing) are not costless, the costs associated with tracking and manipulating data to generate leading indicators had to be assessed.

Once all this information was in hand, LEI researchers would be in a position to select a leading indicator (or subset of leading indicators) and follow these series over time.

Three additional issues have proved to be increasingly important in the research agenda for LEI. First, the evolution of leading economic indicators is critical -- economic indicators that worked well in the 1950s for the United States economy might not be particularly useful in predicting economic activity today. LEI researchers needed to link the usefulness of particular economic indicators to the structure (and more importantly the changes in structure) of the economy and adjust (and perhaps discard) certain leading economic indicators as time and circumstances suggested.

Second, the critical role of consumer and producer expectations, and behavior had to be integrated into LEI research. (See, for example, de Leeuw, 1991, or Berry, 1994.)

Finally, and perhaps most importantly from the point of view of LIS research, LEI researchers are increasingly challenged to link leading indicators with policy action. For example, in the United States, the

Gramm-Rudman-Hollings law mandates that the Federal deficit be eliminated over time. It does so, however, recognizing the need for expansionary fiscal and monetary policy during recessionary periods, and contractionary policy during expansionary periods. The problem both from the point of view of LEI researchers and policymakers, is to identify, *concretely*, exactly when an economic recession has begun or ended (Zarnowitz and Moore, 1991). This is the ultimate interface between policy and research, and the challenge that the sustainability research community must be prepared to face.

Data and Methods

LEI researchers enjoy a vast array of information and data at their disposal, and use a wide array of statistical methods to identify and evaluate leading indicators.

LEI researchers make use of primary data, in the form of questionnaire responses, from both producers and consumers, as well as a wide variety of secondary information. These data are used in different forms -- sometimes quite "raw." For example, responses from telephone interviews from chief executive officers of major companies are quickly combined to produce a leading economic indicator. Or, primary and secondary data can be quite thoroughly "processed" before being utilized in the construction of leading indicators -- for example, seasonally adjusting data for subsequent use.

The statistical techniques employed vary from the very simple (for example, simple averages of consumer expectations declared in telephone interviews) to the very complex (for example, probabilistic models based on information gained as time marches on). Owing to the cyclical nature of targets, techniques employing time series analyses are prominent. Autoregressive models, e.g., using last quarter's GNP as a predictor of next quarter's GNP, are common. Models using autoregressive and other predictor variables simultaneously are also common. (See, for example, Zellner and Hong, 1991.) Increasingly common are probabilistic Bayesian learning models in which information is gained sequentially (though not necessarily shared uniformly across the economy), and each new bit of information is used to improve the quality of leading indicators. Duration-dependence analysis, that is, analysis focused on the amount of time between economic upturns and/or downturns, is being increasingly applied (Diebold and Rudebusch, 1991). And finally (but certainly not exhaustively!), co-integration analysis, which assesses the potential for (and usefulness of) disentangling data series that seem to move more or less synchronically in time is being increasingly applied (Maddala, 1988).

Two other LEI methods are also noteworthy, particularly in the context of sustainability research. The first, a consensus forecast (that is, pooling the "best guesses" of LEI experts and their models) is employed to improve forecasting performance (Renshaw, 1991). The second, a composite indicator (that is, indicators comprised of weighted averages of single leading economic indicators) have received quite a lot of attention -- both in terms of their inherent properties, as well as the generation of appropriate weights for the various single indicators being combined.

CONCLUSIONS AND IMPLICATIONS FOR SUSTAINABILITY RESEARCH

Against this backdrop of LEI research issues, foci, and methods, let me suggest some lessons for LIS research.

(1) Sound, convincingly tested, empirical based leading indicators of sustainability will be required in order to meet the needs of policymakers and the donor community. Failure to meet this requirement will signal the end of LIS research.

(2) Providing policy guidance must be an integral part of LIS research. Our work must generate leading indicators of sustainability that are quick, accurate, and can be used to take action. LEI research has been particularly good at this, and if the LIS research is to survive ten years (let alone fifty years!), we may need to borrow some of the LEI tools of the trade quite soon.

(3) Measurement without theory may indeed be a "blessing in disguise" at this juncture for LIS research. Theory (drawn from both social and biophysical sciences) can and should suggest where and how to look for leading indicators, even if conceptual and analytical frameworks associated with these theories are not sufficiently developed to explain the nature or timing of cause-and-effect. If LIS research is successful in identifying effective leading indicators, theory will "catch up."

(4) Incorporating household and community behavior into LIS research is essential, and a disproportionate focus on biophysical properties would seem unwise. The role of household and community objectives and expectations needs to be taken into consideration -- what are household and community objectives/expectations, how widespread are they, and to what degree are these objectives/expectations being met? Answers to these questions are critical. Millions of rural households are making resource use decisions every day, and they are driven by their needs, their expectations, and the constraints and incentives they face. For poor households in environmentally fragile areas, food security, the incidence of malnourishment among children, food prices, and real wages may indeed turn out to be our best indicators of sustainability, since they are the objectives and the immediate instruments of rural poor whose resource use decisions determine sustainability, or the lack thereof.

(5) Broadening the focus of LIS research to incorporate intersectoral, interregional, and even international links is essential. "Getting out of agriculture" might be the objective of many farmers in environmentally fragile areas. Failure to allow for such intersectoral links will weaken indicators of sustainability.

(6) Structural change is ongoing and very rapid in many areas experiencing environmental stress. This structural change must be incorporated into LIS research, both as a conditioner of leading indicators, as well as objective of research in itself, since some types of structural change (both in terms of direction and speed) might be more environmentally benign than others.

(7) There are many different types of data used by LEI researchers, and a vast array of statistical techniques are brought to bear in identifying and evaluating leading economic indicators. Some of these types of data and some of these analytical techniques could, with appropriate modifications, be useful in LIS research. Perhaps more importantly, as regards both data and methods, LIS re-

searchers *can* have data and analytical methods similar to those used by LEI researchers -- but data collection and the search for appropriate methods must be initiated now (and *with* the benefit of experience of LEI research) in order to guarantee that comprehensive, long-term LIS research can be done in the future.

(8) Finally, there is an important divergence between LEI and LIS research that must be acknowledged and researched. LEI research almost always assumes the existence of well-performing markets. Such markets often do not exist in developing countries in general, and environmentally fragile areas in developing countries, in particular. Markets are imperfect and sometimes even completely missing. These imperfections affect price determination and price transmission -- both of which have important implications for the spatial and temporal usefulness of leading indicators. Some indicators might have much higher degrees of "viscosity" than others -- both in terms of the geographic area for which they are relevant, as well as the time span for which they are useful.

ENDNOTES

1. The title was originally suggested by Townsend Swayze and modified at the suggestion of a visiting dignitary, identified in a subsequent footnote. Helpful comments on a preliminary draft were contributed by Peter Hazell, Phil Pardey, Marc Nerlove and Julie Witcover.

2. When originally contacted by SANREM to prepare a paper for this conference, I intended to contribute a conceptual paper linking poverty and environmental change. Shortly after making that decision, I was visited by the Angel of Hope (in the form of Larry Harrington!--both rarely seen in Washington, DC) who indicated that (yet another!) conceptual flow diagram was not needed. Instead, the Angel suggested I prepare a paper on "tools"--measurement and analytical techniques that sustainability research practioners sorely needed. Never doubting the wisdom of an Angel, I proceeded to prepare this paper. The poverty/environment paper is available upon request.

3. For those unfamiliar with mining history, canaries were often carried in cages by coal miners into mines. Canaries are highly sensitive to some of the poisonous gases that can collect at the bottom of and served as very good leading indicators of dangerous air quality conditions -- if the canary continued to sing, all was well; if the canary fell off the perch and died, coal miners immediately knew that there was a serious air quality problem.

4. Unfortunately, there were a couple of drawbacks. First, canaries were very "problem-specific," that is to say, while they were useful as air quality indicators, they were not particularly useful for floods, falling rocks and other kinds of potential mining disasters. Second, occasionally, canaries had to be sacrificed.

5. Personal communication from Al Philip, University of Pennsylvania.

6. This seeming convergence of purpose and possible (indeed hoped for!) similarity in the evolution of LEI and LIS research led me to focus on the LEI literature, rather than other scientific endeavors concerned with prediction -- i.e., earthquakes, stock market crashes, sun spots, etc.

7. This section borrows heavily from Lahiri and Moore (1991), Chapter 1.

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Sustainability: The Community Level Indicators and Their Research and Policy Implications

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INTRODUCTION

An important feature of sustainability work in the recent years is the widening gap between the conceptualization and the operationalization of the phenomenon. This is because the dominant perspectives of sustainability work are intellectually oriented. These perspectives tend to bypass the concerns and perceptions of the people/communities, who are both the alleged culprits of promoting unsustainability and direct victims of its consequences. We believe that understanding and incorporation of community concerns and perceptions can add to the relevance and increased usability of sustainability work.

The recognition and utilization of the people's approaches and concerns towards sustainability are obstructed by their high degree of invisibility. Three important factors contributing to this invisibility are:

(a) the lack of mechanisms on the part of the people to communicate what they feel rather than what researchers want to know.

(b) the background, orientation and training-induced inability of researchers and others to understand people's decisions and actions with regard to sustainability.

(c) the misapplication of people's economic behavior, represented by a "short planning horizon." This heavy discounting of the future puts "sustainability" (a futuristic phenomenon) far beyond the realm of a common man's thinking.

The factors (a) and (b) are removable disabilities to which this paper is addressed. The factor (c) is a conceptual fallacy, where the individual's behavior is made to represent the social behavior or a social process.

Long-term survival, growth, welfare, and sustainability are concerns addressed collectively in the form of activity patterns and processes evolved over time (as in the case of traditional societies) or established by formal, legal, fiscal and administrative mechanisms in present day societies. The individual's activities, even when they are conducted within short-time horizon, have to be compatible with, and contributory to, the long-term sustainability process.

MANIFESTATION OF COMMUNITY APPROACHES/CONCERNS TOWARDS SUSTAINABILITY

To understand the community's (common man's) concerns for sustainability it is necessary to describe sustainability first. The simplest way to describe sustainability is to couch the whole phenomenon in terms of options (quality and range of production-welfare options) and their undiminished availability inter-and/intra-generationally. This perspective is related to seeing sustainability more both as a process rather than as a consequence. Process implies that prac-

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tices and measures are directed to the protection and enhancement of production and welfare options without resource depletion. As a consequence of this process, production and welfare options are available.

Viewed from the process angle, the traditional resource management practices of folk agronomy, ethno-engineering and collective social arrangements reflect a community's approach and concerns for sustainability or option maintenance/ enhancement while protecting the resource base. Key features of these arrangements include diversification, flexibility, recycling, collective sharing arrangements and management of demand pressure on resources (Jodha, 1993). These, and similar practices are oriented to resource regeneration/protection while helping to production activities to provide an overall operational framework and direction for individual's decisions and actions within a short-time horizon. In this way, sustainability norms (evolved through trials and errors over time) have been codified in adaptation practices. While conducting their short-term activities, according to the well adapted mechanisms, individuals contributed to sustainability processes without explicitly thinking about these processes. By using these practices, they could maintain or enhance current options without reducing their scope for the future.

Decline of Processes

A rapid change in the demographic, institutional, economic and technological situation has made these traditional practices less feasible and less effective. The changed circumstances are less favorable to traditional forms of diversification, flexibility, recycling, collective sharing, etc. Consequently, the sustainability-promoting adaptations are rapidly eroding without any effective alternative arrangements being available.

Local communities are unable to evolve alternatives to suit the changed situations, as they did in the past, because the lead time available for trial and errors is drastically reduced in the face of rapidly changing circumstances and mounting pressures to fulfill immediate needs. Furthermore, opportunities for developing effective adaptations are severely curtailed due to the reduced social cohesion of the communities, marginalization of social sanctions and traditional wisdom, and the loss of community control over its own resources and their usage systems. These changes have been caused primarily by market forces, state interventions and the growth of individualistic tendencies in populations.

Missing Alternatives

While the state (and its agencies including those engaged in research and development policy and program formulation, etc.) has slowly usurped the initiatives and activity mandates from the people they have, by and large, failed to offer sustainability-promoting processes to the communities. Their top down approach and insensitivity to the grass roots level realities are the well-known reasons for the these failures. Moreover, in most cases these agencies have focused on short-term considerations (e.g., famine relief or agricultural technologies based on the use of high yielding varieties).

The collapse of the traditional sustainability-promoting processes and failures to have adequate alternatives have led to the emergence of unsustainability prospects. These unsustainability prospects are especially pronounced in the fragile and marginal resource zones, to which this paper relates.

Emergence of unsustainability, as represented by prospects of reduced range and quality of production and welfare options without external subsidization, are visible in several areas. Identification and understanding of indicators of emerging unsustainability, and the incorporation of the concept of unsustainability, into sustainability work is one way to link community concerns with the mainstream sustainability debate and action. We can reflect on indicators of unsustainability at three levels as discussed below.

INDICATORS OF UNSUSTAINABILITY

Indicators of unsustainability, i.e., failures to maintain/enhance production and welfare options without depleting the resource potential or generating external dependency, can be seen through: objective circumstances reflecting changes in the community's behavior and attitudes as well as their approach to their own resource base and the health status of the resource base itself.

We may examine these quite interrelated indicators of unsustainability in three contexts, namely: changes in social attitudes; persistent negative trends relating to resource conditions, productivity and management practices; and individual or group concerns about their present and future.

These contexts of unsustainability are elaborated below.

Changes in Social Attitudes

The different objective circumstances manifested in people's behavior, attitudes and perceptions, can be viewed as fundamental reflections of emerging unsustainability. Some of these indicators of unsustainability, relating to emerging health and natural resources usage patterns, are often camouflaged as public interventions for development and welfare. Policy makers in these situations should be alerted to the reality behind their achievements and their impact on target fulfillment. In the context of the options maintenance/enhancement-centered operational definition of sustainability, these indicators suggest a decline in the range and quality of options and the people's forced adjustments to this decline (i.e., accepting inferior alternatives).

Information in this paper relating to community behavior and community attitudes that reflect unsustainability, is based on the field studies and observations from mountain (hill) areas and from the dry tropics of South Asia.

Information on these aspects from the Himalayan countries represents a focused synthesis of what I have learned based on formal surveys, RRA (rapid rural appraisal) exercises, case histories, collaborative field activities and observations over a period of six years ending in 1993.

(a) **The community's (or the individual farmer's) acceptance of inferior production/consumption options (e.g., consumption of conventionally disregarded, low quality food, fodder or fuel items).** Examples of this acceptance of inferior fodder and fuel include the use of vanmara (*Eupatorium*) for fuel. This shrub from the middle hills of the Himalayan region formerly was rarely used. In the past, sesame stalks and pearl millet husks were considered as waste and left for decomposition. These residues are now used as fuel and fodder, respectively, in several parts of India (e.g., in Rajasthan). Similarly, in hills and dry tropical areas, material from field clearing is now used for fodder and fuel purposes instead of being thrown away. In many dry villages of Maharashtra and Andhra Pradesh poor people have started using congress grass as a fodder. This grass is an annual weed which causes skin irritation and disease.

The consumption by people of disease affected, shrunken, light and tiny grains of sorghum, millet and other pulses is an example of the use of inferior food items. In the dry land villages of India, these inferior grains, which are separated in the process of threshing and winnowing, were traditionally discarded for human consumption and given to the birds. Now people collect them and consume these grains. As a result, structures made in the past for pooling waste-grain for use by birds have now been demolished.

(b) **An intense degree of "desperation" in resource use, and production practices leading to over-extraction and degradation of the resource base.** "Desperate" land use practices include planting annual crops (with or without terraces) on the slopes beyond 30°. This is done in several parts of the Himalayan region, despite full knowledge that this practice accentuates the soil erosion process and that the expected yields from such cropping will be low. Another example, taken from areas of Rajasthan, is the extensive cropping of sand dunes, which results in dune destabilization and the movement of sand to neighboring fertile patches of land. A further example is the lopping of premature trees for fuel and fodder to the extent that their growth is stunted. A new phenomenon, manifesting high degree of desperation, has been observed in India during the drought periods in dry areas. This practice involves digging the roots of trees and shrubs for fuel, which permanently abolishes the source of fuel and fodder. Collecting food items from common property lands (e.g., village forest) soon after the seed formation and much before the product ripens is another example of desperate actions taken for survival. For example, in parts of Madhya Pradesh and Gujarat, honey gathering is done much before the appropriate time.

The practices listed above represent violations of all the norms of nature associated with higher and sustainable resource use. These actions are undertaken as very desperate people try to at least partially fulfill their immediate needs. Previously, violators of collective norms guiding the use of community resources were identified and punished. Now, regulations are no longer enforced due to the large number of people violating these norms.

(c) **Acceptance of external dependency as a normal basis of survival (e.g., closely linking the conduct of normal production and consumption activities to availability of subsidies and charity).** Examples of dependency on subsidies and charity include the dependency of farmers in dry and mountain regions on subsidized supplies of seeds and other inputs from the government. Traditionally, these farmers practiced seed selection, storage and mutual exchange of seeds. Similarly, maintenance and repair of collective assets, including village water tanks, the village hall, community grazing lands, or village temples, now are dependent on the receipt of government grants rather than based on collective self help. Drought relief and subsidized food from public distribution systems (as against self help) have became important parts of the community's pleading with the government for help. Communities in various areas feel it a matter of great achievement if they are able to get free resources from the state for any purpose. This is in contrast with the past (even 40 years ago), when dependence on charity (or even borrowing) was considered a sign of incompetence and disability of a person and their household and people avoided marital alliances with such families.

(d) **Loss of resilience or the capacity to face shocks (e.g., the decline of collective sharing systems to effectively face the impact of drought, flood and other disasters without external relief).** Related to the dependence on subsidy and charity is the collapse of collective arrangements and group action to meet environmental risks and undertake activities involving collective responsibilities, including providing help to the needy. Group responsibilities are replaced by individual efforts, as the former are too altruistic for the people so desperate to meet their current needs. The decline of traditional forms of group action for common property resource management and for upgrading local resources are other manifestations of this trend. In the ultimate analysis this loss of resilience amounts to the loss of the community's capacity to function collectively and perform specific functions.

What has been stated represents a loss of people's will, values and capacities to live with self confidence, self-help and collective effort. This is a loss of "social capital", on which social sustainability depends.

Health and Usage of Resource Base

The unsustainability trends related to the resource base and production processes of a system are manifested through:

(a) **Loss of "systematic integrity," implying the disappearance or weakening of resource-regenerative, resource-protective mechanisms or the non-functioning of linkages between different components of a system.** "Systematic integrity" means there are effective and reinforcing linkages between different components of a system as an organic entity. Farming-forestry linkages that facilitate nutrient cycling and sustained productivity of mountain agriculture is one example. Crop-livestock based mixed farming, mountain inter-cropping of cereals and legumes and the use of specific crop combination and rotation sequences in mountain and dry tropical agriculture are other examples. These practices facilitate the energy and material flows of nature in a specific ecological context. Discarding such practices under the pressure of short term needs implies a weakening of the organic integrity of a production system. And the breakdown of such integrative linkages between key components of a farming system means the emergence of unsustainability. The decline of diversified farming systems or resource use systems resulting in the breakdown of "systematic integrity" has been extensively documented by different researchers (Jodha, 1991).

(b) **Ever-increasing (biochemical, economic) subsidization of the production processes to maintain the same or even lower levels of performance (e.g., different forms of external subsidies to production, consumption activities).** A production system's crucial dependence on biological, chemical, and economic subsidies for its stability and productivity is more a symptom of unsustainability of a system than a sign of progress. Maintaining the level of crop yield through an ever-increasing use of external inputs (e.g., fertilizer) is a case in point. This trend is nowhere more visible than in several areas covered by the "green revolution" where crop yields are maintained increasingly through a variety of subsidies.

(c) **Marginalization, decline, and disappearance of the system or its components due to the loss of its identity, or its substitution by other component.** A prime example of the loss of system identity and efficiency is the replacement of land-use extensive, mixed farming systems by land-use intensive, high input technologies. The increasing unfeasibility of slash and burn (shifting cultivation) in the eastern Himalayas and crop-bush fallow rotation systems in the arid-semi arid parts of India are concrete examples of this trend.

(d) **Loss of recoupment capacities of the resource base.** Loss of recoupment is, for example reflected in the failure of rangelands to recover following droughts or the degradation of community forests or village pastures to the extent that it prevents their natural regeneration. Another manifestation of reduced recoupment capacity of production resources is the failure to replenish soil fertility lost due to the continuous cropping of cereals. Failure to provide rotations with legumes or periodic resting of the land may lead to permanent nutrient deficits or imbalances. In general, the high demand pressure on natural resources combined with people's resource extractive practices contribute to the loss of regenerative/ recoupment capacities of the resources.

In more concrete forms, the above changes are manifested through persistent negative trends in different variables. These verifiable or measurable negative changes (with varying degrees of visibility), are described as indicators of unsustainability and are discussed below:

Persistent Negative Trends

Persistent negative trends reflect the emergence of unsustainability, including reduced range and quality of options and are often concrete and more observable, verifiable, and in some cases, measurable. Some of these negative trends are integral parts of the unsustainability-inducing processes initiated by policy and research and development interventions. Examples include the discouragement, by new technologies, of crop diversification, land-use flexibility, collective sharing, and resource recycling. Other indicators of negative changes include the consequences of these processes.

However, our focus should be more on processes, since processes offer the entry points for policy makers to understand and incorporate community level indicators in their development framework. As illustrated by Table 1, these indicators of unsustainability relate to:

(a) resource base (e.g., decline of groundwater table or reduced extent of agro biodiversity);

(b) resource productivity (e.g., persistent decline in crop yields as well as in production of biomass);

(c) resource management/production practices (e.g., disappearance of various forms of diversification, facilitating resource regeneration; disappearance of institutional arrangements to enforce resource conservation measures).

Table 1: Negative Changes as Indicators of the Unsustainability of Agriculture in Dry Tropical Areas.[a]

	Changes Related to:[b]		
Visibility of Change	**Resource Base**	**Production Flows**	**Resource Use/Management Practices**
Directly visible changes	Various forms of resource degradation: emergence of salinity, coverage of fertile soil by shifting sands, vanishing topsoils due to water/wind erosion; deepening of water tables, groundwater salinization; emerging plantlessness, reduced perennials, increase in inferior annuals and thorny bushes; reduced per capita availability of productive resources.	Reduced total and per capita biomass availability; reduced average productivity of different crops, increased cropping on sub-marginal lands; reduced input product recycling; higher dependence on inferior options, (e.g., harvesting/lopping premature trees), rising severity of successive drought - impacts; increased dependence on public relief, increased migration.	Changes in land use pattern: cropping on sub-marginal lands; decline in common property resources; reduced diversity of agriculture (e.g., number of crops/enterprise and their inter-linkages); reduced feasibility and effectiveness of traditional adaptation strategies (e.g., rotations, inter-cropping, biomass strategies).
Changes concealed by responses to negative changes.	Substitution of cattle, camels, by small ruminants; increased emphasis on mechanization of cultivation and water lifting; reduced resting of land; large-scale reclamation (!) of wastelands; shift from local to external inputs (e.g., from manure to chemical fertilizers, wooden tire to rubber tires for bullock carts).[c]	Higher coverage by public distribution system (food, inputs) and other anti-poverty programs[c]; reduced reliance on self-provisioning system and greater dependence on external market sources; changes in land-use pattern favoring grain production.	Discarding of minor crops, shift towards monocropping with standardization inputs/practices; increased land-use intensity; shift from two oxen to one ox plough; tractorization[c]; replacement of self-help systems by public support systems.
Development initiatives etc. - with potentially negative changes[d]	R&D focus on: crops rather than on resources; technique rather than user - perspective (e.g., method/species/inputs rather than group action for watershed/ range development); resource-upgrading ignoring its limitations (e.g., irrigation in impeded drainage areas); inducing high use intensity of erodible soils, and other resource-extractive measures (e.g., tractorization).	Highly subsidized, narrowly focused production programs: focus on crops ignoring other land-based activities; grain yield ignoring biomass; monocropping ignoring diversification; relief operations focused on people and livestock ignoring resource base, thus promoting high pressure on poor resource base.	Sectoral focus of R&D and other support systems ignoring flexibility and diversification needs; privatization of common property resources; extension of generalized external approaches to specific areas: disregard of folk knowledge in formal interventions; replacing local informal arrangements by rigid legal/ administrative measures.

[a] Source: Table adapted from Jodha 1991. Based on synthesis of evidence and inferences from Jodha (1986a, b, 1989a, b, 1990b), Jodha et.al. (1988), Jodha and Singh (1990), Whitaker et al. (1991).

[b] Most of the changes are interrelated and they could fit into more than one block.

[c] Since a number of changes could be for reasons other than unsustainability, a fuller understanding of the underlying circumstances of a change will be necessary.

[d] Changes under this category differ from the ones under the above two categories, in the sense that they are yet to take place, and their potential emergence can be understood by examining the involved resource-use practices (i.e., processes) in relation to the specific characteristics of the resource base of the area.

The author has put together more than two dozen indicators for dry tropical and mountain areas (Jodha, 1991). Some indicators for fragile resource zones are summarized in Tables 1 and 2.

While some negative changes, such as yield declines and increased salinity of groundwater and soil, are clearly visible, others are concealed by human responses to these negative changes. Processes that conceal negative changes include substitution of shallow-rooted crops for deep-rooted crops due to erosion of topsoil and the increased dependence on chemical fertilizers, following the reduced regeneration of organic matter as a result of decline in farming-forestry-livestock linkages. Alternatively, some of these changes are visible at the macro-level while others are visible only at the micro-level.

It will be noted that some indicators of unsustainability represent the process of negative change while others are the negative consequences of change. For instance, the decline of diversification and resource-regenerative practices is a "process type" of indicator while the decline in productivity following these changes is a "consequence type" of indicator.

Community concerns and expectations

Community-level indicators of sustainability or unsustainability relate to people's concerns, desires, expectations, frustrations, and hopes as reflected by their decisions, actions, and expressed views as individuals or as groups. Some of these concerns converge with the objective circumstances (indicators of unsustainability) discussed above and offer a subjective interpretation of these circumstances. But more importantly, these concerns represent an assessment of the current situation and future possibilities by people both as individual participants in the process of change and as members of groups affected by the process of change.

The real value of this qualitative information on community level indicators of unsustainability and the people's strategies against unsustainability lies in an understanding of the whole dynamics of change processes affecting sustainability and unsustainability. For policy and research managers, this information may reveal both hitherto unrecognized signals of danger as well as alternative approaches to manage unsustainability. Table 3, based on information developed for the World Resource Institute's Project 2050 (Jodha, 1993) provides an example of how people's information can be integrated with policy information.

SUMMARY

This paper illustrated, in different ways, the emerging prospects of unsustainability in the fragile resource zones such as Himalayan region and dry tropical regions of India. The indicators of unsustainability, including reduced range and quality of production, welfare options without external support, were discussed in different inter-related contexts. Their policy implications were also identified. The key message of this paper was to incorporate these community level indicators to enhance relevance and usability of sustainability promoting efforts. (Jodha, 1993, 1991; Nigel et al.)

Table 2: Negative Changes as Indicators of the Unsustainability of Mountain Agriculture.[a]

	Changes Related to:[b]		
Visibility of Change	**Resource Base**	**Production Flows**	**Resource Use/Management Practices**
Directly visible changes	Increased landslides and other forms of land degradation; abandoned terraces; per capita reduced availability and fragmentation of land; deforestation, changed botanical composition of forest/pasture. Reduced waterflows for irrigation, domestic uses, and grinding mills.	Prolonged negative trend in yields of crops, livestock, etc.; increased input need per unit of production; increased time and distance involved in food, fodder, fuel gathering; reduced capacity and period of grinding/saw mills operated on water flow; lower per capita availability of agricultural products, etc.	Reduced extent of: fallowing, crop rotation, intercropping, diversified resource management practices; extension of plough to steep slopes; replacement of social sanctions for resource use by legal measures; unbalanced and high intensity of input use with subsidization.
Changes concealed by responses to changes	Substitution of: cattle by sheep/goat; deep rooted crops by shallow rooted ones; shift to non-local inputs. Substitution of water flow by fossil fuel for grinding mills; manure by chemical fertilizers.[c]	Increased seasonal migration; introduction of externally supported public distribution systems (food, inputs)[c], intensive cash cropping on limited areas, reduced availability of seasonally, spatially diversed products.[c]	Shifts in cropping pattern and composition of livestock; reduced diversity, increased specialization in monocropping; promotion of policies/programs with successful record outside, without local evaluation.[c]
Development initiatives etc. - with potentially negative changes.[d]	New systems without linkages to other diversified activities and regenerative processes; generating excessive dependence on outside resource (Fertilizer/pesticide based technologies, subsidies), ignoring traditional adaptation experiences (new irrigation structure); programs focused mainly on high resource use-intensity, resource extraction.	Agricultural measures directed to short term quick results; primarily product (as against resource) centered approaches to development; sectoral focus, narrow specialization (e.g., horticulture); high dependence on subsidies, development activities focused on limited products ignoring diversity.	Indifference of program and policies to mountain specificities (fragility, diversity, etc.); focus on short term gains; high centralization; excessive, crucial dependence on external advice ignoring traditional systems; generating permanent dependencies.

[a] Source: Table adapted from Jodha 1991. Based on synthesis of evidence and inferences from Jodha (1990), Shrestha (1992), Singh (1992), Shutain and Chunru (1989), Hussain and Erenstein (1992), Bajracharya (1992).

[b] Most of the changes are interrelated and they could fit into more than one block.

[c] Since a number of changes could be for reasons other than unsustainability, a fuller understanding of the underlying circumstances of a change will be necessary.

[d] Changes under this category differ from the ones under the above two categories, in the sense that they are yet to take place, and their potential emergence can be understood by examining the involved resource-use practices (i.e., processes) in relation to the specific mountain characteristics.

Table 3: People's Concerns and Responses to Unsustainability Prospects.

Concern 1. Rapidly shrinking resource base:

Declining Extent	Causes and Processes	Negative Responses	Limited Positive Responses	Policy and Research Implications
a. Per capita land holding; b. Access and availability of common property resources (CPRs); c. Soil fertility and resource productivity; d. Access to seasonally spatially diversified production opportunities.	a. Increased family size and land fragmentation; reduced migration possibilities, limited off-hand activities; b. State policies and market forces encouraging privatization, decline of group action/collective sharing systems, rapid growth human/animal population; c. Erosion of top soil, reduced availability of organic matter (dung, liter), reduced extent of: fallowing, crop rotation, inter cropping, recycling, diversification and regenerative practices; d. Decline of common property resources (CPRs) and collective sharing systems, reduced extent of diversification involving inter-linked land uses as encouraged by market forces, state subsidies and new technologies.	a. Reduced extent of fallowing the land, overcropping of exhausted land, cropping on sub-marginal (steep slope) lands, substituting crops for natural vegetation, discarding traditional slow-impacting resource conservation/ regenerative practices; b. Disregard of CPRs, grabbing CPRs as private property resource if possible, over exploit residual CPRs; c. Shift to low fertility requiring crops, shallow rooted crops with low productivity; increasing use and dependence on external, subsidized inputs (e.g., fertilizer); d. Forced reconciliation with reduced diversified opportunities, depend on opportunities as permitted/generated by market, new infrastructure and public supplies.	a. Focus on and skill acquisition for off-farm activities, land-use intensification using high value crops, resource-upgrading through irrigation inputs; b. Focus on activities with the lowest dependency on unworkable group action, revival of group action through user groups for forest, pasture, irrigation; c. Revival of biomass centered diversification, including agro-forestry, production of organic matter; d. Initiation of farm level diversification and market-induced linkages, focus on income generation rather than on diversified physical production.	a. Promotion of off-farm activities through skill generation and infrastructural support focused on harnessing of local resources and comparative advantages; development of technologies farming diversification, resource regeneration, recycling and harnessing of local 'niche,' technologies focused on biomass stability and agro-processing; b. Pro-active CPR policies; restoration of effective community control on CPRs; encouragement to user groups; technologies promoting/harnessing of CPR-PPR complementarities. c. Technologies promoting diversificatin and fertility management, biomass productivity and recycling, resource conservation/ regeneration technologies usable without group involvement; learning from the rationale of traditional practices.

Table 3: People's Concerns and Responses to Unsustainability Prospects. (Continued)

Declining Extent	Causes and Processes	Negative Responses	Limited Positive Responses	Policy and Research Implications
Concern 2: Falling production and shortages of supplies:				
a. Increased scarcity and instability of local products; b. Reduced availability of food, fodder, fuel and number and variety of products and increased dependency on external subsidized supplies.	a. Decline of crop/biomass/animal productivity due to emerging imbalances in resource use, resource degradation; shift of prime lands to limited high value crops; b. Reduced diversification of land use and cropping systems; decline of CPRs and collective sharing systems.	a. Increased use of traditionally discarded inferior products; over extraction of land and vegetative resources to meet current needs; increased dependence on external supplies and subsidies (public distribution system);	a. Dependence on farm level in place of village level diversification, revival of agro-forestry, complementary use of subsistence and high value crops.	a. Policy and research focus on locally appropriate diversification strategy; promotion to spontaneously emerging tendencies in resource management indicated by revival of agro-forestry, user groups.
Concern 3: Reduced dependability of traditional technologies and institutional arrangements:				
a. Folk-agronomic practices less feasible and less effective; b. Institutional arrangement, collective sharing, group action supporting resource management marginalized, made effective.	a. Reduced land holding obstructing land-extensive traditional practices; stable but low productivity and slower impacts make traditional practices less attractive, erosion of essential group actions for resource management; backlash of subsidized new technologies and their impressive impact in the short-term context. b. Imposition of formal legal, fiscal, administrative arrangements from above making traditional institutional arrangements ineffective.	a. Slowly discarding the traditional measures; adapting new technological measures with state subsidy; increasing demands for more and more state patronage and subsidies; combining traditional and modern technologies as possible; b. Switching over to new arrangements and alignments in place of participatory traditional arrangements; dependence on individual-centered strategies/approaches in place of group action;	a. Participation in transformation processes involving new technologies and new institutional support systems; integration of modern and traditional technologies, as appropriate, revival of task specific group action.	a. Recognition and utilization of rationale of traditional practices in designing new technologies and policies; bottom up and participatory development approaches, greater sensitivity to people's concerns in development intervention, community capacity building and local resource control

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Indicators of Sustainability: Community and Gender

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INTRODUCTION

A landscape approach to sustainability includes people, both individually and collectively. Viewing human interaction from a systems perspective, we understand that a community is greater than the sum of its individual members, although each member is critical to it. In this paper we will examine the community as a site where system-based indicators of sustainability can be identified and measured.

An alternative to aggregating individual behavior is to look at the community as a whole. By looking at community-level indicators related to sustainability, rather than a collection of individual knowledge, attitudes, and practices, we can better assess the potential of the community as embedded in the landscape to changes in the political, economic and biophysical environment. Further, a more structural approach to community sustainability can aid us in assessing the way in which sustainability is defined and change takes place in other indicators.

COMMUNITY SUSTAINABILITY

Community sustainability can be defined as the ability of a community to utilize its resources to ensure that all members of present and future members of that community, as well as those in adjacent communities, can attain a high degree of health and well-being, economic security, and a say in shaping their future while maintaining the integrity of the ecological systems on which all life and production depends (Kline, 1994). The definition implies a strong equity focus within the community, across generations, and across communities. This definition takes us well beyond the conventional indicators used for community development.

Community sustainability is based in part on the resiliency of that community in response to changes in conditions in the larger environment. This is true for plant communities and human communities. Following the biological systems model, community can be defined as the interactions among individuals. While for plants, such a definition is locality determined, for human communities, interactions may or may not be limited by geography, and there are communities of place and communities of interest. Just as the technology that made mass society possible gave us the ability to shop, worship, sleep, recreate, and work in different places, so the technology of the information age has made it possible to have our most intimate personal interactions with those a continent or more away, forming and reforming a vast number of overlapping communities of interest or affinity (Dillman, 1991). (Letter writing served this function in the past.) Yet the interactions based on locality are still critical for locality survival, particularly community resiliency. And because agriculture, of all productive activ-

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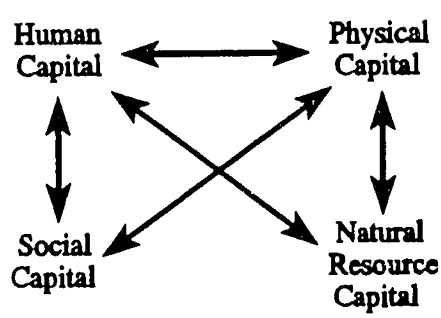
ities, is most bound to locality, it remains important to look at the sustainability of locality-based communities.

COMMUNITY RESOURCES

Resiliency depends in part on the resources available to a community. Those resources can be viewed as forms of capital which can be reinvested locally to produce new wealth. Capital can be thought of as any resource capable of producing new resources. Two forms of capital have conventionally been viewed as important for community development: physical or financial capital and human capital. When looking at community sustainability, it is also important to analyze natural resource capital and social capital. (See Figure 1.)

Figure 1: Forms of Capital Within Communities.



PHYSICAL CAPITAL

Physical capital in a community consists of the private and public capital goods and financial assets (Flora, et al., 1992: 109). Physical capital is what economists generally refer to as capital: human made inputs used in the production process. These include buildings, sewers, water systems, power stations, public revenues and bank deposits. There is a tendency to judge community development in terms of the increase in physical capital, in part because it is easy to measure. Physical capital is either already monetized or immediately convertible to monetary terms. Strategies of sustainability aim at maintaining physical capital over time and include concerns about distribution as well as total amount.

HUMAN CAPITAL

Human capital includes individual capacity and training. Economists define it as a productive resource, labor, consisting of the skills, abilities, education, and training which workers possess and bring to their jobs. Conventionally human capital has been measured in terms of formal educational attainment (again, probably because of ease of measurement and readily available census figures on this variable). Increasingly, there has been a great concern for leadership skills as a crucial part of human capital necessary for community development to take place. Human capital also includes non-formal skills that are associated with experience carrying out a particular task and indigenous knowledge about an area. Health status is another aspect of human capital important in development and sustainability. Strategies of sustainability aim at increasing the capacity of individuals within a community and diversifying the human capital resources.

NATURAL RESOURCE CAPITAL

Natural resource capital encompasses both the quantity and quality of water, soil, biodiversity, and scenery. Economists refer more narrowly to land to summarize the natural resources used in the production process. These assets can either be consumed or invested. A great deal of the emphasis in developing more sustainable agriculture and natural resources has been focussed on maintaining natural resource capital. There has been a major effort on the part of a wide variety of scientific organizations, from Land Grant Universities to the Agricultural Research Service of USDA to the International Agricultural Research Centers to develop measures of the sustainability of natural resource capital. There is as yet no agreement on what appropriate measures are. (For example, see the debate over the Revised Universal Soil Loss Equation (Glanz, 1994).

SOCIAL CAPITAL

Social capital in a community is defined as collective norms of reciprocity and mutual trust. Putnam (1993) describes social capital as referring "to features of social organization, such as networks, norms, and trust, that facilitate coordination and cooperation for mutual benefit. Social capital enhances the benefits of investment in physical and human capital."

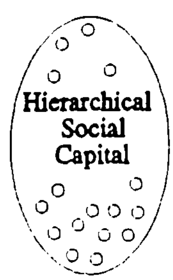
A number of scholars have looked at social capital as an individual attribute, focussing on the importance of networks of relations as a resource for persons (Coleman, 1988, Portes & Sensenbrenner, 1993). Many of these scholars base their discussion of social capital on rational action theory, related to public choice theory. As a result, they conclude that the decline in social capital and the tendency not to invest in social capital creation are because of the public goods nature of social capital, which means individuals capture little of the asset enhancement of their investment. Here we argue that there are structures, rather than individual motivations, that are biased against the formation of social capital. For example, the way that physical capital is enhanced can either help or hurt social capital development. When agricultural inputs are delivered in a top down fashion, with the decisions and resources coming totally from outside the community, social capital decreases and dependency increases.

Social capital has a variety of configurations. Each configuration has different implications for community sustainability. Social capital can be horizontal, hierarchical, or non-existent. Horizontal social capital implies egalitarian forms of reciprocity. Not only is each member of the community expected to give (and gains status and pleasure from doing so), but each is expected to receive as well. Each person in the community is seen as capable of providing any other member of the community something of value. Further, contributions to collective projects, from parades to the volunteer fire department and Girl Scouts, is defined as a "gift" to all. Horizonal social capital tends to embed networks within the community. An example is an established farmer in southeastern Minnesota who wrote a check to his neighbor, a sustainable agriculturalist who had been struggling with excessive debt load since the farm crisis. That money allowed the neighbor to get out of Chapter 11 (bankruptcy). He delivered the check with the message, "I hope you will be able to help out another young farmer some day." Social capital was being created -- for the community. Payback to the donor was not required or even expected.

Hierarchical social capital is quite different. While it is also built on norms of reciprocity and mutual trust, those networks are vertical rather than horizontal (see Figure 2). Traditional patron-client relationships, typical of urban gangs, are created. Receivers (have-nots) are much more numerous than givers (haves), and, as a result, the receivers owe incredible loyalty to their "patron". As a result, horizontal networks, particularly outside the sphere of influence of the patron, are actively discouraged. Dependency is created and mistrust of outsiders is generated. This type of social capital is prevalent in persistent poverty communities (Duncan, 1992).

Figure 2: Configuration of Social Capital Within Communities.

Presence of Social Capital



Absence of Social Capital

Absence of social capital is characterized by extreme isolation. In these communities, there is little trust, and, as a result, little interaction. Such communities tend to have high population turnover and high levels of conflict. When middle and upper class communities lack social capital, they are able to substitute physical capital: hiring private guards, fenced neighborhoods, and elaborate security systems. In poorer communities, there are often high levels of crime and delinquency. Putnam (1993) showed that areas in Italy with low levels of social capital had lower levels of government efficiency, lower levels of satisfaction with government, and slower rates of economic development than did provinces with high levels of social capital.

INTERACTIONS OF DIFFERENT FORMS OF CAPITAL

Each form of capital can enhance the productivity of the other forms of capital. Increasing social capital greatly cuts transaction costs, making other resource use more efficient. Granovetter (1985) was one of the first among an increasing number of scholars to propose the independent effect that social capital has on the functioning of economic systems.

Overemphasizing the value of a single form of capital can reduce the levels of other forms of capital. For example, over emphasis on generating physical capital (rice yield) without regard to the pollutants generated can reduce the value of human capital through negative impacts on health (as shown by recent IRRI research) or reduce the value of natural resource capital through destruction of soil and water quality or reduce the value of social capital through by-passing local networks and replacing them with impersonal bureaucratic structures with top-down mandates. Attention solely to natural resource capital can lead to a wasting of human capital and a decline in physical capital, as that form of capital preservation is pursued.

Despite the multiplier effects of social capital, conventionally it has received little attention in the community development literature or in practice or in assessing the interaction between agriculture and community. One reason is that social capital is extremely hard to measure because of its necessarily high level of abstraction, as it "inheres in the structure of relations between actors and among actors" Coleman, 1988: p. 98).

Because of its importance for community sustainability, it is important to try to measure social capital on a community level. Coleman has identified social structure that facilitates social capital on the individual level. He has identified closure of social networks (seeing the same people in more than one setting -- in the case of his study, church functions, school functions, and as parents of your children's friends) as an indicator of individual social capital and tried to operationalize that within the family in terms of the social capital available to the child from the family. In the case of community, Flora and Flora (1993) have identified some basic social structures within a community -- entrepreneurial social structure -- which can be seen as contributing to the development of community level social capital. These are: (1) symbolic diversity; (2) widespread resource mobilization; and (3) diversity of networks.

SOCIAL INFRASTRUCTURE

Symbolic Diversity

Symbols are the source of meaning for human beings. Symbolic interactionist theory informs us that meaning is not intrinsic in an object, but is socially determined through interaction. Different human groups have different sets of shared symbols. Indeed, the same object may have very different meanings for two different groups. The meaning given to the object in turn determines how one acts toward it (Mead, 1934). Symbolic diversity within a community means that while symbolic meanings for objects and interactions may differ, there is an appreciation among different community members of the different meaning sets. With symbolic diversity, there is a recognition of differences, but the differences are not hierarchical. "Different than" does not mean "better than". Thus one farming household can develop a hog enterprise, organized by the women, and a vegetable enterprise, organized by the men, while another household can have mixed grains, legumes, and poultry—with a different gendered division of labor. Neither enterprise mix is privileged by the community if it fits its environmental constraints—and women's enterprises are as valuable as those of men.

Where there is symbolic diversity, people within the community can disagree with each other and still respect each other. There is *acceptance of controversy.* Because differences of opinion are accepted as valid, problems are raised early and alternative solutions discussed. Members of the community are able to separate problems ("We need better medical care") from solutions ("We need a doctor"). People feel comfortable in raising issues without being accused of causing the problem. Discussion of the pros and cons of alternative solutions can be presented and argued. At times, an individual will argue for one solution. At other times, that same individual might make a strong argument for an alternative. An individual's identity is not conflated with her or his position on a particular issue. This is particularly important when management of agricultural and natural resources is becoming more sustainable, because a variety of alternatives must be tested, assessed, and adapted, and premature adherence to a simple "solution" can bring with it a host of unsustainable consequences.

Because controversy is accepted and issues are raised early, communities with social infrastructure which contributes to horizonal social capital have *depersonalization of politics.* Community members do not avoid taking a public position. Stands on issues are not viewed as moral imperatives. Because problems can be addressed early, one's stand on an issue is not equated with one's moral worth. Risk of character assassination -- and the destruction of one's job or ruination of one's social life -- is lessened for those who take on public charges. The much discussed burnout of volunteer public officials, which is often related to the great deal of abuse they face from their constituents, is thus less. People are willing to participate and take leadership roles in community government, cooperatives, parents organizations, and church groups. Broad participation results.

In communities with high levels of symbolic diversity, there is a *focus on process*, rather than on ends only. How we determine what is sustainable and how we organize to become more sustainable is as important as increased soil or water quality or high returns from agricultural enterprise. The process has its celebrations and its concerns. Communities that focus on process tend to have lots of local celebrations, including festivities surrounding planting trees and designing new systems, but also mechanisms of showing concern for those with problems. Problems are something that happen to good people, not a sign of moral weakness. Thus a farmer who has a sudden insect infestation can go to his neighbors and discuss alternative solutions, rather than simply borrowing money for more powerful insecticides.

Finally, communities with symbolic diversity have a *broad definition of community and permeable boundaries*. Such communities find it easy to become part of multicommunity and regional efforts, not by giving up community identity, but by expanding it. Such communities can identify with the landscape and have concern for those below them in the watershed as those above, whose run-off is sitting up on their ponds.

Resource Mobilization

The ability of a community to mobilize resources is critical for social capital to develop and is a vital part of community level social infrastructure. *Resources are defined broadly*, which allows a wider range of community members to contribute. For example, older community members might not have large quantities of cash, but have important knowledge of community history. Women's knowledge is respected as well as men's. This is particularly important in areas where modern varieties have been introduced. Often it is the women who save the land races that allow for genetic diversity (Altieri, 1994; Hoffmann-Kuehnel, 1989).

There is also relative equality of access to resources within a community. For example, it is assumed that every child should have a chance at a good education. School drops outs are viewed as a community-level problem, not the fulfilling of one's social destiny, based on one's parents' social status. Equity of access often means that a wide variety of resources, from swimming pools to golf courses to schools, are financed publicly and open to all, rather than owned by private individuals or elite social groups. In developing countries, it means that women's enterprises and income streams are acknowledged and protected. Women's gardens have equal access to water as men's cash crops, and education and training is made available to women and girls as well as men and boys. There is gender balance in resource allocation.

In order to enhance equality of access, resource mobilization as a part of social infrastructure contributing to community social capital formation includes *collective investment*. Such communities are willing to invest in themselves, through school bonds, public recreation programs, and volunteer fire departments and emergency squads. There is the expectation that all will participate in some way, and mechanisms in place to facilitate that participation. In developing countries, traditions of communal labor for the collective good, such as the *minga*, can represent such collective investment.

Finally, there is also *private investment*. Banks in such communities have high loan-deposit ratios, choosing to invest locally rather than in safe but distant government securities. Local entrepreneurs can find both equity capital and debt capital. And local people are willing to put individual dollars (or pesos) into local community development corporations and enterprises, often assuming that there will be no payback or that the payback will be in the distant future.

Networks

Networks are a crucial part of social capital (Coleman, 1988). Community social infrastructure facilitates their formation. A critical aspect of networks for social capital formation is *diversity*. While homogeneous groups are often the basis for diversity within the community, there must be networks formed with include individuals of diverse characteristics: young and old, men and women, different racial and ethnic groups, different social classes, and, often most difficult, new comers and old timers.

Networks that contribute to sustainable community development are *horizontal* to other communities. We refer to this as *lateral learning* (Flora and Flora, 1993). Communities that develop this kind of networking organize a diverse group of community residents to visit another community which has done something they want to emulate. They visit together, ask lots of questions, and come back determined to adapt the idea -- and do it even better. In the Philippines, the initial activities of the newly formed farm improvement associations included group visits to farms where more sustainable practices had been implemented. This spurred emulation and adaptation.

Vertical networks to regional, state or national centers are important for sustainable community development to take place and thus an important part of social infra-structure. Such networks link a large number of community individuals and groups to resources and markets beyond community limits. Wide access is a crucial part of this part of social infrastructure, because where there is a single gatekeeper between the community and the outside, no matter how well connected they are, the concentration of power in a single individual contributes to hierarchical, not horizontal, social capital. If vertical networks are limited to men or the dominant racial or ethnic group, they tend to generate hierarchical social capital.

Finally, community networks are *inclusive*. This is different from representational. There is a realization that by adding more people to the table means a larger community pie, not that the pie now has to be cut into more pieces. A social infrastructure that keeps adding diverse groups to the leadership networks is more likely to develop the social capital necessary for sustainable community development.

Social capital and social infrastructure can be developed or dismantled. Further more, social capital is gendered.

A study of pastoral women in milk processing and marketing in Zonkwa, Central Nigeria suggest the gendered nature of social capital and how shifting physical capital can destroy it, leading to declining community sustainability (Waters-Bayer, 1994). The central government invests mil-lions of dollars into modernization of dairying in the region, although the bulk of milk production remained largely controlled by Fulani women in the informal sector. That network of production and distribution served to form important inter-tribal recip-rocal exchange.

Their distribution linked producers directly to consumers rather than going through intermediaries. By choosing to deal directly with customers, women in the region had sustained a critical web of relations with their customers in which reciprocity and mutual support constituted the mainframe. For example, they receive the occasional bundle of wheat at harvest time, whilst they in turn make occasional gifts of butter or milk to their customers when they have special occasions. Through the forgoing of such networks, the Fulanis were able to acquire land (use? ownership?) from the indigenous Kaje and Kamantan ethnic group, the traditional holders of land rights in the region. As cited by Bayers, it was even suggested that these traditional mechanisms of exchange and reciprocity engendered the forgoing of bonds that helped to keep the peace and reduced tensions between the different ethnic groups.

The failures of the dairy production program in the region presents a lucid picture of the real consequences of neglecting to explore the more subtle dynamics of community social organization as a basis for implementing sustainable community interventions. Planners had failed to explore a priori the complex web of relations sustaining the traditional milk processing and marketing enterprise. As a consequence, they focused instead on male household members, not recognizing the gender related division of responsibility and control within the households and the traditional dairy enterprise. Capitalist oriented, extractive interventions could weaken complex networks built on horizontal linkages of reciprocity and mutual support such as existed in the Fulani community. In essence, the ability to build on existing social capital, a very important resource for developing community sustainability, could be compromised.

Where gender balance is destroyed by ignoring what women actually do, landscape sustainability declines. In a case study account of an agroforestry research project in the semi-arid farm and rangeland in Machakos District, Kenya, Rocheleau (1991) systematically brings to the fore the pervasiveness of gender in community organization for the management of natural resources. The study evidences the presence of women's self help groups as important signals of community sustainability because of its potential to address equity implications that so often pervade community issues.

These groups were largely reciprocal work groups and mutual aid networks where each member contributes to labor and other forms of productive activity of any member of the group. The range of activities include reciprocal weeding and terrace repair on each other's cropland to sharing of food and household supplies during social functions and periods of scarcity.

It has been suggested that community groups and associations function as more viable vehicles for implementing programs geared towards community development because of the greater degree of participation and equity it enhances (Bebbington, 1991; Rocheleau, 1989; Moose, 1993). It has also been posited that these community groups and associations foster a greater degree of effectiveness and accountability of programs. Thus the preference to work as groups rather than employing individual efforts on separate projects is indicative of a positive trend characterizing a sustainable community. Thus the presence of community self-help groups is an indicator of social capital within the community. The presence of male and female self-help groups is an indicator of potentially more equal access to resources.

Thrupp's (1984) work suggests that availability of cooking fuel is an important gendered indicator of sustainability. Drawing evidence from a rural community study in Kenya, she argues that the related problem of wood scarcity and fuel shortage are tied into women's poverty -- and thus how sustainably they judge a landscape -- because of the cultural restrictions that constrain women's access to or control of land. The widespread introduction of community woodlot and agroforestry projects do not necessarily translate into enhanced opportunities for women which therefore compromises the long term sustainability of such interventions. While a male might assess wood supply as sustainable as long as timber cutting were constant, women would assess the landscape's sustainability quite differently.

The Gendered Nature of Reliance on Social Capital

Both men and women rely on social capital to enhance the productivity of other forms of capital. But reliance on social capital—and the impacts of its absence—are more visible at lower social strata. Relying on social capital is part of a survival strategy which, though not exclusively, is frequently gendered due to the multiple roles that women play in the private sphere of the household and the public sphere of the community.

Social capital is sometimes tucked away in class-, race-, or gender-based social constructions. That is, careful consideration of how communities and households are organized by gender, class and race -- how they are stratified -- can reveal systems of reliance on social capital as a livelihood or survival strategy. Therefore, it is important to be alert, as Putnam points out, to the social inequalities that are sometimes embedded in social capital.

Men are not absent in systems of social capital. Yet studies and ethnographies demonstrate that women seem to *depend* on social capital as a primary livelihood and survival strategy to a much greater extent. Systems of social capital and social networks are gendered due to the different socially-ascribed roles that women and men play in the private and public sphere. In particular, whereas men tend to play a greater role in community politics (where they draw heavily on social capital), women are responsible for community managing as a "natural extension of their domestic work" or reproductive labor (Moser 1993, p. 35). Community managing, according to Moser, consists of "work undertaken at the community level, around the allocation, provisioning and managing of items of collective consumption" (p. 34). These items include water, health care, education, garbage collection, community gardens, playground construction, Christmas bazaars, altar guild, etc. Anglin (1993) tells how women in a small, poor community in North Carolina extended their history of sharing resources in their reproductive and productive labor efforts to struggle against power and job insecurity in the male-dominated mica industry, where their wages were kept lower than men's and work opportunity fluctuated with the seasons. In interviews women described how they took up collections to pay for health care when a co-worker fell ill, since health care was not provided by the factory, and extended illness could result in job loss. When there were new job openings, they informed their sisters and female cousins first. Those women who were unemployed became a part of the social network by looking out for the children of mica factory workers. Anglin describes this exchange of resources as qualitatively different from the experience of male community members who were employed in the factory. Women, she said, recognized and used the strength of kin and community networks to undermine the control that industry owners had over their lives.

Examples of reliance on social capital can be found in resource scarce communities and regions in the industrialized and developing worlds. (Although it is not always present and is frequently undermined by many social and economic policies.) Dill and Williams (1992) compare their research in rural Tennessee and Mississippi to research on women and poverty in developing countries. "As in the third world, low wages and underemployment in the South are made possible by laborers' reproductive costs being born by subsistence enclaves made up primarily of kin and informal sector work -- work that is disproportionately the burden of women" (p. 105). They conclude that poor, black women in the United States depend on informal kinship networks for child care and pooling and exchange of financial and other resources.

In areas where there are low levels of community level social capital, kin networks provide the access to resources in times of stress. These tend to emerge when there is hierarchical social capital, and high resource contentment and lack of trust outside of the family. They describe one 13-person household whose combined Food Stamp allotment ensures the survival of all, as individual allotments were insufficient for individual subsistence. In this case, three sisters and a brother living together on pooled resources makes up the social capital that allows each of them to keep their heads above water.

Similarly, Stack (1974) reveals the adaptive strategies that women predominantly create in an urban black community in the U.S. to cope with economic crisis. She calls them "cooperative networks" or "women's kin networks" through which the exchange of goods and services is channeled. Poverty in this community, she says, creates a necessity for reliance on this type of social capital. Women care for one another's children, share clothing and income among households, challenging the notion of the household as an insular economic unit even in our Western society. Obligation and trust is an important component of resource exchange. By "taking" or accepting goods or services a woman enters into an economic and social pact with the giver in which she pledges to reciprocate as the need arises. Furthermore this pact is monitored by the community. "The people living in the Flats cannot keep their resources and their needs a secret. Everyone knows who is working, when welfare checks arrive, and when additional resources are available" (p.37).

Ironically, the reliance on social capital in situations where community social capital is hierarchical, as both Dill and Williams (1992) and Stack (1974) point out, can prevent upward mobility. In a situation where resources are constantly scarce, no one person is able to accumulate capital. Many women expressed their unwillingness to leave a situation in which the risk factor is diffused. Because of low levels of social infrastructure—particularly when there is unequal access to resources—any change—to non-sustainable agriculture or even to a more prestigious job—puts at risk a scarce, but available capital on which one depends. The numerous sources of goods and services in systems of social networking at least ensures a household of survival. To leave such a community or system of social capital is to increase the risk that one will become destitute. A young black woman in Dill and Williams' study, offered the opportunity to try and find work in a bigger city, chose to remain in her impoverished community. "Alfrenell is reluctant to leave this community even for the prospect of a better standard of living. When one looks at how she manages to care for her children, work, and attend school, her reluctance to leave is quite understandable" (Dill and Williams 1992, p. 106).

A recent study in the Philippines parallels this widespread reliance on social capital among women in particular and the reluctance to leave the system behind despite its negative impact on natural resource degradation (Buenavista et al., 1994). The study, in the small, rural island community of Agbanga, demonstrates that a complex web of social relations based on an age-old system of resource exchange can be linked to specific resource management strategies which ensure villagers' survival. Although all members of this rural community play a role in the exchange network, class and gender emerge as important variables which differentiate reliance on the network and place along the succession of exchanges. Agbangans employ diverse livelihood strategies to ensure their survival, frequently relying on more than one strategy per household. Neighbors share their harvest, catch, products and even labor with one another allowing households to diversify their income and subsistence resources. Despite the encroachment of modernization and privatization of property, social capital is still a measurement of one's assets. It is particularly important to women, who tend to be involved in more subsidiary or sideline occupations (which fluctuate frequently and have historically been relied upon and cultivated when natural disasters wiped out male sources of income such as the fishing industry), like hog raising or selling dried fish. Resource exchange makes up the safety net for villagers as an important means of income diversification which allows households to mitigate the risks associated with agriculture and fishing -- two important male occupations.

Building Social Infrastructure

Thus, both First and Third World women in many cases have creatively transformed their situations of poverty into strategies for survival in remarkably similar ways. A fundamental challenge for development is how groups of poor women and men can gain access to further resources and power that would bring them beyond survival towards equal participation in defining the social, political and economic structures that govern the globe. As development practitioners, we have much to learn from the creative strategies that have allowed communities to survive; we can learn from the way in which communities have organized to allow the flow of social capital. It is particularly important that we do not enhance physical or natural resource capital and reduce or destroy social capital. And it is critical that we recognize the reasons for kin-based, kin-limited networks in situations of hierarchical community social capital. It is naive to conclude that families, communities and individuals can rely on social capital alone for development. As the examples here have shown in situations of hierarchical social capital, social capital tends to spread out resources not necessarily multiply them. However, when their is horizontal social capital, all other forms of capital can be enhanced. Development with the goal of economic gain and greater self-determination for communities and individuals depends on three types of capital: social, physical and human. Yet, as Putnam (1993) stresses, "Social capital enhances the benefits of investment in physical and human capital" (p. 26).

In communities where systems of social capital are present, the potential for building "entrepreneurial social infrastructure" towards a development based on "collective agency" is strong. Flora and Flora (1993) define entrepreneurial social infrastructure as "the diversity of symbols, mechanisms of resource mobilization, and quality of networks provided by social organization and interaction" (p. 49). Social infrastructure, they suggest, is a means by which "physical resources and leadership for community development" is linked. Where social capital is operationally present, social infrastructure can be built. And where attention is paid to enhancing entrepreneurial social infrastructure, social capital can be enhanced. Symbolic diversity depicts ways in which a community is inclusive and is willing to engage in debate which brings together different viewpoints. Resource mobilization entails a willingness to invest collectively. Finally, the quality of networks refers to those informal and formal networks which allow for the flow of resources (Flora and Flora 1993). Elements of these key ingredients are notably visible in gendered systems of social capital which have been systematically neglected as a valid and potentially prosperous form of social and economic organization.

Sustainability of natural resources depends on sustainability of physical capital (economic viability) and human capital (individual health and quality of life). Attention to enhancing horizontal social capital can reduce the transaction costs in investing in the other forms of capital and enhance long term community sustainability.

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Culturally Relevant Indicators of Sustainability

Robert Rhoades[1] and V.N. Sandoval[1]

INTRODUCTION

Since our job here today is to flesh out the traditional "indicators" (biodiversity indices, tree growth efficiencies, erosion rates, poverty measures, pollution levels, etc.) with a "culturally relevant" approach, we thought we would "soften" the discourse with some "down-home" Georgia stories. I (Rhoades) own a 320-acre farm in Oglethorpe County, Georgia, which allows me to mix with the local farm folk down at the feed store in Lexington (population 204). People from the outside would call these people "Red Necks," a pejorative term to some, but a source of pride to those who hang out at the feed store. In fact, this is the original home of Red Neck culture. Back in the days of cotton, farmers would come into town with the backs of their necks and collars red from the iron oxide in the soil; hence, "Red Necks."

My own personal barometer of Red Neck culture is Bubba Beck, a former cotton and soybean farmer who thinks I am from Ohio. I'm actually from Oklahoma which is a far cry from Yankee culture. I could never figure that out until someone told me that just about anyone not from Oglethorpe County and with a different accent must be from Ohio. Ohio is etched in the people's minds around here because, I came to appreciate later, both Sherman and Grant were Ohioans. History informs us what Sherman did to this neck of the woods located between Atlanta and the sea. Despite a natural suspicion of outsiders, it was Bubba himself who brought me back to my senses about this "sustainability question." After telling me about his latest Blue Tick Coon Dawg, we got off on how Oglethorpe County was being ruined by all that development from Atlanta (implies almost any town between the feedstore and Atlanta some 100 miles away). Outsiders, he told me, "was a movin' in, drivin' up the price of land, demanding thangs--like zoning laws, controls on coon huntin', garbage regulation and other pretty dumb 'guvermint thangs."

Bubba got me to thinking about the SANREM brochure advertising this indicators of sustainability conference, the one titled "How Do We Know?" (Meaning: How do we know if something is sustainable or unsustainable?). First, the thought hit me: Who are we? Second, From whose point of view do we know? Thinking about this reminded me of another Bubba Georgia story (rural peoples everywhere have great sense of humor about themselves). Bubba says "Yankees tell me that Georgia was settled by murderers and thieves--prisoners of Mother England. Damn them, every time I hear that it makes me want to kill 'em and steal their wallets." Then there is this story about how this old fellow was out in his cotton field, down around Macon, hoeing away when one of them city slickers pulled up in his big car to the fork in the road where the farmer was hoeing. The city slicker stuck his head out the window and yelled "Hey buster, does it matter which road I take to get to Atlanta?" The old farmer looked up, leaned on his hoe and

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replied "Nope, shore don't" and as the man sped away out of sight on the wrong road headed in the wrong direction, the old farmer yelled out "Don't matter to me no how!"

I am afraid that in our rush to define "indicators" we could be taking the wrong turn and leaving farmers standing in their fields shaking their heads saying "Don't matter to me no how." We have to make sure that "indicators" research comes back down to a cultural reality, to that which matters to people and not as something defined totally by outsiders. According to Webster, an indicator is "any device such as a gauge, dial, register or pointer that measures or records and visibly indicates." If only scientists can understand the dial, scientific "sustainable development" may be of little use to local populations.

Virtually every definition of sustainability in a survey we conducted of over 100 definitions includes the goal of meeting human needs over the long-term. However, while biophysical and economic indicators typically hold center stage in meetings like this one, we tend to forget about the "human needs" or, more arrogantly, we often believe they will be take care of *ipso facto* if the biophysical and economic ones are addressed first. Human needs, however, reach beyond money and even food, except perhaps in relief-emergency situations such as we recently witnessed in Rwanda. However, such famine-disaster situations are more the exception in the world today than the rule.

In this talk we want to argue three simple, but often forgotten, points:

- First, "sustainable development" has as much to do with human values and life purpose, including sense of community and bequeath value, as erosion rates, microbial biomass, bioconcentration of toxins and loss of biodiversity.

- Second, local people's environmental conceptions and "ethnoscience" must play a central role, not just be "taken into account" in any sustainable development project.

- Third, we need innovative approaches to build effective bridges between "culturally relevant" indicators and scientifically determined indicators.

HUMAN VALUES AND SUSTAINABLE DEVELOPMENT

It is easy and convenient to overlook local populations' own standards about what makes life, society and the environment worthwhile. After all, these are phenomenon which are fuzzy, messy, qualitative and mutable. These standards include cultural aspects--aesthetic, emotional, moral, religions and intergenerational (bequeath value). These are all considerations having a direct bearing on resource management and sustainable agriculture and livelihoods.

There have been attempts to address human needs through what is called "quality of life" research which, unfortunately, tends to be constructed through the "lenses" of outsiders. The view through these lenses are urban, technocratic, bureaucratic, academic, short-term and unidimensional. They tend to determine quality of life by how many in-door toilets you have, how close you live to a tarmac, income level, years of formal education, etc. Although bubba may value these things, he also values good neighbors, a dirt road, a good hunting "haller," and a mess of catfish. Its not that money, infrastructure, schools, clinics are unimportant, its just that there are other values beside money and productivity. The ethnographic literature is full of examples illustrating that all this "western" business may not be so desirable (high rate of heart attack, divorce rates, high blood pressure, suicide, murder, violent crimes, etc.) Sri Lankan fishermen like to joke that they must already live the great life since so many Europeans work so hard to earn enough money to come and lie around on the beaches where the Sri Lankans already live.

CULTURAL PERCEPTIONS AND SUSTAINABILITY

"Cultural factors" can determine whether something is perceived as a resource and put to extractive or sustainable use. Natural resources are not so much "natural" as cultural appraisals. A natural resource is a subset that has been carried out by the local population from the physical environment by virtue of its being useful or potentially useful. The carving out process is conceptual and cultural. People manage components of the landscape based on local categories of usefulness, uselessness and harmfulness. Each category embodies a "plan of action," For example, a "crop" is to be cultivated while a "weed" is to be eliminated. Kudzu in Japan is a valued plant, in Georgia its an exotic disaster. Plains Indians perceived black stuff oozing out of the ground as a curio, to us its the most valuable stuff in the world. These cultural plans of action can have powerful impacts. The 160-acre Jeffersonian image applied to the drier plains leads to the dust bowl. On the other hand, these cultural plans of action can provide solutions to sustainability problems. Whether perceptions are "scientifically right or wrong, we have to deal with them.

If we accept that cultural beliefs and behaviors are important in natural resource management, then it follows that "ethnoscience" should play a central role and be used to complement science. Farming or local management of natural resources is "performance" just as science is performance. Both performances require a cultural script or program defining or "orchestrating" how things are done and how they are communicated. For science, its the scientific method (a systematic, rigorous method of proof-disproof well understood by scientists). In fact, "indicators of sustainability" are typically cognitively determined categories of scientists. In farming, the script is based on farmers own understanding of what they consider as significant factors and relationships in their environment, their ethnoscience and how these can be combined to form a workable whole. While guided by different scripts, both scientific performance and farming performance require innovation and experimentation. Without doubt, scientists are innovators and tireless experimenters. What is less recognized is that farmers are innovators and experimenters too.

The point is that we should not overemphasize too much the differences between science and folk science, but rather explore the underlying foundations common to both. One way to look at it is that farmers are concerned with "how to grow rice," while scientists are concerned with "how rice grows." The anthropologist Levi-Strauss contrasted these as a difference between the "Science of the Abstract" and "Science of the Concrete." In sustainable development, scientists are concerned with "how sustainable systems function" while local populations are obviously concerned with "how to survive for the present without harming the chances of future generations."

While the goals of scientists and local people are similar, they are obviously different in their implications.

TOWARD A FIELD METHODOLOGY FOR CULTURALLY DRIVEN SUSTAINABLE DEVELOPMENT

What kinds of innovative approaches do we need to build effective bridges between "culturally relevant" indicators and scientifically determined indicators? This, we submit, is what SANREM is all about. As an integrating project, SANREM is obviously going to come under attack for not being "scientific" enough and for not being "practical" enough. This is the price we have to pay for working on the boundaries or the margins of different interest groups. However, just as evolution and new human cultures are most dynamic along the margins of systems so we feel that an interdisciplinary, interinstitutional project like SANREM will provide the same fertile grounds. SANREM will be successful if the project is able to provide us with the methods of how to more effectively conduct sustainable development projects.

We do not intend, in this paper, to develop the full methodology for SANREM since this is a process which will take much more experience and reflection. However, two suggested changes in traditional rural development research methodology are already forthcoming.

First, the methodology should use local conceptions and measures of biophysical and socioeconomic aspects as much as possible. This means that the questionnaire survey or other quantitative methods should be complemented with research tools which are more orally and visually based. The methodology should attempt to understand local conceptions of time and space and use these conceptions to understand past changes and future images of the "quality of life." These local understandings can be compared with the conceptions of planners, developers, educators, and researchers of the same time and space.

Second, although we might agree that any sustainable development project should aim toward economic security, ecological integrity, social equity and cultural relevance, we should also understand that local communities are not homogeneous blocks of people who think alike and act alike. There are power struggles within communities and even in the most remote area, individuals and groups are linked into supra-local power structures far removed from the immediate geographical contexts. Therefore, a simple "bottom-up" ideology alone may not be relevant. We need to realize that there are interest groups within local communities and most likely there will be trade-offs in any project which aims toward sustainable development. The methodology and, therefore, the results obtained should aim to understand differences within the communities according to ethnicity, class, gender and age.

Finally, we do not believe that sustainable development will be an easy process. It is easy for outsiders to set local priorities and allocate resources to address these priorities. It is much more difficult to give local people a voice in planning and policy. However, increasingly, local power groupings based on ethnicity, religion, community, etc. are demanding more and more of a role in their destinies. A decade ago developers could go into communities throughout the Third World and "do their thing." Today, community authorities are demanding answers at the outset, requiring local involvement in the projects and that something of value remain behind to benefit the local people. There is a widespread questioning today of the formerly accepted wisdom of the outside expert and the distant politician. Our Georgia informant Bubba Beck also symbolizes this emerging questioning of power. His favorite song is American Honky Tonk Bar Association, written and sung by country star Garth Brooks. The setting is a small town bar where the working class gathers to socialize and "cuss" the government. Bubba's favorite line is "Rejoice, you have a voice."

CONCLUSION

We would like to close with an altered poem which we have borrowed and "modernized" from the farming systems era, that last agricultural development movement whose lessons we have largely forgotten. We apologize to the original poet since their name has been lost to us.

Why Do (Sustainable) Farmers Do What They Do?

Ecologists, agronomists, and NGOs of late
Have discovered a new way to pontificate
Beyond more jargon, like "biodiversity indices,"
Bulk densities and input intensities
Working in all their infinite wisdom
They're trying to define a "sustainable system"
To answer the question for all of you
Why do farmers do what they do?

At universities and GIS labs around the globe
In offices, labs and watersheds they probe
Through participatory mapping in developing nations
User and farmer experimentations
With input and output extrapolations
Attempting to explain that profoundest of questions
With the diverse hypotheses they each eschew
On why farmers do what they do.

Variability and generalization
ITK and intensification
The issues discussed, the indicators enrolled
Satellite image and theories unfold
Papers get published, conferences convened
Projects are funded; it becomes obscene
When predictably they conclude in the mid-term review
That a more generous grant might give them a clue
As to why farmers do what they do.

Somewhere farmers plow and plant
Milk their cows, work and chant
After the interview, time lines and calculations
The experts retire to their research stations
And the farmers continue to grow their corn
While old women die and children are born
The men swap stories and drink their brew
And they scratch their heads and wonder anew
"Why do scientists do what they do?"

How Farmers Perceive Changes in Sustainability and How Interactions With Researchers Affect Their Practices

Alex Hitt*

OVERRIDING GUIDELINES USED IN UNDERSTANDING AND DEFINING SUSTAINABLE AGRICULTURE

To understand how farmers perceive changes in the agricultural and natural resource base, some guidelines first have to be established as to what is sustainable and why. An agricultural system that is sustainable is and will be diverse and complex just as an ecosystem is diverse and complex. In designing an agricultural ecosystem, what we are trying to do is to mimic an ecosystem. It will be a site-specific system and it should be governed by three principles.

The first of these principles is that it should be environmentally sound or benign and its interactions and relationships should be diverse and complex. The second of these principles is that it should be socially just. This includes all of the diverse and complex relationships between farmers and the outside world including labor, consumer, researcher, policy and quality of life issues. The third principle of system sustainability is that it should be economically sound. A practice that is environmentally sound does not always make sense economically. If farmers cannot make the bottom line work, then all the correct environmental and social practices will make no difference. It is only where these three principles overlap that a system is truly sustainable. There must be balance among these principles. However, how this balance is obtained will not be the same in all situations.

FACTORS WHY FARMERS CHANGE TO A MORE SUSTAINABLE SYSTEM

Some farmers just start out farming in a sustainable manner for one of two reasons. First, methods used in farming in an area or region that are sustainable may have been practiced for many years or generations. These practices are then passed along from family to family. In the case of many new farmers with no previous farm experience, farmers will start out using methods that are the latest technology and the most economical to implement. In the last five years these methods have been increasingly sustainable.

Alternatively, farmers begin to look for ways to save and improve their resource when they see that their natural resources are degenerating and their profits are falling. They will be motivated to change when they perceive that many of the practices that they have used for years just do not produce the yield increases that they feel they need to be profitable.

Besides resource degradation and decreasing profit, a third reason farmers change to a more sustainable system is because "the pain gets to be too much" for various reasons. Those reasons may be financial, such as rising costs of inputs and

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falling or steady prices. Other reasons are time or labor related. Farmers may decide to scale down to a more manageable size and possibly look for other crops with higher value.

Finally, an increasingly important reason to change is that producers are forced to change by regulations and/or the removal of tools or materials that they have relied upon in the past. As regulations are implemented and materials removed, farmers must learn to farm in other ways or get out of the business.

HOW DO FARMERS PERCEIVE CHANGES IN THE AGRICULTURAL AND NATURAL RESOURCE

When farmers adapt more sustainable systems, there are a variety of areas that they commonly look at for changes that indicate whether the new methods they are implementing are actually improving their resource base. The first of these are environmental changes. These indicators are the easiest to observe, but not always the easiest to measure. Improved soil conditions are the first change that farmers will notice. This includes reduced soil erosion, improved infiltration rates, and less compaction. It also includes less the objective indicator of "how it works," especially in marginal seasons.

Increased diversity of fauna is another observable change. This includes an increase in beneficial insects, birds, toads, ants and worms, as well as increases in some insect pests and other pests such as moles and voles.

There will also be a change in weed pressures and patterns when herbicide use is reduced and rotations are instituted. Reduced disease pressure, especially soil-borne diseases, should be noticed particularly in a good rotational system. These changes will not be immediate, instead they usually occur over at least a 5-year period. During this time pest problems will not be eliminated, but instead will become balanced within the agri-ecosystem.

The second major area of noticeable changes are economic factors. These are usually easier to quantify because they are in numeric form. These changes also reflect some of the socially just aspects of sustainability. Reduced or diversified sources of economic inputs, particularly those from off the farm, will be major changes which should result in an improved bottom line on the financial statement. While yields may not be as high, especially initially in a more sustainable production system, the cost to produce each unit should be less and, therefore, the net returns should be higher. Tied to the improved bottom line is a stabilization in the market resulting in less overproduction and less below cost selling of products. The farmer also may obtain higher average prices due to either producing higher value crops or cutting out the middle men and selling more directly to the consumer.

Managing a complex and diverse agricultural ecosystem requires better management skills. Planning becomes critical. Somewhat like preventative medicine, rotations, crop selection and soil fertility management all have to be planned carefully so that relationships can be taken advantage of for maximum benefit. This is in contrast to traditional practices that are based on waiting for a problem to occur and then finding a remedy. Timing is an important part of the planning process, especially in the area of planting, weed and pest control.

and producing in coordination with market windows. The better the planning and the relationships developed, the better the system works. This then becomes an indicator to the producer that they are headed in the correct direction.

One of the indicators most commonly cited with regard to social justice is the farmers' relationship with labor. In many cases, use of hired labor may not increase due to implementation of sustainable practices. Hired labor may be more efficiently used if it is spread out across many crops on a diversified operation than it would be if only a few crops are grown and peak periods occur requiring additional temporary (usually migrant) labor. If more local sources of labor can be used, then not only do the dollars stay in the community, but relationships and an understanding of farming can be improved with the surrounding non-farm community.

FACTORS THAT LIMIT THE ABILITY TO USE LAND SUSTAINABLY

Several factors can limit the ability of farmers to use land sustainably. These include farm size, markets, policies, and information availability. The size of an operation can be a barrier if diversity is a cornerstone of sustainability. For small farms, there may not be enough land to rotate effectively or to diversify using plots that are economically large enough to work. For large farmers, diversifying and placing some of their acreage into an alternative crop may prevent them from having enough base acreage in a program crop to qualify for government payments. This is a policy problem that probably should have never occurred in the first place, but that we must now must deal with. Another example is that because of limitations a rotational plan place on the size of the cropping area, the size of the plot may not be large enough to be able to produce a sufficient volume to meet the market demand of the marketing avenue chosen.

As indicated above, governmental policy can be a considerable limiting factor or disincentive, especially for a large-scale farming operations. These operations depend on global markets instead of local or regional food systems. Support payments are provided to insure a cheap food supply for industrial growth and national security instead of promoting the production of a reasonably priced food supply grown in a way that enhances the resource base while providing ample supply for the population.

Marketing of new crops suitable for diversification may be difficult and a limiting factor if the infrastructure for handling, processing, and transporting them to market is not available to the producer. This again, is mostly a problem for large producers whose production is not in tune with local or regional demand, but coordinated with global demand.

The most important limiting factor can be the education of and information delivery to farmers. Many people feel that we need to reinvent the wheel because the system is so far out of balance. In fact, most of the information needed is already available, it just needs to be organized well. One area of research that is required involves determining the relationships among all the parts within the system to each other. To date, most research has been targeted at isolated problems and has not addressed how those problems or forces react and relate to each other.

Once the proper information is organized or developed, the best system of information delivery is from farmer to farmer. Information is many times more likely to be adapted if a neighbor or a local farmer is already using the information in his or her operation. Communication lines between small-scale farmers are generally well established since they are usually marketing in the same ways or have similar problems and seek each other and adapt techniques that they observe other large producers using. Communications breakdowns occur if new methods are transferred from small-scale producers to large-scale producers and vice versa. Since small-scale/large-scale links are not well established, research and extension interventions are important in the transfer of information between these sectors.

HOW INTERACTIONS BETWEEN FARMERS AND RESEARCHERS AFFECT PRACTICES BY BOTH PARTIES

These are basic principles and guidelines for farmer and researcher interactions that will help farmers, researchers, and policy makers better understand each other. An overarching theory states that 20% of farmers in the United States are responsible for 80% of the production. However, the remaining 80% of farmers really comprise the farm "community." It is this group of farmers that provide most of the farm jobs and are the "entrepreneurs" in the farm sector who discover and develop the majority of the new methods and technologies. If policy makers desire a significant impact on the farm sector, then policy and research needs to be developed with that 80% as the target and as active program participants. The other 20% will then follow along as it always does.

When it comes to farmers and researchers working together, there are guidelines to keep in mind in insure successful results. The first is that it is important to remember that there are farmers and there are farmers. The best cooperating producers are those who are innovators and early adopters of new technologies and methods. Those farmers generally already have their own research and development projects to help answer site-specific problems that they have. They, therefore, are willing to help with research or obtain help from research that may further their operations. Farmers who are innovators and make their living from farming are also more serious about finding successful solutions to problems because their livelihood is directly related to the questions and the answers. Once a farmer or group of farmers have been identified and have successfully worked on a project, researchers should continue to work with that group. This is because the best results come from working with the same whole-farm systems over time in order to understand all the forces that affect the system.

Time is the most limiting factor for farmers when it comes to their participation in research or policy development. Generally, the smaller the operation the less time the operator has for activities other than those that produce income. In order to enhance the ability of small-scale farmers to participate in research programs, planning sessions should be scheduled for the off-season. Farmers' actual program participation should be limited during the growing season. If possible, it is best to provide some type of compensation to farmers who have to leave their operations to meet since they are not being paid otherwise while away from the farm.

Producers who are active in research projects and other similar interactions also will usually have strong voices in the policy arena. There are several reasons for this. When a person works with groups outside of their daily environment, they are exposed to different view points. Therefore, they are then better able to see the "big" picture and make intelligent decisions regarding this "big" picture. Farmers who regularly work with research teams are better able to speak the "language" and act as translators between the farm community and the research community. These people are taken more seriously by researchers and policy makers since they appear more informed and their information is more statistically based. These farmers also are more credible with other farmers, particularly when small-scale farmers are dealing with large-scale farmers. Just as with farmers, there are researchers and there are researchers. Farmers should not become involved with researchers who are not interested in sustainable agriculture, but who are instead just trying to find less toxic and temporary answers to conventional problems or who just want to write another paper on any subject and sustainable is currently en vogue.

All sides in the agricultural picture have in the past been working in a vacuum and part of the sustainable formula is to have all sides talking to each other. Just sharing information can change how one looks at the system. Those interactions alone can rapidly change sustainable practices.

A final factor that affects practices by both farmers and researchers is the powerful fear of the unknown. Farmers are very hands-on people. Therefore, they need some proof if they are to make changes in the way they operate. Researchers, similarly, are skeptical about farmers' claims until they can observe and measure the situation. By working together each side obtains faster feedback which results in faster changes in the system.

Farmers who participate in research on their own farmers generally take better care of the research area than they would their normal crops. They will follow all the proper steps on the research plot. Often, they will see better crop response and will likely implement those steps on more acreage during the next growing season. When this sense of personal observation is combined with the fact that they have some ownership in this new idea, not only will there be faster adaptation on their own farms, but they are more likely to want to share the idea with other producers.

Further support for farmer-research cooperation is that many times farmers lack the time and technical or financial support for improvement and adaptation of an idea that they have. On-farm research often can augment the farmers resources and such programs such as SARE/ACE Producer Initiated Grants allow farmers to overcome limiting "transition costs."

CONCLUSIONS

For agriculture to be sustainable, the whole system has to be considered. It must be balanced between environmental, social and economic considerations if it is to be truly sustainable. Research and policy decisions need to be made with all the participants working together and with the focus on the needs and problems of the majority of the farm community, not the few major producers.

Return of the Water Spirits: The Role of Environmental Education in Cultural and Ecological Sustainability

William Deutsch,[1] Glicerio Tan,[2] Jim Orprecio,[3] and Constance Neely[4]

INTRODUCTION

In an effort to link environmental education and indicators of sustainability, the Water Resource Management and Education work plan of the SANREM CRSP (Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program)/Philippines has focused on the development of citizen monitoring of water quality. Through this means of participatory research, biophysical indicators of natural resource conditions are being developed in a context of a traditional, spiritual view of environment held by a local tribal community.

WATER AND THE TRIBAL COMMUNITY OF LANTAPAN

The site for the SANREM CRSP/Philippines program includes the municipality of Lantapan, Bukidnon Province, Mindanao. This municipality is approximately 36,000 ha, with elevations ranging from about 800 m (lowland rice zone) to nearly 3,000 m in the Katanglad Mountain Range. It is transected by four major rivers (Kulasihan, Alanib, Maagnao and Tugasan) which flow southeast to the Manupali River. The Manupali forms the southern boundary of the municipality and flows east to the Pulangi River.

Water quality concerns expressed by community members or identified by researchers during a participatory landscape/lifescape appraisal (PLLA) include (1) pesticide and fertilizer runoff resulting in water contamination and subsequent health hazards, (2) soil erosion resulting in high turbidity and sedimentation of streams, reservoirs and irrigation canals, and (3) waterborne diseases of humans and livestock. The community has also expressed concern about water quantity. This includes springs that no longer flow and streams that dry up in the dry season and flood in the rainy season. Many of these changes in the water of Lantapan have occurred within the memory of adult residents (1-3 decades).

The Talaandig are indigenous people of Lantapan and make up from about 40% of the municipal population in the lowlands to 95% in the uplands. Like many tribal groups worldwide, the traditional Talaandig lifestyle is threatened by social, economic and political forces from the encroaching "mainstream" culture. Talaandig leaders are concerned about land tenure issues, degrading environmental quality and cultural assimilation.

Unlike many Filipino or "western" assessments of symptoms, causes and cures of unsustainable land use and environmental

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degradation, the Talaandig world view includes a concept of spirits which influence all aspects of life. A Talaandig leader, Adolino Saway, has said:

> *We cannot talk about the land without also talking about the spirit of the water, the spirit of the trees, the spirit of the wind, the spirit of the fire, the spirit of the word, and the spirit of the thought. Agriculture has declined and the environment has become degraded because we have not entertained all the spirits equally. To avoid conflicts, we must listen to all the seven spirits.*

THE WATER RESOURCE MANAGEMENT AND EDUCATION PLAN

As part of the work plan activities in Lantapan, community members have participated in interactive trainings related to water issues and citizen monitoring. Monitoring teams use portable water quality test kits and other equipment to measure physical, chemical and biological characteristics at several stream sites across the landscape.

Preliminary findings have identified potentially valuable bioindicators and have detected both natural and human-induced water quality gradients for several chemical parameters, related to position in the landscape and land use.

THE "WATER SPIRIT" LINK BETWEEN STREAMS AND THE COMMUNITY

Stream studies conducted on site have included samples of stream organisms called benthic macroinvertebrates. This community is primarily composed of insects, molluscs and worms that live in or on the stream substrates. Macroinvertebrates can be valuable indicators of water quality, and they are often particularly useful for stream assessments because they are abundant, diverse and relatively sessile. Changes in macroinvertebrate community structure (fluctuations in numbers and proportions of various taxa) may reflect changes in water quality (degradation, recovery, seasonal fluctuations, etc.).

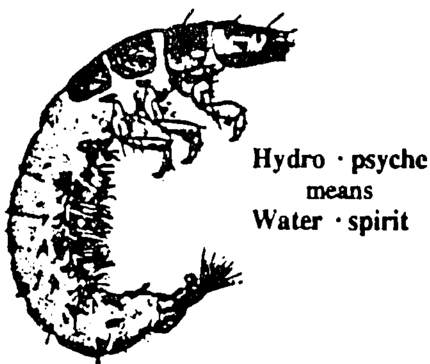
These organisms have been routinely used for streams quality evaluations in North America for decades. The development of "rapid bioassessment" protocols is an active area of research for aquatic ecologists, and such biotic indices of water quality developed for temperate climates are just beginning to be adapted for use in the tropics. Nevertheless, our early interactions with the community have revealed indigenous bioindicators of the environment in general and water specifically. For example, Vidal Villanueva, a citizen monitor and member of the Talaandig community, noted during a stream survey that an abundance of a certain aquatic insect is an indicator of an early dry season.

Among the many macroinvertebrate taxa collected in the streams of Lantapan was an aquatic insect in the Order Trichoptera (caddisflies) and the Family Hydropsychidae. Hydropsychids are found throughout the world and are often a common and important component of stream ecosystems. They have the potential for being a valuable indicator of water quality of Lantapan because of their ecology. The immature (larval) hydropsychids construct shelters attached to solid stream substrates (gravel, cobbles, boulders) and spin silken nets to filter food particles from flowing water.

Because of this behavior, they are sensitive to excessive amounts of suspended soils (their nets become clogged and useless) and siltation (habitat loss for shelters). Like other aquatic insects, hydropsychids are susceptible to agricultural pesticides which may enter streams.

Coincidentally, yet symbolically,

Figure 1: Hydropsyche, the water spirit.



psyche \ 'sī(,)kē \ n
[Gk psychē life, spirit, soul self]

Kingdom · Animalia
Phylum · Arthropoda
Class · Insecta
Order · Trichoptera
Family · Hydropsychidae
Genus · Hydropsyche

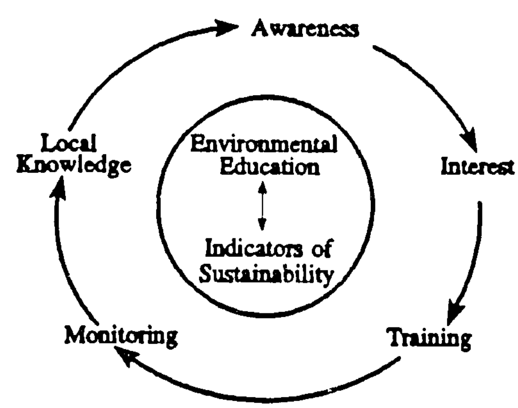
Can the hydropsychids be used as a symbol of environmental health...their "return" to a degraded stream being an indicator of ecological recovery? As "water spirits," can they also signify a link to and appreciation of the Talaandig world view? Could such an educational approach help to return a sense of cultural pride to Talaandig children and enable tribal members to incorporate potentially useful science and technologies without abandoning traditions?

> *Moving forward, looking back ...ecological sustainability is rooted as much in past practices, folkways, and traditions as in the creation of new knowledge.*
>
> \- David Orr, 1992

ENVIRONMENTAL EDUCATION AND INDICATORS OF SUSTAINABILITY

Figure 2 illustrates how environmental education and locally developed indicators of sustainability may interact. Awareness of water issues through education generates interest which leads to training and monitoring of the resource. This generates or "rediscovers" local knowledge (including both traditional and newly developed indicators) which in turn increases awareness.

Figure 2. The Cycle of Indicators of Sustainability Arising From Environmental Education



Ideally, environmental education could be instrumental in moving toward social sustainability. The formation of community-based, water quality monitoring teams has a potential that extends beyond the immediate intention of environmental measurement. Workshops that create new associations of people and introduce principles and techniques to the community may have many other positive, yet unpredictable outcomes. Excitement about new skills, pride in taking a personal part in environmental protection and unity of people with common goals contribute to the "social capital" which may propel a community into a more sustainable future (see Flora et al. this volume for an elaboration on social sustainability).

CONCLUSION

What can be the highest aspirations of a well-implemented plan of environmental education? Among other things, it would impart skills and ideas that would empower a community to better understand and address environmental problems. Practical indicators of ecological sustainability, developed through participatory research, would enable people to detect environmental deterioration or recovery and evaluate their land use practices. Ever-increasing environmental awareness could lead to continued refinement of indicators and improved farming and conservation practices. The process of people taking an interest in such a venture is, in itself, an indicator of cultural and social sustainability.

ACKNOWLEDGMENTS

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Ecological, Financial and Social Monitoring to Develop Highly Sustainable Farming Practices[1]

George Boody[2] and Larry L. Johnson[3]

INTRODUCTION

This paper discusses a farmer-driven participatory research project that is currently being conducted. The project, in response to questions raised by farmers, examines a farming practice that appears to be highly sustainable.

The long-term goals of the project are to (1) increase the number of farmers who employ environmentally sound, profitable farming systems that support wide biological diversity in the landscape and (2) forge stronger economic and social links between farmers and other community members. This project focuses on Management Intensive Grazing (MIG), which appears to be a highly sustainable farming system. Unfortunately, farmers and researchers do not have sufficient knowledge about what to monitor to determine the effects of farming systems such as MIG on the agro-ecosystem. The project team combines the expertise and participation of farmers, researchers, public agency staff, non-profit staff, and consultants to develop monitoring approaches that will help farmers measure ecological, financial and social impacts of changes in their farming systems.

BACKGROUND

The National Research Council's report "Alternative Agriculture" (NRC, 1989) identified a number of environmental and economic problems associated with conventional U.S. agriculture. These problems include surface water pollution, of which agriculture is the largest non-point source, groundwater pollution from nitrates and pesticides, soil erosion, pest resistance to pesticides, pesticide residues in food, the high cost of purchased inputs, and the high cost of federal farm programs. In Minnesota, problems include significant levels of sedimentation and other forms of pollution in key river systems as a result of conventional agricultural practices (Hawkins and Stewart, 1990; Kolze, 1992) and chronic negative effects of modern agriculture on terrestrial and aquatic wildlife (Robinson, 1990).

An example of a sustainable farming system that is an alternative to conventional animal agricultural production systems is Management Intensive Grazing (MIG). In this system, vigorous plots of grass are harvested by livestock rotated among numerous small paddocks (Murphy et al., 1986). MIG appears to be an example of a farming practice that uses minimal off-farm inputs, increases profitability, improves farm family quality of life, and reduces soil erosion (Parker et al., 1992; Zartman, in press). As farmers in southeastern Minnesota turn to MIG, representatives of conservation groups and natural resource agencies also are being attracted by the potential for greatly reduced soil erosion and water

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quality impacts, and by improved habitat for both terrestrial and aquatic species (Hawkins, 1993 personal communication; Robinson, 1989). In this project, monitoring methods are applied to farms in various stages of transition to MIG.

Many farmers are looking for highly sustainable farming systems, such as MIG, that reduce the cost of inputs, maintain or improve the resource base, and protect human health (NRC, 1989). They also are looking for approaches to research that include farmers as members of research teams working on problems relevant to their farming systems (Ikerd, 1993; Mulins, 1991). Farmers are missing, and have requested, the tools to concretely assess whether new management systems are actually moving their farm and family's health in the desired direction.

MONITORING INDICATORS

A critical component of effective farm management is establishing realistic goals and then monitoring the system with those predetermined goals in mind. This project identifies and monitors ecological, financial, and social changes associated with MIG. These indicators will be integrated through a participatory, whole-systems research process into new "farmer friendly" monitoring approaches and methods. Farm families will be able to do their own monitoring of the impacts their farming practices are having on the ecology of the farm and family well-being.

On-farm monitoring to ascertain the status of the farm ecosystem is usually limited to measuring production factors such as yield, nutrient levels in soil and plant tissue, and identification of weeds, insect pests, and diseases. Soil physical and chemical properties, for example, have been the traditional measures of soil response to changes in management because of the difficulties in quantifying and predicting soil biological behavior (Parr et al., 1992). A minimum set of soil quality indicators has been distilled from a number of recent meetings [Rodale Research Institute, 1991; North Central Regional Committee (NCR-59) on Soil Organic Matter and Soil Quality, 1991-93; and two symposia at American Society of Agronomy Meetings (1990 and 1992)]. Many of these indicators are included in this project and thus will make it comparable to ongoing projects in other states, as well as to the Northwest Area Foundation Soil Quality Indicator Project (NWAFSQI), the EPA-USDA sponsored National Environmental Monitoring and Assessment Program (EMAP), and the NSF Long Term Ecological Research Site at the Kellogg Biological Field Station (KBFS). The sensitivity of these indicators to changes in farm management make them effective measurements (Reganold et al., 1993; Karlen and Colvin, 1992; Weil et al., 1993).

Ecological Changes

The research team has chosen a range of ecological indicators for this study to begin to document management impacts on the farm environment. These indicators include birds, insects, frogs and toads, and nematodes. Birds and insects are commonly monitored, as they respond to rapidly changing habitat conditions (Spellberg, 1991). Birds are readily observable and can be identified by call (BBS, 1990). Frogs and toads are sensitive to water quality and adjacent land uses (MHS, 1993). The EMAP Agro-ecosystems section is planning to use nematode community structure as a measure of soil microbial diversity (Campbell et al., 1993). Their reasons include the ubiquitousness of nematodes, relative ease of sampling and separation into trophic groups, and the fact that disturbance of nematode populations is generally reflected in a change in trophic structure (Campbell et al., 1993).

The connection between land use and surface water quality is well established (Hawkins and Stewart, 1990). Assessing the impacts of individual farms on surface water quality is difficult at best due, in large part, to regional influences on surface water quality, which cannot be separated from the impacts (positive and negative) an individual farm might have on water quality. Based, however, on observations and physical measurements taken this summer on Sugar Loaf Creek, Wabasha County, in conjunction with this project, we have been successful in quantifying differences in surface water quality due to riparian zone management. Preliminary analysis suggests that the current grazing management at this location provides more desirable stream physical characteristics (e.g. low width: depth ratio) than does wild wooded riparian corridor management. The interrelationship between surface water and ground water will also be evaluated.

Financial Changes

Economic and production parameters will be measured to evaluate how changes in management influence the sustainability of the farm. Whole farm profitability coupled with gross margin enterprise return is necessary to evaluate the performance of a sustainable system (Lee, 1992). Odum (1989) has discussed the need to evaluate production based on energy analysis. Production parameters such as biomass, animal health, and animal product yield must be measured to understand the whole farm impacts of changing management systems (Zartman, in press).

Social Changes

Family quality of life is a social factor that can change as a result of adopting a new management system. Family variables are being measured through participatory techniques and through interview/ questionnaire techniques. Family quality of life needs to be measured not simply as another dependent variable, but as an integral systems variable that influences technology adoption (Buenavista and Flora, in press; Danes and Rettig, 1993). Interactive methods of assessment are more participatory and can provide immediate information to the household for their own analysis (Buenavista and Flora in press). Family dynamics, ownership plans for the next generation, long-range goals for the business, and personal and professional development are key parts of family quality-of-life (Handler, 1989).

Participatory Research

Like nature in a microcosm, a farm is a complex system of interaction where each component is connected to everything else. On-farm research and analysis must therefore be carried out in a whole systems context (Flora, 1991). Whole systems research emphasizes interpreting facts in a way that relates them to the real world, including qualitative as well as quantitative analysis. Through a participatory process, the farmers, who are the intended beneficiaries, are given a direct role in the design of research, documentation of findings, and demonstration of new management approaches resulting from their research. Moreover, researchers, agency personnel, and other agricultural professionals also participate in a process that could change their perceptions about how research and policy should be developed and carried out. This process is intended to help research team participants make constructive changes in their own lives and to lead to structural change in the institutions of which they are members (Park, 1990).

PROJECT PLAN

Objectives

Farmers want to improve the ecosystem and sustainability of their farms, but lack the necessary tools for monitoring the effectiveness of the management changes they make. This project encourages the adoption of sustainable systems by developing those monitoring tools. Such tools may help reverse the increasing emphasis on regulation as a way to solve agriculture's environmental problems, which may preempt locally developed management solutions well-suited to individual farms. Project activities will help create an improved climate for cross-fertilization of ideas and creative problem-solving among farmers, researchers and regulators. All members of the team and their institutions will benefit from the availability of these tools, the data generated by this project, and by participating in the whole-systems approach we have adopted. Additionally, farmers considering whether to use MIG will benefit from this project. Once the monitoring approaches have been tested for MIG, they will be generalizable to other management alternatives as well.

The team has developed a set of project objectives for both the short term (two to three years) and the longer term (four to eight years):

(1) Develop and test indicators that can be used by farmers for monitoring:

Ecosystem health.

Economic and social well-being of the farm family.

(2) Implement a new model for designing agricultural research that:

Is participatory and farmer-driven.

Uses a whole-systems approach that depends on dialogue among all team members.

Fosters changes in research approaches by all project team members and their institutions.

(3) Engage farmers, researchers, public agency officials and others in feedback and application of farmer-friendly monitoring and whole systems participatory research.

Activities

During the past year, the team has identified and prioritized key variables and methods for testing. These are categorized as ecological, financial, and social monitoring parameters. In each category variables have been identified that farmers themselves can measure and methods have been developed to compare the results of farmer measures with scientifically accepted parameters. By hiring a post-doctoral scientist to coordinate the data collection and analysis, and by using the team to interpret the data, the team intends to make scientifically valid data as meaningful as possible to the practical concerns of farmers. To meet the objective of developing a participatory whole-systems research process, the team will continue to evolve and to evaluate its own team process. To involve as many farmers as possible and to make the results useful to many others, this project will organize education and feedback sessions and disseminate the findings of this study.

Ecological, financial, and social parameters will be monitored over time on six farms that are undergoing a transition from conventional farming to MIG. These farmers are part of the research team (team farm). Each team farm will be paired with an adjacent or nearby conventionally managed farm to monitor for ecological impacts (paired farm). In evaluating these indicators relative to the transition from conventional farming to MIG the following information will be obtained:

· Changes in indicators will be documented over time as individual team farms make a significant management transition. Time series data will be augmented by sampling from three fields on each team farm that are in different stages of transition from row cropping to MIG. These data will provide the basis for the development of a set of case histories on the ecological, financial, and social changes that accompany a dramatic shift in farm management strategy.

· The paired farms will be used to compare ecological indicators on conventionally managed versus MIG managed farms, thereby providing year by year insights into the potential environmental conditions under which the management strategies differ.

· Data will be collected which permit cross references of the ecological, financial, and social parameters with data collected on a larger scale (regional and national data collected through the EMAP, KBFS and NWAFSQ studies). This broader context comparison will be particularly helpful in determining which ecological indicators are most useful in assessing environmental changes in response to management shifts.

Detailed maps of each of the team farms indicating soil types, fields, land-use history by field, streams, ponds, woodlots or windbreaks, sites for overwintering cattle, and location of farm buildings have been obtained from each of the team farms. Three fields have been located on each farm for monitoring soil and vegetation. Within each farm, the selected fields all have had similar land use or similar soil types, but each represents a stage in the transition from conventional management to MIG. Matching fields have been selected on paired farms with similar soil types.

PARTICIPATORY RESEARCH TEAM

Team Development Process

A very deliberate participatory process has been used by the research team to develop a farmer-driven, whole-systems approach to designing agricultural research. The initial meetings for this project included farmers, university researchers, non-profit and government agency personnel. The size of team increased to reflect the various disciplines necessary for accomplishing the project. At present there are 20 team members including farmers, experts in various disciplines necessary to conduct this research, and educators. Team meetings have been held approximately bimonthly. The group has toured examples of MIG on the team member's farms. Information gathering meetings were held with Dr. Kent Crookston, University of Minnesota Agronomy Department, Dr. C. Lee Campbell, Environmental Protection Agency/U.S.D.A. Environmental Monitoring and Assessment

Program-Agroecosystem (EMAP) data base, and Dr. Mike Klug, Kellogg Biological Field Station in Michigan (KBFS).

Role of Team Members

Six farm families are team members and are involved in the design and execution of the project through data collection and presentations at workshops. In addition, these farmers provide land for observation, family interviews, and economic data, and will host summer field days. All have animals and are in various stages of transition to MIG.

Two academic faculty members are involved in the design, execution, and management of the research. Each will take major responsibility for sampling in their disciplinary area and providing equipment and facilities for sample processing and data analysis. A post-doctorate scientist will coordinate data collection and interpretation and will perform statistical analysis.

Field staff from three state agencies and one federal agency are involved in the design and execution of this project. In addition, the agencies are providing equipment, facilities for sample processing and in-kind expert assistance for observation and measurements.

Consultants are involved to provided specialized expertise in the design and execution of the project. In addition, they are providing in-kind expert assistance, equipment, and/or tools for sample collection.

Staff from the Land Stewardship Project are involved in project d sign, execution. oversight, and coordination of the project. LSP will also provide expert assistance, equipment, facilities, and other services, as needed.

Continuing Team Activities

The team process will continue with bimonthly meetings throughout the life of the project. One meeting will be an annual retreat. The team process will be documented on an ongoing basis and results will be disseminated and shared with others. The team will evaluate its process, including the impacts on team members and effects on institutions represented by team members. It will use the participatory measures of family quality of life to apply to team functioning. Interviews also will be conducted with team members by an outside evaluator.

The farm families and others who are the alumni of LSP's "Introduction to Holistic Resource Management" courses will act as focus groups to provide the feedback necessary to be sure the research is truly "farmer friendly" and relevant to the realities of farming. Two field days during the summer and two winter workshops each year will be held to elicit feedback on the research from other farmers' perspectives, and to disseminate findings to date.

Education and Dissemination

In-depth analyses of team farms will be used as case studies to communicate with other farm families and to provide decision cases for use in teaching. Scientific papers also will be prepared based upon comparison of farm indicators developed in this research with established lab and field measures on team and paired farms. Reports will be submitted to researchers to encourage adoption of this participatory, whole-farm research model and to policy makers to encourage adoption of policies, based on the results of this research, that support MIG as a way to preserve soil and water quality, enhance riparian corridors, and improve wildlife habitat.

A series of ecological, financial, and social indicators will be developed for on-farm use in evaluating whole farm health. These indicators will be assembled into a farmer-friendly kit of needed items for farmers to monitor their farm health. Dissemination of this kit will be part of efforts to foster increased adoption of highly sustainable farming systems. A brochure on the use of biological indicators to observe on-farm ecological health will be prepared and distributed through Sustainable Farming Association chapters, other farm organizations, state agencies, non-profits, the University of Minnesota and the Minnesota Extension Service, other state organizations, and nationally.

Interagency/Institution Cooperation

The project will create long-term collaboration among university scientists, agency officials, non-profit organizations and farmers in a new and critically important area of research. LSP will explore processes for speeding the adoption of sustainable farming practices. Additionally, the Minnesota Department of Agriculture and LSP have completed three case studies on farmers using MIG that focus on economic factors and farm history. Members of the team are involved in the Soil Quality Indicator Project funded by the Northwest Area Foundation. LSP is working with the Whitewater Joint Powers Board to promote MIG in the Whitewater watershed and the Nature Conservancy in the Cannon River area to monitor changes in farming practices and ecosystem impacts. The Minnesota Department of Natural Resources and Minnesota Pollution Control Agency are monitoring as part of this project.

SUMMARY

Sustainable farming practices are being developed by farmers and researchers in response to a number of environmental and economic problems associated with conventional agriculture in the U.S. Increasingly, farmers are looking for sustainable systems that result in long-term benefits to the ecosystem, improve the family's quality of life, and lead to higher profitability and lower cost of production. Currently, however, neither farmers or researchers have sufficient knowledge about what or how to monitor their farms to determine the effects of management decisions.

This project develops and tests indicators that will help farmers monitor the ecological, financial, and social changes resulting from adoption of sustainable management systems. The team of 20 farmers, researchers, public agency staff, nonprofit staff, and consultants are working as partners to identify monitoring approaches to evaluate the impacts of changes in farming systems. In each category variables have been identified that farmers themselves can measure. These farmer-friendly monitoring methods will be coupled with scientifically valid tests to make interpretations of the data that will be developed for on-farm use in evaluating whole farm health. These indicators will be assembled into a farmer-friendly kit of needed items for farmers to monitor their farm health. Dissemination of this kit will be part of efforts to foster increased adoption of highly sustainable farming systems. A brochure on the use of biological indicators to observe on-farm ecological health will be prepared and distributed through Sustainable Farming Association chapters, other farm organizations, state agencies, non-profit organizations, the University of Minnesota, the

Minnesota Extension Service, and other state and national organizations.

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Assessing the Sustainability of NGO-led Agroecological Interventions in Latin America

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ABSTRACT

NGOs are the new actors of rural development in Latin America. Many have embraced the agroecological approach as a new solution to the problem of small farm productivity. This paper analyzes several case studies of NGO agroecological interventions in Latin America, assessing their impact in terms of production, enhanced food security, improved income and better conservation of the natural resource base. A specific study of wheat production in Chile using a natural resource accounting technique, demonstrates the economic viability of agro-ecological technologies when soil depreciation is considered.

INTRODUCTION

The deficiencies of conventional agricultural development strategies in Latin America have demanded a broader approach to rural development, one that is centered around an ecological understanding of agricultural systems as well as a social, cultural and economic dimension. Many NGOs organized under the umbrella of the Latin American Consortium on Agroecology and Development (CLADES) have endorsed and implemented such an approach. Though formal and detailed evaluations are lacking in many NGO projects that emphasize this agroecological approach, there is strong evidence that the NGOs have generated and adapted technological innovations that significantly contribute to improving peasant livelihood by increasing peasants' food security, strengthening subsistence production, generating income sources, and improving the natural resource base. They have achieved these successes through innovative technologies and institutional arrangements as well as through novel methodologies for working with rural communities.

Though adequate methodologies for weighing the results of these efforts are still lacking, there are hundreds of individual efforts that hold great promise for the development of more sustainable ways of growing food. As already noted, appropriate means for evaluating the impact of such programs, and a satisfactory set of indicators to judge their viability, adaptability and durability, are in short supply. However, some progress has been made using two relatively new procedures: rapid rural appraisal (RRA) and natural resource accounting (NRA). RRA techniques emphasize the informal gathering and presentation of information, to foster a participatory process between local people and researchers. Technologies are evaluated through very general criteria, addressing environ-

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mental, economic and social concerns expressed by residents. NRA techniques incorporate environmental factors in conventional cost-benefit analyses, and can be used to measure the real profitability of alternative systems, including their effects on the natural resource base. In this paper we share some preliminary results from evaluations using an alternative framework which includes various quantitative and qualitative criteria that assess the relative virtues of agroecological interventions. Needless to say, these attempts at incorporating sustainability concerns into the rural development process is proving to be a complex task.

AGROECOLOGICAL ELEMENTS OF A SUSTAINABILITY EVALUATION FRAMEWORK

A definition of sustainability in the context of Latin American rural development includes at least four criteria:

- Maintenance of the productive capacity of the agroecosystem (productive capacity)

- Preservation of the natural resource base and functional biodiversity (ecological integrity)

- Social organization and reduction of poverty (social health)

- Empowerment of local communities, maintenance of tradition, and popular participation in the development process (cultural identity)

An important attribute of agroecological technologies is that they must maintain a non-declining crop yield over time, within a broad range of environmental conditions and avoiding degradation of fragile and marginal ecosystems. The challenge of small farm development is that agricultural production requires ecosystem modification and resource utilization, while environmental protection requires some acceptable level of resource conservation. This balance must be achieved in the context of overcoming rural poverty. Thus monitoring of productivity, ecological integrity, and social equity must go beyond quantification of food production and monitoring of soil or water status to include levels of peasants' food security, social empowerment, and economic potential and independence or autonomy. Table 1 lists some indicators actually being used by some NGOs to evaluate the impact of their programs.

A PRELIMINARY ASSESSMENT OF NGO AGROECOLOGICAL PROJECTS

Latin American NGOs have been actively trying out new farming strategies based on local participation, skills and resources. Their approach gives unprecedented significance to local farmers' knowledge of their own areas' ecosystems - plants, soils and ecological processes. The resulting agricultural approximation to the peasant production process is radically different from that of the Green Revolution of other high-input approaches. It also tends to be more socioculturally acceptable, since it builds on local tradition. Techniques are ecologically sound because they don't radically modify or transform the peasant system, instead identifying traditional and/or new management elements that, once incorporated, lead to optimal production. Documented effects of agroecological practices used by NGOs on various parameters are given in Table 2.

Table 1: Association between rural development assessment points and indicators of sustainability utilized by Latin American NGOs.

Indicator	Productive Capacity	Ecological Integrity	Social Health	Cultural Identity
Crop Productivity	x			
Soil Fertility and Nutrient Cycling Capacity	x	x		
Soil Erosion		x		
Crop Health (pest, disease incidence)	x			
Biodiversity Status (native germplasm, forests, etc.)	x	x		x
Landscape Health (watershed status, biological corridors, etc.)		x		
Health and Nutritional Status			x	x
Community Participation and Solidarity			x	x
Income and Employment			x	
Required External Inputs, Costs of Production	x		x	

By emphasizing the use of locally-available resources rather than expensive or hard-to-obtain imported inputs, these technologies are also more economically viable.

In practical terms, NGO programs emphasize six key points (see also Table 3):

(1) Improving production of basic foods, including traditional food crops (*Amaranthus*, quinoa, lupine, etc.), and conservation of native crop germplasm.

(2) Rescuing and application of peasants' knowledge and technologies.

(3) Promoting efficient local resource use (land, labor, agricultural by-products)

(4) Increasing crop and animal diversity in the form of polycultures, agroforestry systems, integrated crop/livestock systems, etc., to minimize risks.

(5) Improving the natural resource base through soil and water conservation and regeneration practices.

(6) Reducing the use of external chemical inputs, through developing, testing, and implementing organic farming and other low-input techniques.

Table 2: Documented effects of agroecological productive strategies implemented by NGOs in Latin America.

Effects on the soil

(1) Increase in the organic matter content
Stimulation of biological activity
Increment in nutrient mineralization

(2) Erosion decline
Soil and water conservation
Improvement of structure and general soil conditions

(3) Improvement of retention and recycling of nutrients
Positive nutrient balances

(4) Enhancement of micorrytic and antagonistic activity

Effects on pests, diseases and weeds

(1) Diversification affects insect pests, reducing herbivores and stimulating natural enemies

(2) Multi lines and mixed varieties reduce pathogens

(3) High soil cover polycrops suppress weeds

(4) Cover crops on fruit trees diminish insect and weed infestations

(5) Minimum tillage can reduce soil diseases

Effects on yields

(1) Yields per unit of area can be 5-10% less, but yields in relation with other factors (i.e. per unit of energy, of soil losses, etc.) are greater

(2) Polycrops over yield monocultures

(3) An initial loss of production can exist during the conversion to organic management, but it can be minimized with input substitution
Production improvements with time

(4) Yield variability is lower, yield stability is greater and there are lower risks involved

Table 2: Documented effects of agroecological productive strategies implemented by NGOs in Latin America. (Continued)

Effects on economic aspects

(1) Low production costs

(2) Low environmental costs (externalities), lesser soil depreciation, low contamination costs

(3) Higher energy efficiency and lower total energy use

(4) The labor requirements are bigger for some practices and lower for others. A dilution or spreading effect of the labor needs exists during the season, avoiding peaks on labor demands

The following is a description and preliminary evaluation of NGO-led agroecological interventions across two biophysical and socioeconomic contexts of peasant agriculture: Andean slopes and rainfed Mediterranean ecosystems.

MAINTAINING PRODUCTIVITY ON ANDEAN HILLSIDES

In the Colca Valley of Peru several NGOs have sponsored terrace construction by offering peasant communities low-interest loans or seeds and other inputs to restore abandoned terraces, up to 30 ha at a time. Although labor intensive, the advantages of terraces are that they minimize crop loss risk in times of frost or drought, improve crop yields, reduce soil losses, and amplify cropping options because of the micro-climatic and hydraulic advantages they provide. First year data from new bench terraces showed a 43 to 65 percent increase in yield in potatoes, maize and barley, compared to yields grown on non-terraced slopes.

In Cajamarca, Peru, EDAC-CIED, an NGO initiated together with peasant communities in 1983, is an all-encompassing soil conservation project. In 10 years, they planted more than 550 thousand native and exotic tree species and constructed about 850 has of terraces and 173 has of drainage and infiltration canals. The end result is about 1,124 has of land under conservation measures (approx. 32% of the total arable land), benefitting 1247 families (about 52% of the total).

Crop yields have improved significantly (for example potato yields went from 5 t/ha to 8 t/ha and Oca yields jumped from 3 to 8 t/ha). Raising of cattle for fattening and alpaca for wool, and enhanced crop yields has increased the income of families from an average $ 108 per year in 1983 to more than $ 500 today.

IMPROVING FOOD SECURITY AND INCOME IN MEDITERRANEAN AGROECOSYSTEMS

Since 1980, CET, a Chilean NGO, has engaged in a rural development program aimed at helping peasants reach year-round food self-sufficiency while rebuilding the productive capacity of their small landhold-

Table 3: Agroecological Projects in Latin America.

NGO	Characteristics of intervened area	Agroecological and socioeconomic constraints	Goals of the agroecological strategy	Technical components of the strategy	Impacts and/or achievements
SEMTA (Bolivia)	Pacajes Province, Altiplano (3500-3800 m.a.s.l.) Potato, cereals, andean crops, bovine/ovine cattle, alpacas	Frost, low soil fertility, erosion, deforestation, drought. Generalized poverty, low access to credit, public services, and markets.	Slow environmental degradation process and regenerate productive potential	Organically managed mud-built greenhouses for vegetable production. Terracing, crop rotations for erosion control. Reforestation with native species. Improvement. management of native pastures.	Early production of vegetables under greenhouses resulted in premium prices in nearby La Paz markets, increasing income of participating farmers.
CIED (Puno-Peru)	Altiplano(3500 m.a.s.l.) Natural pastures (ichu), andean crops, potato, cattle, camelids	Frost, droughts, flooding, soil and genetic erosion, low productivity. Poverty and marginalization.	Food self-sufficiency, conservation of natural resource base, rescuing of traditional technologies.	Rehabilitation of waru-warus and terraces (andenes). Crop rotations. Reintroduction of alpaca. Improved cattle management and sanitation.	Waru-warus ensure potato production in the midst of frost, therefore reducing risks in food production.
IDEAS (San Marcos-Peru)	Interandean valleys of Cajamarca (18 C, 450 mm rainfall). Potato, maize, cereals, cattle.	Steep slopes, erosion, seasonal drought. Poverty, low access to good land.	Design of self-sufficient farming system. Rescuing and enriching traditional technology. Soil and water conservation.	Predial design with rotation and polycultures. Organic soil management. Management of small mammals and poultry.	Organic crop production has proved viable, stabilizing yields without use of toxic chemicals
PTA/CTAQ (Brazil)	Northeastern Brazil, semi-arid tropics. Eight-11 dry months. Perennial cotton, maize, beans.	Rapid organic matter photo-decomposition, low biomass production, low soil fertility, hardpan, and salinity. Poverty, low access to land, marketing problems.	Improve traditional shifting cultivation system (rozado). Offer new productive options for vegetable, fruit, and animal diversification. Water harvesting and conservation. Improved management of animals, in-situ conservation of local germplasm.	Agrosilvopastoral management of catinga (xeric natural vegetation). Design of rotations, agroforestry schemes and polycultures.	Water harvesting techniques and design of drought tolerant cropping systems have enhanced productive potential in semi-arid areas.

Table 3: Agroecological Projects in Latin America. (Continued)

NGO	Characteristics of intervened area	Agroecological and socioeconomic constraints	Goals of the agroecological strategy	Technical components of the strategy	Impacts and/or achievements
CPCC (Paraguay)	Subtropical serrania (600-800 m.a.s.l.) Cassava, maize, peanuts, beans, cotton, sugarcane, and rice.	Seasonal drought (4-6 months), low soil fertility. Low income, small landholdings.	Design of agroforestry systems, soil conservation and diversification of production.	Community tree nursery. Forest enrichment, soil conservation in slopes, organic soil management.	Agroforestry systems have enhanced production of multiple resources and reverted deforestation processes.
CETEC (Colombia)	Southwest of Cauca Valley (1500 mm rainfall). Cassava, tropical fruit trees.	Acid and erosive soils, crop pests and diseases, weed interference. Low income, no access to credit or technical assistance. Low prices of agriculture commodities.	Diversify production with low-input technologies. Natural resources conservation. Alternatives to pesticides.	Improved cassava cropping systems. Soil conservation systems. Home gardens. Pest control with parasites and botanicals.	Soil erosion has been reduced and alternatives to pesticides are proving effective.
INDES (Argentina)	Dry subtropical area (600 mm). Cotton and subsistence crops (maize, squash, cassava).	Drought, high temperatures, wind erosion, low soil fertility. Poverty, unemployment, lack of credit.	Food self-sufficiency. Optimize use of local resources.	Rationalize cotton based rotations. Improve soil cover to avoid erosion. Use of adapted crop variety.	Diversification schemes have brought new crops into production, challenging dominance of cotton.
CET (Chile)	Chiloe Island Southern Chile (2000-2500 mm rainfall). Potato, wheat, pastures.	Frost, acid soils, phosphorous deficiency, overgrazing of pastures, genetic erosion. Poverty, marketing problems.	Improve and stabilize productive systems through diversification, use of local resources, rescuing of traditional varieties and technologies, and soil conservation.	In-situ potato genetic community conservation programs. Pasture-based crop rotations. Rotational grazing systems. Silvopastoral systems.	More than 100 traditional potato varieties rescued, with about 56 families involved in-situ conservation programs.

ings. The approach has been to set up several 0.5 ha model farms which consist of a combination of forage and row crops, vegetables, forest and fruit trees, and animals. Components are chosen according to crop or animal nutritional contributions, their adaptation to local agroclimatic condi-tions, local peasant consumption patterns and, finally, market opportunities. Most vegetables are grown in heavily composted raised beds (5x1 meter each) located in the garden section, each of which can yield up to 83 kg of fresh vegetables per month. The rest of the 200-square meter area surrounding the house is used as an orchard, and for animals, (a Jersey cow, a Holstein cow, 10 laying hens, three rabbits and two Langstroth beehives).

The rest of the vegetables, cereals, legumes, and forage plants are produced in a six-year rotational system within a 4200 m^2 area adjacent to the garden. Relatively constant production is achieved (about six tons per year of useful biomass from 13 different crop species) by dividing the land into as many small fields of fairly equal productive capacity as there are years in the rotation. The rotation was designed to produce the maximum variety of basic crops in six plots, taking advantage of the soil-restoring properties and built-in biological control features of the rotation.

Throughout the years, soil fertility in the farm has improved (P_2O_5 levels, which were initially limiting, increased from 5 to 15 parts per million) and no serious pest or disease problems have been noticed. Fruit trees in the orchard and around rotational plots produce about 843 kg of fruit per year (grapes, quince, pears, plums). Forage production reaches about 18 tons per 0.21 ha per year. Milk production averages 3200 liters per year, and egg production reaches a level of 2.531 units. A nutritional analysis. of the system based on its production components (milk, eggs, meat, fruit, vegetables, honey) shows that it produces a 250 percent surplus of protein, 80 and 550 percent surpluses of vitamins A and C, respectively, and a 330 percent surplus of calcium. A household economic analysis indicates that, given a list of preferences, the balance between selling surpluses and buying preferred items provides a net income of US $790. If all of the farm output is sold at wholesale prices, the family could generate a net monthly income 1.5 times greater than the monthly legal minimum wage in Chile.

In Tomé, a depressed industrial-textile town in southern Chile, CET assisted unemployed workers to satisfy subsistence needs through an urban agriculture program reaching 400 families. The model includes a 62 m^2 production unit in which the following can be grown or raised:

Intensive, raised bed for vegetable production	40.5 m^2
32 chicken	6 m^2
38 rabbits	7 m^2
4 bee hives	4 m^2
bread mud-oven	1 m^2

This production unit allows of the production of about 354 kgs/year of vegetables, rabbits (53.4 kgs), eggs (40.1 kgs), chicken meat (28.8 kgs), honey (66 kgs) and bread (453.7 kgs). This production covers 66% of the protein requirements of the family and about 35% of the caloric requirements. Due to the fact that the various food items are produced and not purchased, savings can reach up to $ 736 per year per family. These levels obviously substantially enhance the family's nutrition and overall economic well-being.

Figure 1a: Cumulative soil losses in wheat production systems under conventional and organic management.

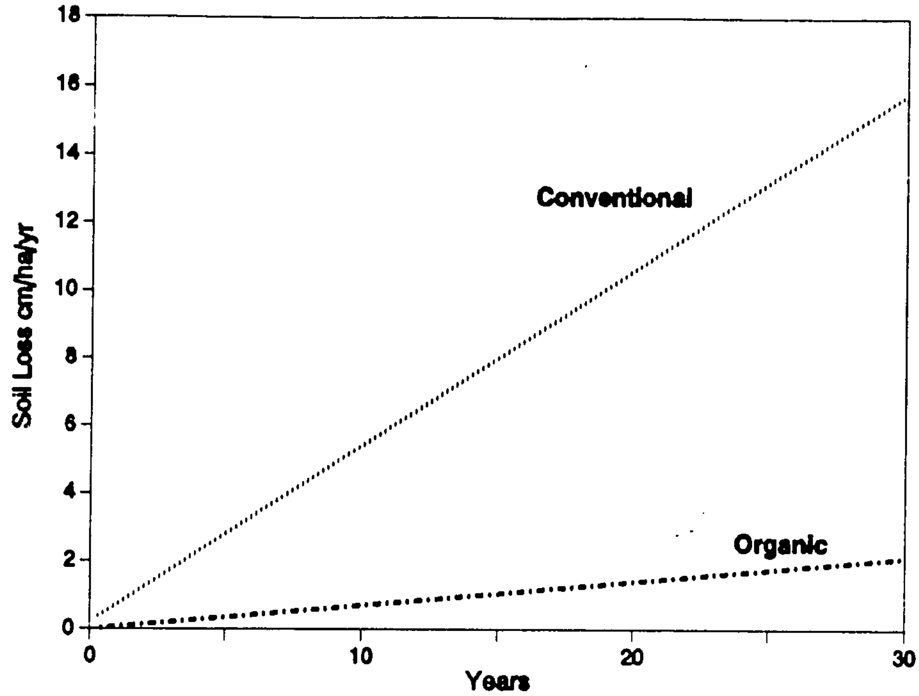
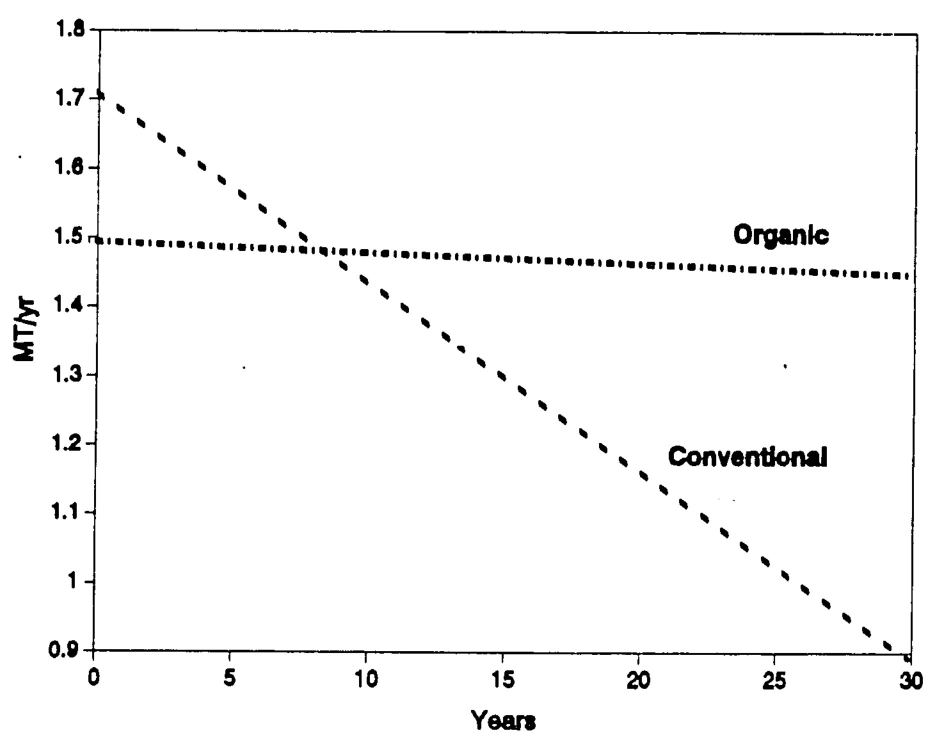


Figure 1b: Wheat yields as a function of soil losses in two peasant wheat cropping systems.



ASSESSING WHEAT PRODUCTIVITY IN PEASANT SYSTEM USING NATURAL RESOURCE ACCOUNTING

An attempt to compare profitability, productivity, input use and soil productivity in peasant wheat farming under conventional and organic management in Chile, was done using a two-sector linear programming model. Evaluated alternative cropping practices included the use of wheat undersown with a red clover living mulch, fertilized with 15 metric tons of manure per hectare.

The organic management system showed lower estimated cumulative soil losses after 30 years which kept yields relatively high over the long run (Figures 1a and 1b). Conventional wheat monoculture exhibited higher rates of soil loss which caused significant yield declines with time. For peasants, the adoption of resource-conserving practices depends on labor availability and on the existence of new agroecological technologies and on an appropriate participatory extension system to disseminate them. The model showed a total shift to organic farming practices in the rainfed areas of Chile, when peasants had enough knowledge about the practices and labor to use them, and did not ignore or underestimate the importance of natural resource degradation.

CONCLUSIONS

This paper has highlighted some promising NGO-led local experiences among the rural poor in Latin America, assessing the impact of agroecological interventions on food security, resource conservation, crop productivity and income generation. The use of simple indicators in the evaluation of technological adoption by peasants is providing NGOs with a sufficient level of confidence in the agroecological approach to rural development.

More sophisticated and integrated methodologies and indicators are needed, and this could be a productive role for researchers interested in sustainability issues and a fruitful way for them to create partnerships with NGOs actively involved in field work within communities of resource-poor farmers throughout a range of farming conditions in Latin America.

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Sustainability and Participatory Integrated Pest Management

George W. Norton*

ABSTRACT

Integrated pest management can reduce commodity losses to pests while reducing or preempting reliance on chemical pest control. The participatory IPM approach is directed at developing new technologies, management systems and institutions as well as changing knowledge, abilities and attitudes. It involves scientists from multiple disciplines and includes farmers, community leaders, policy makers, marketing agents and other stakeholders in a collaborative IPM research effort. Nine indicators of sustainability, with respect to pest management are identified and participatory methods are briefly described for enhancing multidisciplinary, multi-institutional and community involvement in IPM research. Some of the indicators are outcome-based, some are process-based and others are people-based. The participatory IPM process includes a diagnosis phase, a design phase and a dissemination phase. Successful participatory research requires both community participation and ... injection of new technologies or information into the system.

INTRODUCTION

The objectives of integrated pest management (IPM) are to reduce commodity losses to pests while reducing or preempting reliance on chemical pest control. Achievement of these objectives contributes to the long-run sustainability of agricultural systems.[1] The goal of IPM is to increase farm income and economic benefits to society, while improving human health and the environment. IPM plays a central role in sustainable agricultural development because (a) insects, diseases, weeds, nematodes, and other pests cause severe losses in many farming systems and (b) misuse of pesticides threatens farm worker health, impairs the quality of drinking water supplies, harms aquatic ecosystems, and causes pests to become resistant to pesticides.

...rd sustainability implies maintenance ... not improvement over time. Agricultural systems are seldom static and maintenance or improvement of these systems requires investments in new technologies, management systems, and institutions as well as changes in knowledge, abilities, and attitudes. The participatory integrated pest management (PIPM) approach of the IPM CRSP is directed at changing each of these factors. It attempts to do so by involving scientists from multiple disciplines and by including farmers, community leaders, policy makers, marketing agents, and other stakeholders in a collaborative IPM research effort. One implication is that indicators of sustainability related to IPM should include changes in adoption of new IPM technologies and management systems, in institutions, and in knowledge, abilities, and attitudes about pests and pest management. These indica-

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tors are in addition to the more common ones of reduced pest losses, reduced pesticide use, and increased farm income. A second implication is that some of these indicators will be found at the farm or community levels while others will be found at the policy or national level.

The purpose of this paper is two-fold. First, it describes and justifies specific indicators used to assess changes in agroecosystem sustainability from a pest management perspective. Second, it discusses participatory methods being used by the IPM CRSP to enhance multidisciplinary, multi-institutional, and community involvement in IPM research.

SUSTAINABILITY INDICATORS FOR IPM

Sustainability indicators for IPM can be outcome-based, process-based, or people-based.

Key Outcome Based Indicators

Key outcome-based indicators are reduced commodity losses due to pests, reduced variability over time of commodity losses due to pests, reduced pesticide use, increased farm income from adoption of IPM practices, and government policies that encourage rather than discourage adoption of IPM.

Reduced losses due to pests. An IPM practice or system that fails to reduce crop or livestock losses due to pests will hardly see sustained adoption. Hence, measurements that compare commodity losses for adopters and non-adopters are an indicator of sustainability. In the Mali site on the IPM CRSP, for example, few pesticides are currently applied to the target commodities but crop losses due to pests are often substantial. Hence, an indicator such as reduced pesticide use is not much help in that site but crop loss assessment is.

Reduced variability in commodity losses. All farmers, but particularly those close to the margin, are as concerned or more concerned about large losses in particular years than they are about modest losses over several years. Hence, measurements taken over time that enable the calculation of the risk associated with IPM compared to conventional pest management practices provide a useful indicator of sustainability.

Reduced pesticide use. Evidence is mounting that indiscriminate use of pesticides in many countries is creating an escalating set of problems with environmental damage, human health effects, and increased pesticide resistance. The environmental problems are multi-fold, but one of the most serious ones for pest control is the harm caused to beneficial insects. Certain pesticides, particularly when applied in strong dosages or at the wrong times, disturb the balance of nature in which certain insects or birds keep other insects in check. Beneficial insects, including many spiders and wasps, are easily destroyed by broad-spectrum pesticides. Furthermore, pests evolve and develop resistance to certain pesticides over time, often causing farmers to alter pesticide dosages which may exacerbate the problem. Most scientists now agree that while some pesticide usage may be needed in the short run until adequate substitutes are developed, pesticide reductions are needed in many systems to make them sustainable. Hence, IPM practices that require less pesticide use tend to be more sustainable, and measurements over time indicate increased sustainability of the farming systems in that area.

Increased farm income. Measured increases in farm income from adoption of IPM practices are arguably the best indicators of sustainability. First, few IPM practices will continue to be adopted or spread to additional farmers if they are not profitable. Reductions in environmental damage are usually not enough to ensure adoption as many of the environmental costs are borne by others besides the farm family. Second, increased income contributes to sustainability by placing downward pressure on population growth, a major cause of non-sustainable farming systems. Also, as incomes rise, people tend to place more value on environmental benefits. Poor people are more concerned about meeting basic needs today than they are about environmental effects that are felt more in the future.

Government policies that do not discourage IPM. In some countries, governments subsidize pesticides or require pesticide use as a condition for participation in government credit programs. They may have a lax set of pesticide regulations that permit use of broad spectrum, highly toxic pesticides, paying little regard to the environmental and human health costs involved. In Indonesia, the government found that removal of pesticide subsidies provided a major stimulus for adoption of IPM practices. Research and extension systems can develop and extend effective IPM programs but unless the policy environment is conducive, adoption may not occur because pesticides are abundant and inexpensive. Therefore, government policies favorable to IPM development and adoption are an indicator of sustainability.

Process-based indicators. Key process-based indicators are whether new IPM technologies and pest management systems are being developed and adopted, whether IPM units or research and training centers are in place, and whether the IPM network in a country is growing. These indicators provide evidence of institutionalization of the IPM infrastructure in a country.

Technologies and pest management systems. Evidence that a stream of new IPM technologies and pest management systems are being developed and adopted that rely on biological controls, resistant varieties, altered planting dates and rotations, etc. are an indicator that the groundwork has been laid for continued development and extension of IPM. In some countries, a limited set of IPM practices are available and are being extended in training programs. However, sustainability requires a stream of these technologies and systems over time as the pest environment does not remain stable. Development of this stream requires the existence of scientific capacity.

IPM units or centers. Evidence that the basic infrastructure has been developed to sustain an IPM program in a country is provided by the existence of a participatory IPM unit or center that is within or linked to the national agricultural research system and has ties to NGOs, universities, other relevant institutions, and of course farmers. Both the continuity and expansion of IPM research and training depends on its institutionalization.

IPM network. The IPM unit mentioned above must be linked both to national and regional entities within the country as well as to the burgeoning international IPM network. Many of the pest management problems and potential solutions in one region or country bear similarity to those in other regions or countries. The development of an IPM network within a country, which today often includes a computer linkage, is an indicator of whether new IPM ideas and technologies will spread.

People-based indicators. Important as the outcome based and process-based indicators are, the people-based indicators are fundamental to assessment of sustainability related to IPM. The reason they are so important is that IPM is more than a set of technologies or practices. It is a management philosophy that requires changes in knowledge, attitudes, and abilities.

Knowledge and attitudes. One measure of whether a sustainable farming system has been developed with respect to pest management is whether community members exhibit increased knowledge of and attitudes towards pests and beneficials. As Bentley (1989) points out, farmers know much more about plants than they do about insects and diseases. Although they know a lot about their environment and how to control pests without pesticides, there is a lot they do not know. Central American farmers, for example, do not know about insect predation or parasitism (Bentley et al, 1994). Insects are often difficult to observe and look different at different stages of their life cycle. Because insects and diseases can destroy crops, there is a tendency for farmers to think that almost all of them are bad. They may know that toads, birds, and some spiders eat insects, but not that many insects prey on other insects. They often overreact and spray pesticides at times when the pests are not creating damage that will affect yields.

Farmers in many developing countries are bombarded with pesticide advertisements, and because farmers often view insects and diseases as their enemies and like to experiment, they tend to apply and experiment with toxic chemicals. However, farmers are often receptive to IPM alternatives once they gain increased knowledge about insect and disease ecology. Hence, one objective of an IPM program is to raise the level of knowledge about and attitudes toward pests and beneficials. This knowledge and attitudes indicator can be measured through interviews with farmers and observations of their pest management practices.

Farmer ability to conduct research and access information. Sustainability requires that farmers be able to experiment and adjust to changing pest conditions and to access the latest IPM information. Participatory IPM research facilitates both of these activities as does education in general. This ability indicator is best assessed in times of disequilibria with respect to pest problems.

PARTICIPATORY IPM METHODS

The diversity of the sustainability indicators described above underscores the need for a participatory IPM process that merges the expertise of both natural and social scientists and extends the farmer- or community-participatory concept to farm workers, growers' associations, marketing agents, policy makers and others. Through the iterative process of participatory research, these actors collaborate with scientists and extension workers throughout the research process. IPM programs are at different stages of development in our IPM CRSP sites and PIPM is versatile enough to interact with each of these programs.

The Diagnosis Phase

The participatory IPM process can be broken down into three phases: diagnosis, design, and dissemination (Figure 1). The **diagnosis** phase begins with identifying stakeholders, and meeting with them (a) to review current pest management programs including possible gaps and intervention points, (b) to select commodities and sites within the country, and (c) to establish a country-site committee. Secondary information is reviewed, a tentative plan for a participatory appraisal developed, and a workshop held on participatory appraisal methods. A multidisciplinary participatory appraisal is undertaken to generate baseline data on biophysical and socioeconomic characteristics of the research sites. A more formal diagnostic survey is also undertaken in addition to the use of less formal participatory appraisal methods such as development of resource maps, and seasonal calendars, preference rankings, innovation assessments, key informant interviews, direct observation, and group discussions. At the conclusion of the participatory appraisal fieldwork, an information validation workshop is held in which key research questions are identified and plans are developed for research and other activities. A community advisory council made up of farmers, marketing system agents, bankers, local educators, and others is formed to assist with validation of plans and provide input into the development, testing, and evaluation of PIPM systems.

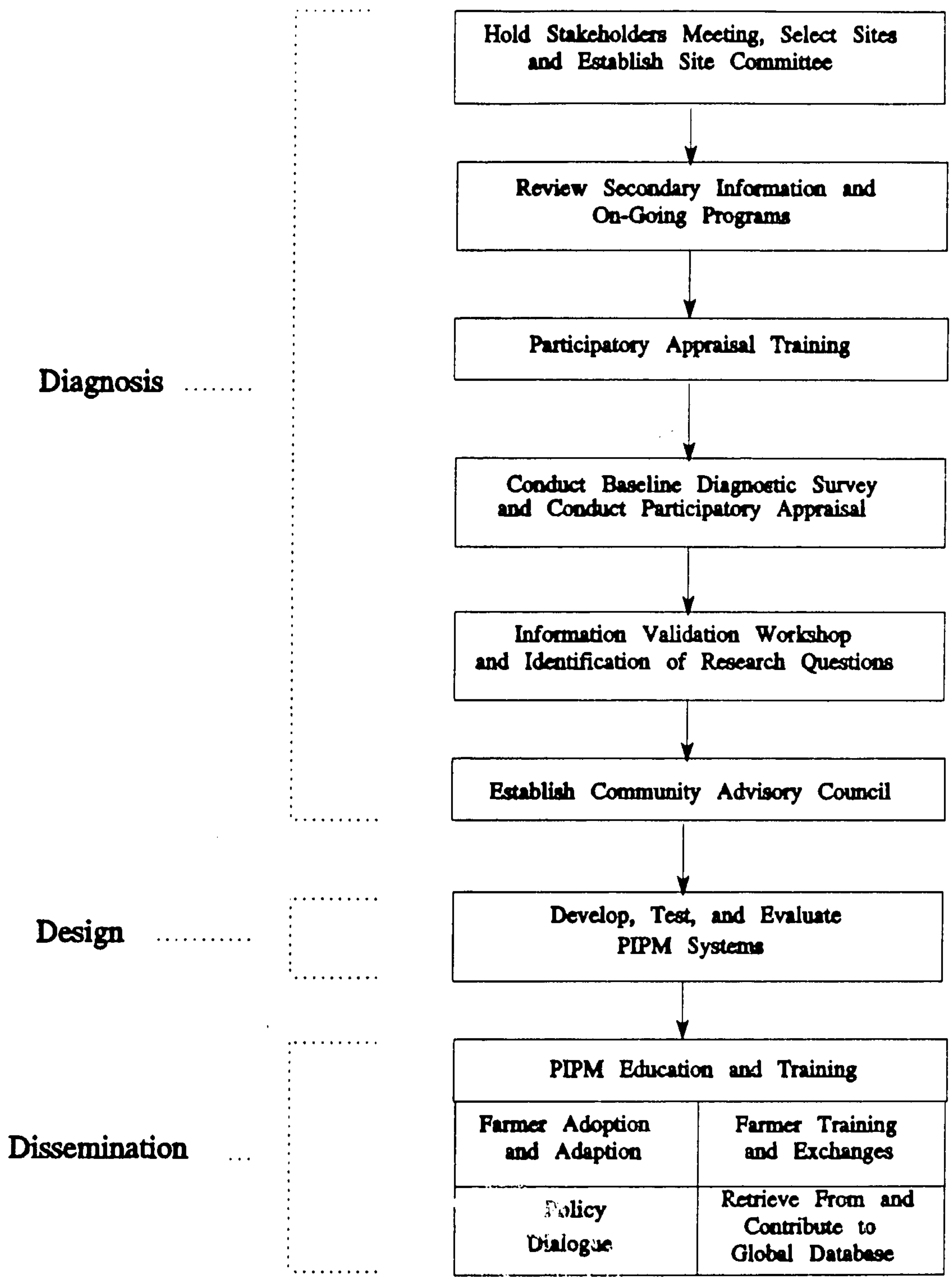
The Design Phase

The **design** phase encompasses participatory design, testing, and evaluation of PIPM systems. PIPM is approached as a series of activities that culminates in decisions by farmers and policy makers that are consistent with the goals of farmers and society. Based on the current and potential economic and environmental importance of pests and pesticides, particular pest ecosystems are selected that constitute the focus of research and extension efforts. Potential IPM tactics and strategies are identified through discussions among members of the site committee and community advisory council. Examples of preemptive IPM solutions that reduce or eliminate pest problems before they arise are use of pest-resistant cultivars, developing production systems and natural habitats that encourage growth of natural enemy populations, adjusting planting times to avoid key points in pest biology, and crop rotations and systems that discourage pest population buildup. Examples of reactive solutions that are implemented only in response to high pest densities in critical periods are manual removal of insect egg masses, hand weeding, selective use of pesticides and other controls when conditions are severe enough to warrant them.

Some research and demonstration plots are usually required both on-station and in farmers' fields. On-farm testing will occur on whole farms and in whole villages. However, PIPM research is more than technical research. Marketing research addresses the potential for profitably selling increased production of particular commodities either domestically or in export markets. Economic and sociological research examines factors influencing adoption of IPM practices and strategies.

Particular attention is focused on government policies that encourage or discourage IPM adoption. Regulations, taxes, subsidies, cooperative organizations to control pests in a region, laws and policies that influence land tenure, cooperative marketing

Figure 1: Summary of Participatory IPM Process.



schemes, and other types of policies and institutions are difficult to change. Yet incentives created by these "rules of the game" often spell the difference between successful and unsuccessful IPM efforts. Sociological and gender research focuses on community and farm-household factors that influence the design of appropriate IPM systems.

The Dissemination Phase

The **dissemination** phase in PIPM programs begins during the diagnosis and design phases as participatory research spreads knowledge right from the start. However, specific educational and training activities also must be built in that recognize barriers to acceptance of knowledge related to age, class, gender, and ethnicity. Special workshops and field days are held on specific IPM strategies for farmers, extension agents, NGO personnel, and other groups. PIPM coordinates with training programs run by other organizations and projects as well. It involves farmers in training farmers. Policy dialogue is initiated with government officials, often working through other institutions and projects. PIPM research approaches and results will be spread through training manuals, publications, regional workshops, and the internet. Close coordination with international agricultural research centers and several regional IPM networks also assist with information dissemination.

INTERSECTORAL COORDINATION AND COMMUNITY PARTICIPATION

The above brief summary of PIPM methods highlights the importance of (a) interdisciplinary and interinstitutional coordination and (b) community participation. Interdisciplinary and interinstitutional coordination is facilitated on the IPM CRSP by a committee structure in which scientists and other representatives from host country institutions form a local site committee that interacts with a committee of scientists from the external institutions. This overall site committee has a chair and vice-chair from different institutions and draws it expertise from whomever is most appropriate in any of the collaborating institutions. All workplans are initiated at the site committee level.

Community participation is initiated by the participatory appraisal activities and continues with farmer participation in the research and training activities and through a community advisory council that is involved in validating information and evaluating IPM research results. This active participation of farmers, marketing firms, policy makers, etc. in the information gathering and research evaluation is one of the two key factors associated with successful participatory research. The participatory appraisal in which local participants help in mapping key variables, providing preference rankings, and participating in group analysis discussions establishes the principle of local involvement.

The second principle of successful participatory research is that scientists and extension workers must bring something new to the farmers, policy makers, or other clients. That something new might be a new IPM tactic or strategy, a suggested policy change, or a new institutional structure. Unless the clients feel they are learning new methods or ideas, they quickly lose interest. Farmers, for example, are rational and relatively efficient. They usually know a lot about their environment but are not all-knowing. They often test outsiders to see what they know, and many are willing to experiment with what scientists suggest if they think it may work. This willingness to experiment is why many farmers have gotten into trouble with pesticides. Many farmers are looking to scientists and extension workers to suggest new pest control methods. They would eagerly accept pest-resistant varieties, biological-control methods, and other means suggested by scientists for controlling insects, diseases, and weeds. They respect scientists, but are understandably skeptical until the scientists gain their confidence. Scientists must respect farmers and their indigenous methods, but not romanticize them. Some farmers are smart; some are less so. Some are stubborn; some are quick to change. The same can be said for scientists.

SUMMARY

In summary, successful participatory IPM research requires (a) involvement of clients in the research, and (b) high quality biophysical and social science research so that new IPM factors and strategies are in fact developed that are profitable and appropriate for the social and cultural setting. Good intentions are not sufficient.

ENDNOTE

1. IPM can also be applied to non-farm settings such as lawns and gardens, commercial buildings, forests, and roadsides.

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Indicators of Sustainability at the Guayllabamba Watershed, Northwestern Ecuador: A Preliminary Assessment Framework

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INTRODUCTION

The research region in Ecuador for the SANREM CRSP (Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program) is located within the Chocó forest landscape. This landscape, extending from northwestern Ecuador over the border into Colombia, is one the most important ecological "hotspots[1]" of the world. Hotspots are those areas of the world which are highly valuable in landscape and biological terms due to their high level of biodiversity, endemism, and ecological variation (Meyers, 1988). The site is also located at the heart of one of the main areas of agricultural colonization, the main process behind deforestation of the Chocó tropical forests. Colonization is the most important form of human occupation and transformation of tropical rainforests in Latin America and perhaps worldwide. Indicators of sustainability developed for this site should provide information regarding the sustainability of agriculture, farming communities, and natural resource management practices within the context of a colonization lifescape[2] and landscape.

This paper provides a description of the landscape and lifescape of the research site. The main ecological, social, and economic transformations that have occurred within the zone as a consequence of the process of colonization are discussed. The paper also describes methodologies and approaches for identifying participatory, field-based indicators of sustainability. To provide background information regarding how we are approaching research on indicators of sustainability, a description is provided of the Participatory Lifescape/Landscape Appraisal (PLLA), a participatory research appraisal (PRA) methodology used to identify local perspectives concerning priority research questions. As discussed below, this method also provided insights into both potential indicators of sustainability and issues that must be considered in any research addressing "sustainability." Throughout this paper, our main proposition is that the study of indicators of sustainability should be closely related to the local perceptions of nature and economic and social development.

THE SITE LOCATION

The SANREM CRSP/Ecuador research site is the Middle Guayllabamba River basin, located within the buffer zone of the Cotacachi-Cayapas Ecological Reserve (Figure 1). The Middle Guayllabamba River basin is located in the northwest of the Pichincha Province, about 50 km, as the condor flies, from the city of Quito. Following the highway that goes from Quito

[1]Facultad Latinoamericana de Ciencias Sociales (FLASCO-Ecuador).

[2]SANREM CRSP/Ecuador.

[3]FUNDAGRO.

[4]Centro de Conservacion de Datos para la Naturaleza/Facultad Latinoamericana de Ciencias Sociales (FLASCO-Ecuador).

to Centro del Mundo, the town that stands on the Equatorial line, one takes the turn to Calacalí. A paved road descends steeply toward the coastal zone of Esmeralda Province. The Andean landscape, relatively dry and marked by plots of corn and eucalyptus trees, gives way quickly to a tropical rainforest landscape. In the upper zone of the slope, the gradients are steep and covered with a thick forest. The road then descends over this irregular topography in which scars, left by major landslides associated with the road, are visible. Descending the steep slope, the predominant landscape becomes increasingly agricultural. Where the topography is too steep or the soils too poor for human exploitation, patches of dense forests remain. In the less steeply sloping areas, these patches are combined with wide expanses of former forests now turned into crop and grazing lands.

The Guayllabamba River basin includes territory in a number of *parroquias* (parishes) located predominantly in the provinces of Pichincha and Imbabura. These parroquias border the Cotacachi-Cayapas Ecological Reserve. The parroquias are composed of *comunas* (communities), the smallest type of population center officially recognized by the Ecuadoran government. The comunas are the political units responsible for the administration of services such as education, health, potable water, and electricity.

For purposes of SANREM CRSP research, the Guayllabamba site is divided into two areas. The central research area is located in the lower section of the Alambi River watershed, a tributary of the Guayllabamba river. Complementary research and development areas are located in the vicinity of the Cotacachi-Cayayas ecological reserve (Figure 1). This division is made due to the community-based and people-centered focus of the work to be conducted. The research area for the SANREM CRSP includes five rural parroquias, that have from 20 to 30 years of settlement history: Nanegalito, Gualea, Nanegal, Pacto, and Minas, comunas within the central research area include Nangegal, La Perta, Palmitopanba Chacapata Palma Real and Medidiano (Figure 2).

In the complementary area, closer to the ecological reserve, there are communities in the process of formation as well as individual farmers not associated with collectives who are encroaching on the ecological reserve. The goal of the SANREM CRSP is to work with them to identify more sustainable forms of land and resource use that will enhance the protection of the reserve.

The Guayllabamba watershed is a lifescape transect that encompasses a continuum of farming communities. This transect includes people who initiated the settlement of the area about one generation ago as well as those who are still in the early stages of colonization. The lifescape is equally a mosaic of farming household types (German, 1994), including:

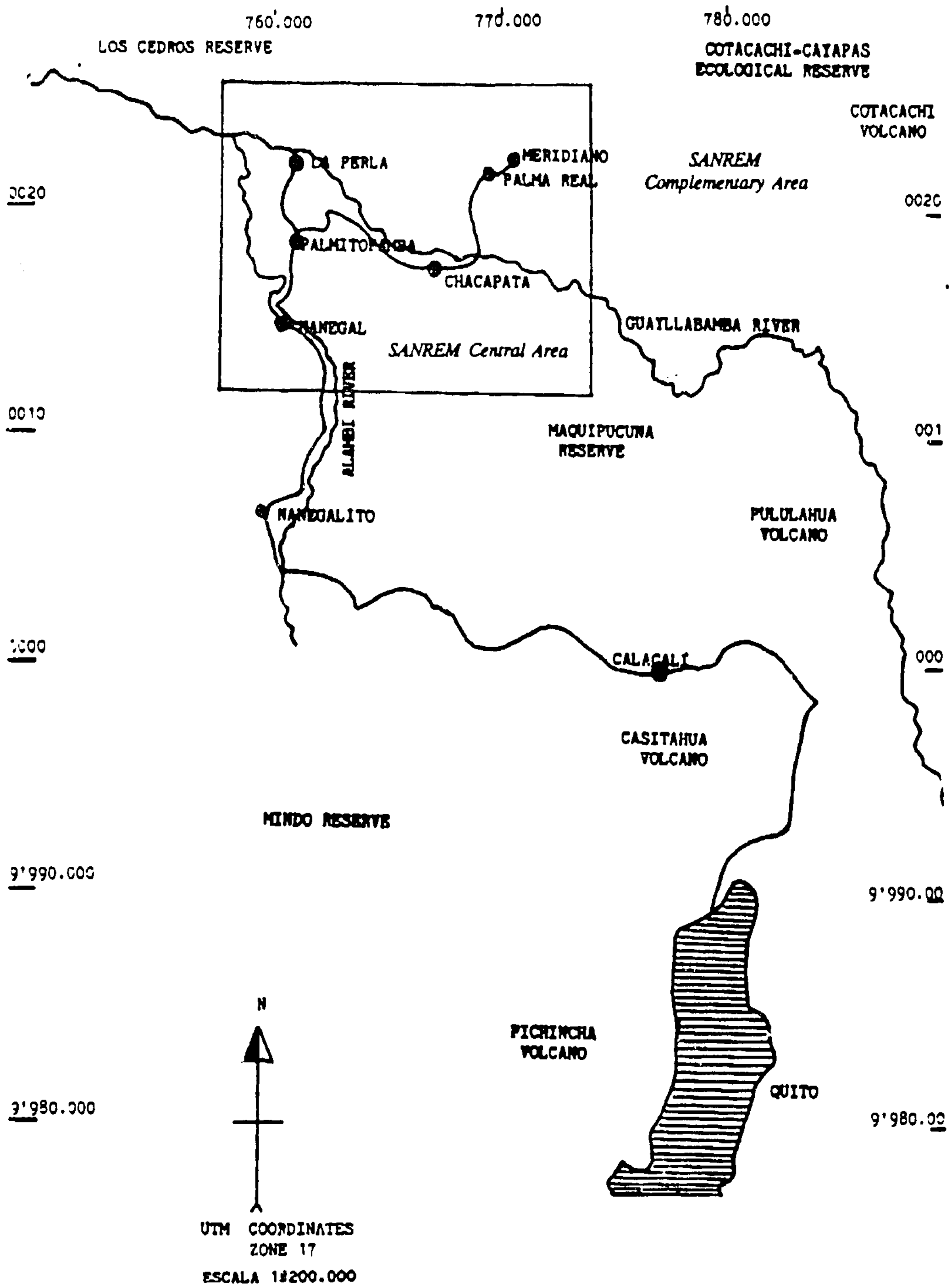
1) resident hacienda owners, who hold medium to large properties that serve as their main source of income.

2) "weekend" hacienda owners, so-called because they have no local residence and do not rely exclusively on farm income for household reproduction;

3) subsistence farmers who own small properties that allow them to make a living, yet apparently do not provide them with the capacity to improve their livelihood;

Figure 1: Location of the SANREM CRSP Project Site in Ecuador.

Figure 2: The Central Research Area of the SANREM CRSP (in the box) and the Surrounding Complementary Research Development Area in the Vicinity of the Cotacachi-Cayapas Ecological Reserve.



4) landless sharecroppers, working mostly for the hacienda owners;

5) sugarcane growers producing cane alcohol and brown sugar. These small-scale farmers have a relatively better economic position than their neighbors who do not process their agricultural products; and

6) business-oriented households that may own some land for subsistence agriculture but rely on commerce for their main source of income.

THE LANDSCAPE

The Cotacachi-Cayapas Ecological Reserve's buffer zone is located within the rainforest belt in the northwestern Andean escarpment. This area is a natural extension of the great rainforest ecological formation of the Chocó which runs along the Pacific Coast from southern Panama to the northern portion of Ecuador. More than 10,000 biological species have been identified to date in Ecuador's northwestern forests, of which 25% are endemic (Suárez and Ulloa, 1993).

The Middle Guayllabamba River area is within the climatological belt referred to as the Very Wet Sub-Tropical Region (Cañadas, 1983). This zone is located between 500 and 1,800 m.a.s.l (meters above sea level). Average annual temperatures in this belt fluctuate between 18.0° C and 22.8° C, depending on the altitude. The average annual rainfall ranges between 2,000 and 4,000 mm. The study area has two distinct seasons; a rainy season beginning in September and ending in June, and a short, dry season occurring only during the months of July and August.

The Guayllabamba River basin landscape is a combination of zones extensivaly covered with natural vegetation (72%) interspersed with large patches of land dedicated to agriculture and livestock raising (28%) in areas where the topography is more gently sloping (Table 1). According to government statistics, the area dedicated to agricultural use is planted primarily to pastures (80%), permanent or semi-permanent crops such as fruit trees and sugar cane (17%), and short-cycle agricultural crops (4%) (PRONAREG, 1982) (Table 2).

The most important agricultural products of the region are sugar cane, beef, and milk. Sugar cane is used primarily for the local production of alcohol and raw sugar, with particular rural communities specializing in either one or the other of these products. The majority of the products from the sugar cane and milk cottage industries are sold outside the area.

Other major commercial crops planted in the area include maize, cassava, beans, watermelons, turnips and peanuts. Products from these crops are sold through commercial intermediaries to markets located outside the zone. Some farmers are experimenting with crops that are commercially exotic to the zone, such as jalapeño chili peppers, which are produced for international export markets.

THE LIFESCAPE

This region has no indigenous culture, although it was occupied in pre-Hispanic times by indigenous people known as the Yumbo. These indigenous societies had an economy articulated through commerce to the highland valley of Quito. The region is presently colonized by people who originated from different regions of the country.

Table 1: Land Use in the Guayllabamba River Region.

A.S.A.[1]	Cultivated H.A.		Uncultivated H.A.		Area H.A.
Nanegalito[2]	29,725	28%	75,655	72%	105,380
Minas[3]	12,713	38%	20,447	62%	33,160

[1]A.S.A. is the land area of the agricultural extension service.
[2]Includes parroquias of Nanegal, Nanegalito, Pacto, Gualea, Mindo.
[3]Includes parroquias of San Jose de Minas, Atahualpa, Chavezpamba y Perucho.

Source: Ministry of Agriculture, Departamento de Geografia (PRONAREG). 1982. Division Agro-Socio-Economica. Direccion de Regionalizacion Agraria.

Table 2: Agricultural Land Use in the Guayllabamba River Region.

A.S.A.[1]	Short Cycle Crops H.A.		Permanent Crops Has.		Pastures Ha.		Total Cultivated Area Ha.	
Nanegalito[2]	1,061	(4%)	4,848	(16%)	23,816	(80%)	29,725	(100%)
Minas[3]	7,037	(56%)	445	(4%)	5,231	(41%)	12,713	(100%)

[1]A.S.A. is the land area of the agricultural extension service.
[2]Includes parroquias of Nanegal, Nanegalito, Pacto, Gualea, Mindo.
[3]Includes parroquias of San Jose de Minas, Atahualpa, Chavezpamba y Perucho.

Source: Ministry of Agriculture, Departamento de Geografia (PRONAREG). 1982. Division Agro-Socio-Economica. Direccion de Regionalizacion Agraria.

Most settlers, however, came from the neighboring highland provinces. The colonization process took place over a long period of time, although it was intensified during the second half of the 20th century.

In colonial times, the upper sections of the Guayllabamba River, located approximately 500-1000 m.a.s.l higher than the SANREM CRSP research site, were exploited by the Jesuit order until their expulsion from Latin America in 1767. The Jesuits developed sugar cane haciendas in the neighborhood of the villages of Guayllabamba, Puellaro and Perucho. It is interesting to note, in spite of the agro-ecological differences with the areas below, that these sugar cane farms have been in production for centuries. Historically, sugar cane was used for the production of cane alcohol (trago) and raw brown sugar (panela) (Basille, 1974: 99). These two agro-industrial products remain the most important products in the SANREM CRSP research site.

The occupation of the warmer valleys below the town of Guayllabamba started in approximately the 1940s. Colonization was spontaneous in its origin, yet the influence of the state - in the form of road construction and the concession of legal titles to land, among other factors - increased gradually, and therefore contributed to the pattern and extent of colonization. For example, a colonizer, in order to receive a property title, was required to clear at least 50% of the forest, a situation that encouraged farmers to plant pastures.

Properties were deeded to colonizers in lots of 50 hectares. The settlement of available lands combined with apparently dynamic land market, however, has resulted in a reallocation of land. Currently, in the agricultural district of Nanegal, the size of agricultural properties fluctuates between 2.5 and 364.5 hectares (Table 3). There are indications that there are a significant number of landless farmers (not identified in Table 3). The existence of this farming class would mean that sharecropping arrangements are probably quite important in the Guayllabamba lifescape.

Demographic data indicates that population pressure between the 1982 and 1990 census has remained basically stable in the Nanegalito ASA[3] (42.2 inhabitants/km2 in 1982 compared to 45.5 inhabitants/km^2 in 1990) (Table 4). Crop area also has remained relatively unchanged, an indication that the agricultural frontier within the study area has reached a limit.

The population of the parroquia of Nanegal, located at the center of the SANREM CRSP research area, is almost 3,000 persons (Table 5). The total population in all the parroquias where the SANREM CRSP is planning to work is approximately 17,000 persons, comprising probably more than 3,000 families. This large figure indicates that SANREM CRSP research teams will have to rely on local social institutions, local knowledge, and local processes of communication in order to achieve positive, practical impacts on the sustainability of the region at the landscape/ lifescape level.

The cultural perspective, dress and mannerisms of the population is similar to that of mestizos, the Spanish-speaking rural population. This feature contrasts with the fact that the cultural origins of the majority of the settlers is Andean. Related to this feature is the fact that the population places a high value on public education services for their children. Illiteracy in the parroquias of the study zone is low (between 9 - 14%), far less than in other rural areas of the country.

ADAPTION OF THE PARTICIPATORY LIFESCAPE/ LANDSCAPE APPRAISAL (PLLA) METHODOLOGY TO THE ECUADOR SETTING

Similar to the research process used in the other SANREM CRSP sites, initiation and planning of action-oriented research at the Guayllabamba site is based on a landscape-based PRA method referred to as the PLLA. The first step of the PLLA in Ecuador was to sponsor a community participatory self-diagnosis. This participatory activity, called PAC (*Planificacion Andina Comunitaria* or Andean Community Planning), is a type of PRA used by COMUNIDEC (Sistema de Investigacion y Desarrollo

Table 3: Landholding Size.

Size of Property Percent Has.	Number of Families	Total Areas Has.	Average Size Has./Fam.	Percent	
				Families	Area
Parroquia					
0-5	31	64	2.1	16.2%	0.8%
5-10	18	120	6.7	9.4%	1.4%
10-20	26	370	14.2	13.6%	4.5%
20-50	62	1,993	32.1	32.5%	24.0%
50-100	30	1,883	62.8	15.7%	22.6%
> 100	24	3,884	161.8	12.6%	46.7%
Total	191	8,314			
Gualea					
0-5	27	64	2.4	12.3%	1.0%
5-10	40	264	6.6	18.3%	4.1%
10-20	51	656	12.9	23.3%	10.2%
20-50	58	1,795	30.9	26.5%	28.0%
50-100	33	2,036	61.7	15.1%	31.7%
> 100	10	1,606	160.6	4.5%	25.0%
Total	219	6,421			
Nanegal					
0-5	52	130	2.5	18.5%	1.1%
5-10	53	323	6.1	18.9%	2.8%
10-20	48	627	13.1	17.1%	5.5%
20-50	76	2,144	28.2	27.0%	18.8%
50-100	35	2,000	57.1	12.4%	17.5%
> 100	17	6,197	364.5	6.0%	54.3%
Total					

Table 3: Landholding Size. (Continued)

Size of Property Percent Has.	Number of Families	Total Areas Has.	Average Size Has./Fam.	Percent	
				Families	Area
Pacto					
0-5	42	82	2	13.3%	0.4%
5-10	38	252	2.6	12.0%	1.3%
10-20	40	541	13.5	12.6%	2.8%
20-50	79	2,352	29.8	25.0%	12.2%
50-100	86	4,978	57.9	27.2%	25.8%
> 100	31	11,116	358.6	9.8%	57.5%
Total	316	19,321			
Minas					
0-5	705	1,052	1.5	60.5%	8.7%
5-10	198	1,319	6.7	17.0%	10.9%
10-20	116	1,523	13.1	9.9%	12.6%
20-50	95	2,807	29.5	8.1%	23.2%
50-100	37	2,203	59.5	3.2%	18.2%
> 100	15	3,188	212.5	1.3%	26.4%
Total	1,166	12,092			

Table 4: Changes in Population Density in the Period 1982-1990.

A.S.A.[1]	Population 1982	Population 1990	Rate of Growth 1982-1990	Rate of Growth Annual
Nanegalito[2]	12,529	13,522	7.8%	0.9%
Minas[3]	11,936	11,072	-7.2%	-0.9%

[1]A.S.A. is the land area of the agricultural extension service.
[2]Includes parroquias of Nanegal, Nanegalito, Pacto, Gualea, Mindo.
[3]Includes parroquias of San Jose de Minas, Atahualpa, Chavezpamba y Perucho.

Source: Ministry of Agriculture, Division de Estudios Agro-Socio-Economicos. Direccion de Regionalizacion, 1992.

Table 5: Basic Population Data of Main Parroquias in the Guayllabamba River Region.

Parroquias	Total	Males	Females
Gualea	2,085	1,130	955
Nanegal	2,948	1,600	1,348
Pacto	4,403	2,389	2,014
Minas	7,594	3,902	3,692
Total	17,030	9,021	8,009

Source: Instituto Nacional de Estadistica y Censos. (INEC 1990)

Comunitario) (Ramon, 1994a), one of the institutions that form the SANREM CRSP/ Ecuador consortium. COMUNIDEC's experience with PAC had previously been restricted to highland Andean communities. The ecological and cultural context of the Andean landscape includes strong community institutions and values, the product of centuries of local history. Andean social relationships are organized and managed through communal and kinship group institutions. As a result, communal politics and communal labor parties are common, and there is a historical tradition of community planning. For both COMUNIDEC and the SANREM CRSP team, it was a challenge to observe how the PAC method adapted to the ecological and human conditions of a colonization zone.

The PLLA typically involves secondary literature reviews of conditions in the area, introducing the SANREM CRSP program methodologies to the local officials and community members, and visits by researchers to communities in the research area. The PAC method also recommends the use of secondary information which is presented in a pedagogical format for community debate. However, lack of time prevented its use within the initial PAC activities.

The steps involved in the PAC were followed in the same sequence in the five communities, with minor adjustments made as experienced was gained. Briefly, the steps in this sequence were:

(1) **Development of "Debate Questions."** Based on a review of secondary literature and preliminary knowledge of the area, COMUNIDEC developed, and the SANREM CRSP team reviewed, a set of questions that was posed to the communities to foster and organize debate. The questions, based on the conditions of the Andean highland, were adapted to the historical and ecological features of the Guayllabamba zone. Team members recommended the inclusion of questions that addressed issues of household production and reproductive functions.

(2) **Introduction of the SANREM CRSP project to the local authorities.** This introduction was made by a team of two COMUNIDEC members who had established residence in the site.

(3) **Identification of social groups that should be given priority to participate.** This activity purposefully focused on those groups who were incorporated into the community life but excluded large-scale landholders with political power.

(4) **Extending of an invitation to participate to the identified priority social groups.**

(5) First meeting (lasting approximately 5 hours). PAC meetings were held at night to allow day laborers and women to participate. The meeting began with an introduction that focused on concepts of community planning, interactions as perceived at the watershed level, and the meaning and goals of the SANREM CRSP. Participants then divided into groups. Each group addressed one of the "debate questions." At the conclusion of their discussion, group members presented a written synthesis of their debate to the other participants. The first work session was closed with a "community meal" sponsored by the SANREM CRSP.

(6) Second meeting (lasting approximately 5 hours). Additional debate questions were addressed by the groups and presented to the community. The meeting concluded with the participants developing a general synthesis of problems and identifying potential solutions to these problems.

The work performed in each community was synthesized and presented to the communities. Based on this information, the community members indicated to the SANREM CRSP team members their priorities for action and research. This prioritized local agenda served as a guide to organize the SANREM CRSP work plans.

During the self-diagnosis, participation by researchers was intentionally limited. The purpose of limiting the inclusion of researchers was to empower local community members and allow them to independently identify local concepts related to their biophysical and social environment. It was concluded after the community meetings, however that, in the future, researchers should be included in more active roles since the self-diagnosis could have provided the researchers with a unique opportunity to observe local debates (Ramón, 1994b). In spite of this limited participation, a key benefit of the PAC, besides the generation of community-based information, was to establish a solid rapport between the local community and the SANREM CRSP. This rapport was established as the SANREM CRSP research and development objectives in the area were introduced through an analysis of the agricultural strategies, community needs, and the environmental conditions conducted by the community itself (Ramón, 1994b).

INDICATORS OF SUSTAINABILITY IN THE GUAYLLABAMBA WATERSHED

This section discusses two important issues for indicator of sustainability use within the context of SANREM CRSP/ Ecuador. First, the methodological implications of the community self-diagnoses and the local perception of sustainability for the identification of indicators in Guayllabamba are discussed. Secondly, a framework for the assessment of interdisciplinary, integrated biophysical and socioeconomic indicators is provided.

Local Perceptions of Sustainability

The design of research will be closely tied to the self-diagnosis carried out by the communities. It is therefore crucial to consider the implications that this research method has for our work with indicators of sustainability. The PAC was designed, primarily, to provide an opportunity for the local population to develop and express their own historical perspective of their communities, and more specifically and to verbalize their own view of "development." Community self-diagnosis includes having community members develop an understanding of the kind of future the community envisions for itself. This vision illuminates issues of "sustainability", community needs, and local issues of concern for applied research.

A second dimension of the method involves a preliminary understanding of how local residents conceptualize their productive and natural space. This includes simple descriptions of their main farming systems, forest resources, and an assessment of the conservation status of their soils, water, and wild flora and fauna.

A third aspect of the community diagnosis is a description of the local lifescape: the main socioeconomic strata recognized in the community and descriptions of the household productive and reproductive functions, including some preliminary, mostly normative, information related to gender.

Although the PAC certainly generated a wealth of information about biodiversity (between 41 to 72 named species were identified in each community) and agriculture practices (primary cropping systems, animals raised, and local family industries), the thrust of the community analysis was related to the social organization of the community. This social focus of the PAC is due to the function of this process to build the social and organizational ground for future research work. This self-diagnosis was therefore especially effective in helping to develop an understanding of the activities, responsibilities, and status of people in different age groups and social and economic strata. The PAC also generates information about the importance of family, kinship, and neighborhood or interest groups, as well as the factors that underlie these organizational forms.

Considering the centrality that the PAC will have for the design of research, it is important to discuss the type of "farmer" represented in the community self-diagnosis. The community workshops included balanced participation by both men and women as well as by different age groups, including children (approximately 10% of the population participated in the workshops). The PAC, however, purposefully excluded hacienda owners and other local power brokers in order to enhance the participation and empowerment of small-scale farmers, town dwellers, and sharecroppers. It is clear, therefore, that not all actors are represented in the local view portrayed by the community self-diagnosis.

The Guayllabamba lifescape has been described as a "mosaic" and includes more stakeholders affecting management of the landscape that have been addressed in this paper. The perspectives of sustainability will differ among the players in this mosaic. For example, the income produced by the farm may not be an indicator of sustainability for a "weekend farmer" who owns land for reasons related to financial speculation or cultural prestige. In contrast, for sugar cane farmers income produced by the farm is probably a very obvious indicator of sustainability.

Because the PAC method was developed in highland settings, the methodological procedures were not fully adapted to the agroecology of the Guayllabamba region. For instance, highland communities make sharp distinctions among production zones which often run along altitudinal belts. As a consequence of environmental features, Andean communities have highly structured agricultural calendars. Production zones and a normative agricultural calendar appeared in the PAC conducted in Guayllabamba, although it is not yet clear to what extent these are important in the area or were described as a result of the "highland bias" of PAC (Ramón, 1994b). This is a question that will have to be resolved through empirical research. In the interim, research activities (including the indicators components) will be organized using the spatial categories that emerged through the community self-diagnosis.

An Indicators of Sustainability Assessment Framework

For purposes of our work on indicators, we use the definition of sustainability provided by Hart (1994). This definition describes sustainability as the relationship between society's use of the natural base and the impact that such use produces on the quality and quantity of those resources, and hence on the likelihood that such relationship will sustain extant livelihoods through time. Indicators, therefore, can be described as figures that provide relative and approximate measurements of the status of the use/impact nexus.

Within this conceptual framework, indicators of sustainability may serve two general purposes in Guayllabamba: a) to promote local debate about "sustainability" (the use/impact nexus), and b) to provide both the local population and researchers with a set of qualitative and quantitative figures that can be used to avoid environmentally negative development alternatives.

Indicators and local debate: One of the main products of the PLLA was the identification of a tension between the way communities see the ideal, "developed" community (urbanized with public services) and the harsh realities that they observe in their own communities of ecological deterioration and its negative consequences for community well being (water supply problems for humans and domestic animals, lack of wild animals and flora for the diet or medicinal use, lack of timber products for household use, and landslides, etc.). While farmers perceive and are concerned with negative ecological trends, they still conceive of their development model as ideal (Ramón, 1994b).

The farmers of Guayllabamba noted in their self-diagnosis the dimensions of use and impact, although they did not necessarily recognize or discuss the nexus between them. It is clear from this initial research step that there is ground in Guayllabamba to conduct research work related to "sustainability" (Ramón, 1994b). Indicators of "sustainability" can serve as a research tool to promote local debate about the use/impact relationship and to stimulate the design of research agendas, technical or organizational solutions, and new development paradigms. Including local indicators in the design of research projects and community activities in Guayllabamba will serve primarily to stimulate local debate about "sustainability."

Identifying Indicators of Sustainability: Indicators of sustainability in Guayllabamba are expected to integrate biophysical and socio-economic dimensions. Integration and interdisciplinarity are necessary if indicators are going to be useful to guide local action and policy making. Indicators must also provide insights into sustainability at landscape and long-term perspectives, scales that are usually absent from the design of traditional development research. A unique feature of Guayllabamba is the fact that is located in a hotspot. On one hand, this is a colonization region that is quickly transforming the natural ecosystem. On the other hand, the zone is located a stone's throw away from a hotspot protected area, the ecological reserve of Cotacachi-Cayapas. This reserve is the landscape equivalent of a keystone species. Indicators of sustainability in Guayllabamba should explore the hotspot dimension of this region.

The main challenge concerning the development of indicators will be to design processes and methodologies that have the flexibility to include the technical, social, and cultural values that colonizer farmers have regarding their forest, soil, and water resources. For example, an indicator of biodiversity will primarily have biological variables, but it also should include economic, cultural, and other factors that affect the valuation of this resource in their environment. Another way of achieving integration could be to search for families of indicators that are grouped together within the system interactions that local people themselves perceive as relevant for sustainability. This process would link together indicators based on system interactions as perceived by local people. The loss of timber species in Guayllabamba is associated with loss of income and products for household building and maintenance. But, loss of this resource is also associated with a deterioration of water supply, especially for cattle that require access to large amounts of clean water for drinking.

Action-oriented research in Guayllabamba will be conducted at system hierarchy levels ranging from the plot level to the watershed and regional levels. These activities will require methodologies for analyzing problems at both micro and macro temporal and spatial scales. Guayllabamba farmers can describe the process of change undergone by their landscape and lifescape since they first arrived some 20 to 30 years ago. They also can identify positive and negative trends between past and present points in time. Indicators should use the approximate knowledge that people have about their ecosystems in a long-term framework. Tapping this local knowledge, however, requires the development of innovative, revolutionary techniques of data collection and analysis (Rhoades, 1991). Examples of innovative methods that are currently in use include participatory documentation of the local history and adapting Geographic Information Systems products to folk models in order to encourage local debate about landscape problems and solutions.

Since this area is an agricultural zone of colonization located within one of the world's most important conservation hotspots, an important area of research on indicators of sustainability would be a comparison of the condition of the natural ecosystems within the reserve compared to the equivalent condition of resources in the transformed ecosystems of the buffer zone. In spite of the fact that the buffer zone of the reserve has been thoroughly transformed as a result of its conversion to agriculture, approximately 70 % of land is still covered by forests, according to the estimates of the Ministry of Agriculture (MAG, 1994). An assessment of the status of "hotspot" indicators within the buffer zone might yield insights into the potential for biodiversity conservation within the areas transformed for agriculture. Practical products of this research could be the identification of bio-indicators to show where to establish conservation corridors between the ecological reserve and its adjacent agricultural areas.

A second dimension of "hotspot indicators" research is related to comparisons between the elements and processes that characterize natural ecosystems within the Ecological Reserve with those of the agro-ecosystems in the buffer zone.

In conclusion, the major challenge in the development of indicators to monitor the status of the hotspots will be to find ways to include variables that are relevant to an understanding of how local people behave in relationship to their ecosystem. These indicators must have meaning to them, have the ability to motivate them to monitor their resource use, and produce results that are useful in guiding their actions.

CONCLUSIONS

Work with indicators of sustainability at Guayllabamba will help to promote local debate about the relationship between the use of the natural resources within this unique hotspot and the impact that such use has on the biophysical and socioeconomic environment. A better understanding of this nexus known as "sustainability" must contribute to better management of the natural resource base by the local population, to more locally and culturally appropriate applied research, and to the promotion of public policies that promote development with respect for ecosystem conservation.

To become a reality, this process requires community empowerment. It also requires supporting the capacity of local communities to use indicators for monitoring data in order to better manage their local development alternatives. Addressing the complexity of "sustainability" interactions at large spatial and temporal scales only through traditional western scientific research and technical development is extremely demanding in time, expensive, and difficult to adapt to local needs. Participatory local research on indicators of sustainability is an alternative and realistic solution to better management of the natural resource base.

ENDNOTES

1. The identification of hotspots is based on 1) an analysis of biodiversity indices as determined by key flora and fauna indicators; 2) the percentage of endemic species in relation to the total number of species observed; and 3) the number of distinct ecological systems in the zone (Meyers 1988). Hotspots are measured using strictly technical measures.

2. Lifescape is the term used by SANREM CRSP collaborators to describe the social, cultural and economic interactions by people living, working and trading within a landscape.

3. A.S.A. is the land area division used by the Ecuadoran Agricultural Extension Service.

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Search for Indicators of Sustainability for Philippine Uplands: Focus on Manupali Watershed

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INTRODUCTION

As an archipelagic country, the Philippines is characterized by rugged terrain. Out of its total land area of 30 million hectares, 18 million are upland areas with slopes greater than 18%. Roughly one-fourth of the Philippine population of 65 million live in these upland areas. The Philippine uplands are also the location of 18 major watersheds, several of which have been dammed for hydroelectricity production.

Unfortunately, most of these major watersheds are now in a critical stage of degradation due to a history of unregulated logging, forest occupancy, and shifting cultivation. Of the eight million hectares of Philippine forests remaining, most are in the uplands. The ecological stability of the country depends on how these remaining resources are managed and developed.

The Manupali Watershed is typical for major watersheds in the country. It is characterized by continued recession of its forest margin due to timber cutting and shifting agricultural cultivation. The Pulangi Dam, less than 30 km downstream from the confluence of the Manupali River with the Pulangi River, is threatened with rapid siltation.

The Manupali Watershed is the Philippines site for the Sustainable Agriculture and Natural Resources Management Collaborative Research Support Program (SANREM CRSP). The purpose of this paper is to describe the Manupali Watershed and the Philippine policies that affect this site. Based on this background information, we will describe indicators of sustainability that have been identified and are currently being used within this program.

THE SANREM CRSP/PHILIPPINES

The SANREM CRSP is a 5-year research, training and information exchange program which offers a new paradigm in international research and development. The mission of the SANREM CRSP is to implement a comprehensive farmer participatory interdisciplinary program that will elucidate and establish principles of sustain-

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able agriculture and natural resource management on a landscape scale in the tropics. This landscape approach to sustainability is a new approach to food production and natural resource management within an ecological framework.

The SANREM CRSP methodology sits on four cornerstones - intersectoral, participatory, interdisciplinary and landscape/ lifescape development. These cornerstones reflect the overall strategy and reason for existence of the program.

Intersectoral: This cornerstone refers to the involvement in program development of all concerned sectors; including the community local government units (LGUs, government agencies, non-government organizations (NGOs) people's organizations (POs), state colleges and universities, and international development institutions, and national and international agricultural research centers.

Participatory: The participatory cornerstone relies on the active participation of all sectors, especially members of the community, in all aspects of program development including planning, implementation, monitoring evaluation, and impact assessment.

Interdisciplinary: This cornerstone encourages efficient and harmonious teamwork between people of different expertise including ecologists, biologists, sociologists, economists, agriculturists, foresters and animal husbandry specialists.

Landscape/Lifescape Development Approach: This cornerstone takes into consideration the interaction and interrelationship between different components of adjoining ecosystems, emphasizing the need to maintain harmony and synergy among them.

The Philippines is one of the major sites of the SANREM CRSP. Launched in 1992, the SANREM CRSP/Philippines is offering important insights in the discourse on the agricultural and natural resource sustainability of the uplands. Although still at a nascent stage, the SANREM CRSP/ Philippines experience also has important implications for creating policies and procedures for conducting research on sustainability in the Philippines.

THE MANUPALI LANDSCAPE

The Manupali Watershed is located in north-central Mindanao in the Province of Bukidnon, the Philippines. Considered as one of the major watersheds in the country, it is composed of 220 streams traversing a total of 636,000 meters and draining approximately 40,000 hectares (FORI, 1982). The Manupali River drains into the Pulangi River which flows into the Pulangi IV Reservoir. This reservoir is one of the six reservoirs developed by the National Power Corporation (NAPOCOR) to generate hydroelectric power.

Six municipalities are situated within the watershed. The Municipality of Lantapan, where the SANREM CRSP/Philippines currently focuses its research activities, covers about 44% (16,947 ha) of the entire catchment basin (38,130 ha).

Lantapan is located 30 kilometers south of Malaybalay, the capital of the Province of Bukidnon and 85 kilometers south of Cagayan de Oro City, which is a major port. It has a total land area of 31,820 hectares and is comprised of 14 *barangays* or villages (Figure 1). Elevation ranges from 500 masl

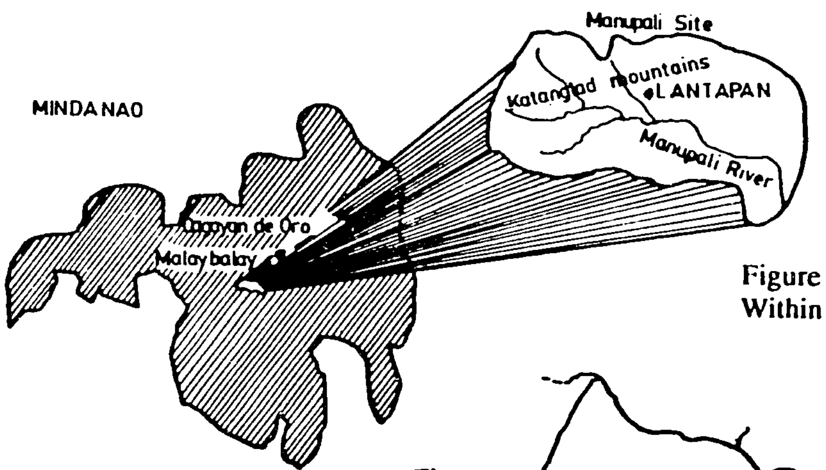

Figure 1a: The Location of the Manupali Watershed Within the Province of Bukidnon, the Philippines.

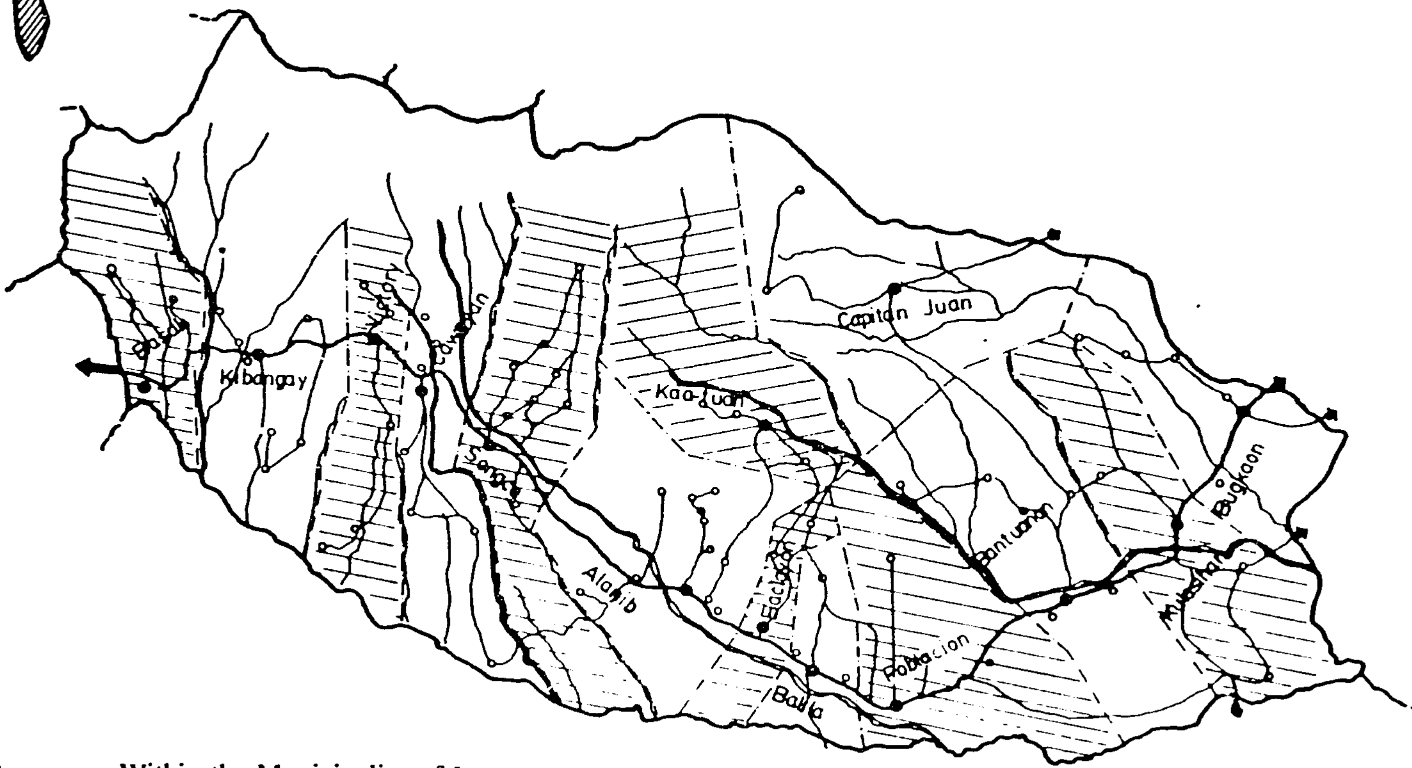

Figure 1b: Barangays Within the Municipality of Lantapan, Bukidnon.

(meters above sea level) in Barangay Bugcaon to 2,150 masl in Barangays Kaatuan and Capital Juan. Of the total land area, 61% is steeply sloping (slopes of >40%), 7% is rolling to hilly, 8% is undulating to hilly and 24% is flat to gently undulating. The municipality's land classification status (legal status) shows that about 59% (18,807 ha) is classified as Alienable and Disposable (A & D) lands and 41% (13,013 ha) is classified as forest lands.[1] Approximately 27% (8,600 ha) of the forested land is within the Mt. Kitangland National Park, a forest reserve area designated in conjunction with the National Integrated Protected Areas System (NIPAS).[2]

The Municipal Statistical Profile of 1994 reports that Lantapan has a built-up area of 1,814 ha. This area includes 143 ha of residential property, 0.7 ha of commercial property and 1,670 ha used for other purposes. Areas under cultivation are estimated at 17,000 ha (DA/BSWM 1989).

The two major soil types in the area are the Adtuyon clay and the Kidapawan clay loam. Both soils are of volcanic origin. These soils are underlain with pyroclastic rocks and quaternary volcanic flows consisting of andesitic and basaltic materials.

Five principal rivers flow through the municipality: the Alanib, Tugasan, Maagnao Timago and Kulasihan Rivers. These rivers drain into the Manupali River, which serves as the boundary between the municipalities of Lantapan (to the north) and Valencia (to the south).

Lantapan's climate is classified as Type III, relatively cool and humid with no pronounced seasonal variation in rainfall. It is wet throughout the year with a relative dry period extending from November through April. The average monthly rainfall recorded between 1989 to 1992 was approximately 128 mm. For the same period, annual rainfall ranged from 921 mm to 2,075 mm.

Under normal weather conditions, all of the municipalities 14 barangays are accessible by jeepney, the primary form of transportation. Access to barangays located on the upper slopes of the watershed may be difficult, however, during heavy rains. Some remote *puroks*, or sub-villages, are only accessible by using a four-wheel drive vehicle while others can be reached only by foot or on horseback.

THE LANTAPAN LIFESCAPE[3]

Demographics and Ethnic Diversity

Between 1980 and 1990, Lantapan experienced a rapid growth in population. Population size increased by 48% from 22,678 in 1980 (National Census and Statistics Office, 1980) to 33,574 in 1990 (National Statistics Office, 1990). The average household size remained at approximately 5.8 people/household through this time. The projected population for 1994 was about 39,497, encompassing 5,826 households. The rapid population increase in this municipality can be attributed to both high rates of birth and inmigration.

Ethnic diversity characterizes Lantapan's lifescape. Ethnic groups include the Dumagat, Talaandig, Igorot, Higaonon and Muslim. The Talaandig are indigenous to the area. The Dumagat are Visayan migrants from the central parts of the country or other parts of Mindanao. They can be classified into two linguistic groups, the Cebuano speakers and Ilonggo speakers. Both groups occupy the lower slopes of the municipality.

The upper slopes are dominated by the indigenous Talaandig natives.

On the lower slopes, the Talaandig culture has become integrated into the dominant Dumagat culture and intermarriage between the two ethnic groups is common. In the more remote puroks of the upland barangays, the Talaandig are less integrated into the Visayan culture and continue to speak the indigenous Binukid dialect.

The integration of the Talaandig and Dumagat cultures was expedited by the spread of Christianity and through the activities of national government programs. The most influential of these programs was the National Resettlement and Rehabilitation Administration (NARRA). This program occurred in the late 1950s and facilitated the migration of Filipinos from the northern and central regions of the Philippines to Bukidnon (Lao, 1992).

Health and Education

Lantapan has 18 primary and elementary schools and three secondary schools (Department of Education, Culture and Sports Bukidnon Annual Report, 1993). The majority of these schools are state funded. For the school year 1993-94, 5,442 pupils were enrolled in the elementary schools while 806 pupils enrolled in the secondary schools. The average educational attainment in the municipality is elementary level.

Municipal health records indicate relatively high levels of malnutrition and disease among the children of the municipality. To monitor malnutrition levels, the Department of Health conducts the Operation Timbang (child weighing) program. Results from this program showed that of the 7,030 pre-schoolers (0-6 years old) weighed in 1993, 82 were severely underweight, while 634 were moderately below the normal weight requirement. Data from the municipal health officer revealed that the morbidity of children in this age group was 782 per thousand while mortality rate was 5.6 per thousand. The major causes of mortality and morbidity were respiratory and gastro-intestinal diseases.

Health services available in Lantapan include one rural health center located in the Barangay Poplacion and eight barangay health stations. These government health facilities are supported by 16 government health workers and 191 trained health volunteers.

Livelihoods

Farming is the primary livelihood in the area. Members within the household are involved in various agricultural production activities. Many households also have one or more member engaged in off-farm economic activities.

The major crops produced in the lower elevation are maize, sugarcane and irrigated rice. Tree plantations, including rubber and gmelina, are found in the lower elevation. In the upper elevation, farmers cultivate maize, coffee, and high value vegetable crops including potatoes, cauliflower, and chinese pechay.

Local Government

The municipality is administered by elected officials headed by the mayor assisted by the vice mayor and nine members of the local legislative body. Each of the 14 barangays are headed by an elected Punong Barangay (also called Barangay Kapitan) and seven Kagawad (council members). Governance within the tribal community is exercised by the members of Talaandig Tribal Council. This council was created by PANAMIN, a government program designed to address the concerns of indigenous peoples (Lao, 1992). The Tribal Council is headed by a Datu or tribal leader. To obtain land use rights, community members must request permission from the Datu, who has the authority to distribute lands to his constituents.

POLICY SCENARIO

The context of the Manupali landscape is greatly affected by the policy scenario for the Philippine uplands and countryside. Policies related to agriculture and natural resources have important implications on Lantapan's resources and political climate. Policies can affect how community members use natural resources, impact on socio-economic relationships among community members, and affect the potential for programs to enhance sustainability. The most important of the national policies affecting this site are briefly discussed below:

Philippine Strategy for Sustainable Development (PSSD). The PSSD is an umbrella policy enacted by the Philippine legislature, and duly approved by the president of the republic, to serve as an environmental guide for all development initiatives in the Philippines. This policy institutionalizes the incorporation of environmental considerations into the planning and implementation of development projects and the enforcement of the Environmental Impact Analysis (EIA) system. The PSSD seeks to advance equality between the current and future generations of Filipinos with regard to the exploitation and protection of natural resources. It covers all sectors of agriculture, industry and natural resources management.

Ban of commercial logging in remaining virgin forests. Realizing the devastating impacts of logging over the past decades, the government, in January, 1992, banned logging in the remaining virgin forests. This ban declared these areas as protection forests to help improve the deteriorating Philippine environment and to protect remaining biodiversity. These areas will serve as sources of seeds for rehabilitating denuded areas. With this policy, logging activities are now concentrated in selected residual or secondary growth forests. In support of this policy, ten priority old growth forest areas throughout the country have been declared as protected areas under IFAS. One protected area includes Mt. Kitangland and vicinity in the Manupali Watershed.

Rationalized management of residual forests. This policy parallels the protection of the virgin forests by promoting wise utilization and providing protection of the residual or secondary growth forests. A massive cancellation and suspension of timber concessions has occurred over the past years. As a result, about three million hectares of secondary growth forests are now accorded open access status, a status which subjects these areas to encroachment and abusive use. This rationalized management policy seeks to protect secondary growth forests by recruiting qualified settled communities as managers of these forests. These communities may manage the forests either individually or in partnership with the corporate sector.

Community participation in the management and utilization of the Philippine forests. These programs are based on the realization that benefits from timber harvesting have previously accrued mostly to wealthy timber concessioners. To enhance community benefits from the remaining forest stands, communities are trained and guided by Forest Service Organizations (FSOs) on the management and utilization of the forest. The trained communities then must implement, on their own, the regeneration, protection, management and utilization of the forest. For their efforts, the community obtains 80% of the resulting harvest benefits while 20% of the profit goes back to the government. Specific programs under this scheme include the Integrated Social Forestry Program (ISFP), Community Forest Program (CFP), Contract Reforestation (CREF) and the Forest Land Management Agreement (FLMA).

Adoption of agroforestry in upland community development programs. To ensure soil and water conservation on fragile uplands subjected to occupancy, policies have been implemented to encourage the use of agroforestry and other tree-based land uses in these areas. These policies also envision tree-based systems as providing stable livelihood strategies or alternatives for upland communities. Lands held under ISF lease contracts will be inspected five years after the initiation of the contract to determine if trees or other agroforestry species have been established on the land. Failure to plant trees on the land will result in the cancellation of the stewardship agreement.

Forest classification for all lands above 18% slope. According to this policy, land areas with a predominant slope of 18% or more are legally categorized as forest lands (regardless of whether the land is covered by trees). Forest lands are legally not subject to ownership and title nor are these lands available for cultivation. In practice, the lower slope limit is not strictly adhered to. The government continues to allow cultivation on sloping land provided the cultivation is in conjunction with agroforestry.

Poverty alleviation in the countryside. Traditionally, the cities and urban areas are associated with advancing development and better quality of life while the countryside is equated to poverty. People tend to leave the countryside and migrate to the urban centers hoping for a better life. To counteract this trend, the government is pursuing programs designed to alleviate poverty in the countryside. These programs focus on agricultural and natural resources development and agro-industrialization.

Key Production Area (KPA) approach to agricultural development. This recently adopted program is aimed at increasing the productivity of selected commodities through provision of necessary financial and supportive services. It is based on the identification of production areas or selected commodities with strategic advantage. Selected commodities include grains, high value crops, livestock and fisheries. Specific regions or sites are pinpointed and given implementation support. To ensure successful implementation, multi-sectoral partnerships, that include farmers, are encouraged.

Single commodity credit system. This credit system addresses the problem of lack of capital for production ventures based on identified single commodity crops. To ensure profitability of the venture, the farmer agrees to adhere to the recommended cultural practices for the crop. Intensification and diversification with other crop species is not allowed. Both this policy and the KPA are criticized by some sectors as being monocrop-oriented and, consequently, promoting agricultural practices that are ecologically unstable and prone to pest and disease infestations.

INITIAL AND PROSPECTIVE INDICATORS OF SUSTAINABILITY

Indicators of sustainability have been employed in each stage of the development of the SANREM CRSP/Philippines. During the initial program planning workshop in January 1992, four major areas of concern were identified: soil conservation; water conservation; biodiversity conservation; and access to land, labor, marketing and credit. Research questions and indicators of sustainability were identified for each of the four areas of concern. These research questions and indicators of sustainability were incorporated into the Framework Plan, a document that presents the objectives, action-oriented program areas, database requirements and expected outputs for program development. The Framework Plan served to guide SANREM CRSP partners in the preparation of their project workplans. Workplans developed by inter-sectoral teams of collaborators underwent evaluation both by the Community Advisory Council (CAC) and the National Coordinating Council (NCC).[4] These intersectoral councils, involving farmer leaders, NGO representatives, and scientists, conducted an assessment of the stated indicators of sustainability within their program review process. The indicators identified within the Framework Plan and the funded workplans now guide workplan implementation and monitoring and evaluation within the program. These indicators will also allow project personnel to evaluate the impact of project activities, policy changes, and decision-making by community members on the sustainability of the Lantapan landscape and lifescape.

Soil Conservation

Soil organic matter levels. A land use intervention is deemed sustainable if, through time, the level of organic matter in the soil is either maintained or increased.

Soil physical, chemical and biological properties. The sustainability of the soil system is being enhanced if there is an improvement in the soil structure, water holding capacity and porosity (physical properties), improved nutrient status, decreased soil acidity (chemical properties), and improved biological properties measured in terms of biodiversity, enhanced activities of beneficial microorganisms, and more efficient nutrient cycling.

Crop and livestock productivity. This would be assessed in the form of sustained or increased crop harvest and animal productivity and use of biodiverse production systems.

Crop diversity. This factor is considered as an indicator of sustainability based on research and experiences that shows diversified planting to be less susceptible to the attack of pests and diseases than monocropping. Crop diversity may also enhance socioeconomic sustainability by ensuring that rural homes get sustained harvests and income throughout the year.

Time spent in weeding and cultivating. Weeding and cultivation require capital input. The elimination and minimization of weeds reduces production threats to favored crops while reducing labor and maintenance costs. In addition, reduction in the frequency and extent of cultivation reduces the risk of soil erosion. Currently the monocrop cultivation of potato and vegetables in Lantapan has been steadily advancing upwards towards the forest margins. The replacement of these monocropping practices with multiple cropping schemes, including agroforestry, may restore soil fertility and reduce cultivation needs.

Water Quality and Quantity

Reduced stream siltation. The establishment of plantations and improved cropping system and land use in the Lantapan Watershed would enhance sustainability and reduce stream siltation. A project funded by the SANREM CRSP is taking measurements of changes in siltation levels and sediment loads in the Manupali Watershed streams during the rainy season.

Availability of irrigation and potable water year round. This aspect of sustainability will be a long-term envisioned result of improved land use practices in the Manupali Watershed. Water free from waterborne disease-causing microorganisms is the desired result. While this might not be felt within the duration of the program, it is hoped to be evident in later years.

Improved aquatic biodiversity. The promotion of environmentally-friendly technologies in the landscape is designed to protect aquatic ecosystems in streams, rivers, the Pulangi Reservoir, and in rice paddies. Protection of aquatic ecosystems will help sustain the economically important fishes.

Less time spent hauling water. Improved hydrologic cycles and better water retention in upland areas will improve water availability across the landscape. At the household level, this translates into less time spent hauling water for home use.

Biodiversity Management

As a tropical rain forest, the Manupali Watershed is endowed with a diverse array of plant and animal species. A number of SANREM CRSP workplans are designed to inventory and protect these species. Indicators being used to assess the sustainability of the watershed biodiversity are discussed below.

Balanced and harmonious relationships within the landscape/lifescape. This harmony results from complementarity and symbiotic relationship among the plant, animal and human components of the ecosystem.

Food security and optimum productivity. A restored and conserved biodiversity will provide varied useful products from plants and animals in the Manupali landscape. An increased availability of these products will improve food security.

Absence/minimal occurrences of plant and animal pest and diseases. A biodiverse ecosystem in the Manuapli Watershed will provide natural built-in equilibrating mechanisms which will protect against the outbreak of harmful populations of pests and diseases.

Microclimate improvement and maintenance. This characteristic is associated with the presence of intact floral vegetation. Sustainability is enhanced by creating favorable habitats or growing conditions for associated plants and animals.

Land, Labor, Marketing and Credit

At the planning stage of SANREM CRSP/Philippines, land, labor and credit was a distinct focal area. At present, these concerns are integrated as a cross-cutting issue embedded within the first three focal areas of soil, water and biodiversity conservation. As seen in the examples provided above, issues associated with access to land, labor, marketing, and credit are incorporated into the indicators developed for the other three focal areas. Additional indicators are provided below.

Land Equity **Equity of land distribution.** Equity can be examined in the form of land distribution equity among people of different income levels and between indigenous and migrant families. This issue is currently being examined by SANREM CRSP workplans.

Security of land tenure status. Current land ownership or tenure status in the area ranges from title to tax declaration to occupancy without title. The relationship of these different forms of tenure status to sustainability are currently being studied.

Labor Availability and Equity **Timely availability of affordable labor for agricultural activities.** This socioeconomic indicator of sustainability is being assessed in regard to other non-farm labor opportunities including projects in the area that use local labor.

Access of farm laborers to reasonable wages. The impact of a competitive local labor market influences the wage rate.

Access to and use of exchange-labor relationships. The indigenous *hugpong* (social or family-tie based) workgroup system is being studied within the SANREM CRSP to determine its potentials for promoting cooperation and mutual help.

Credit and Market Availability and Equity **Timely access to credit at reasonable interest rates.** This indicator includes socially just alternatives to the current financier system.

Access to natural resources and credit as related to gender, social and ethnic group. This is an important indicator due to the diversity of ethnic groups in the area and the traditional lower access of women than men to resources.

Access to market price information. Market price information is vital both to the traders and consumers to facilitate the marketing process.

SUMMARY AND PROSPECTS FOR THE FUTURE OF SANREM CRSP/PHILIPPINES

At the time of this writing, the SANREM CRSP/Philippines is entering its second year of workplan implementation. Even at this early stage, the indicators of sustainability that we have identified are proving to be a useful guide in assessing the first year of implementation and in tracking the second year of operation. Throughout the process, we have found that partnership and frequent interaction with the local farmers is crucial for putting these indicators to useful work. The intention is that, ultimately, the farmers, by themselves, can use these indicators to measure their progress towards sustainable development.

It is worthy to note that the SANREM CRSP/Philippines has set the pace in institutional arrangements, partnership, community work, and program management. The target communities are gaining a clearer understanding and acceptance of the program. Moreover, facilitated by program activities, the local farmers are gaining deeper insights and understanding of their complex situation and available resources and learning to create new possibilities for themselves in partnership with scientists.

ENDNOTES

1. Alienable and Disposable (A & D) lands can be titled and are subject to land reform regulations. Forest lands cannot be legally titled, but ancestral residents can be granted land-use rights under the Integrated Social Forestry Program (ISFP).

2. The IPAS is a project of the Department of Environment and Natural Resources (DENR) which rationalizes the administration and management of national parks, sanctuaries and other conservation areas in the Philippines. It aims to conserve the country's biological diversity through the establishment and development of representative samples of biotic communities.

3. Lifescape is the term used by SANREM CRSP collaborators to describe the social, cultural and economic interactions by people living, working and trading within a landscape.

4. The Community Advisory Council and the National Coordinating Council are advisory boards responsible for coordinating the direction of SANREM CRSP program development.

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Some Key Indicators of Sustainability in Burkina Faso

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ABSTRACT

Agricultural sustainability is undoubtedly an important challenge in a country such as Burkina Faso where lack of wisdom in natural resource management has resulted in important ecological, economical and social disequilibrium, complicating the development process. The holistic approach to development problems promoted by SANREM to insure sustainability is certainly wise, but is complex enough to necessitate proper identification of indicators and measurable indices of sustainability for recommendations to be properly assessed for adequacy. The present paper describes indicators of sustainability for Burkina Faso. These indicators include social, biophysical, socio-economic, infrastructural, institutional and political components. Indices of sustainability have been proposed for the assessment of these indicators.

INTRODUCTION

Burkina Faso is a landlocked country located in the heart of West Africa. It has a dry tropical climate with two distinct seasons. The vegetation is composed of savannahs and steppes which are characteristic of arid and semi-arid tropical formations. An agricultural country with limited resources, Burkina Faso is classified as one of the least developed countries in the world.

The economic and social development of the country is greatly influenced by geographical and biophysical conditions, biotic pressures, high rates of illiteracy, inefficient economic infrastructure and an inefficient industrial development base. These constraints should be considered in the context of the colonial history of the country. In an attempt to overcome these constraints, several five-year plans supported by sectorial plans have been adopted since the independence of Burkina Faso in 1960.

However, the non-integrated thematic approaches of these plans made it difficult to achieve expected results. In recent years, efforts have been invested into formulating global strategies for a sustainable development. Related documents include: the National Environment Action Plan (PANE, 1994); the Foundations for a Sustainable Development, presented at the 1992 UNICED

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[6]Institut de Developpement Rural (IDR), Burkina Faso.

[7]Translator.

conference in Rio (GNT, 1991), Brazil; the Land Use Management (RAF); and the National Management Program of Village-level Natural Resources (PNGT).

The burden of internal and external debt, the structural adjustment program, the recent devaluation of the CFA franc are major constraints to current development implementation, further compounding the sustainability problem of food production and natural resource management.

The present paper describes the context of agricultural development in Burkina Faso and identifies some key indicators and indices of sustainability.

THE CONTEXT OF AGRICULTURAL SUSTAINABILITY IN BURKINA FASO: THE SPECIFIC CASE OF DONSIN

The Biophysical Context

Burkina Faso is a landlocked country covering 274,000 km^2 that sits atop of a highly weathered precambrian basement complex located between 11° and 16° North Latitude. It has two distinct seasons. A dry season extending from October to June and a rainy season covering the remainder of the year. The rainy season is characterized by a great spatial and temporal variability of the rainfall, which adversely affects crop production. The country may be divided into four ecozones based on the amount of annual rainfall, the length of the rainy season and the structure of the vegetation. These ecozones are: (1) the Sahelian Zone characterized by the most variable as well as the lowest amounts of rainfall (< 350 mm/year), (2) the sub-Sahelian Zone (600-800mm/year) also with variable rainfall, (3) the north Sudanian Zone (700-1,000 mm/year) with a regular rainfall, and (4) the south Sudanian Zone (> 1,000 mm/year) with the most regular rainfall.

As a result of the expanding desert, characteristic isohyets of these zones are not static and are shifting southward, causing a massive population movement from north to south in search of better crop production conditions (Vierich and Stoop, 1992). Insufficient and uneven distribution of rainfall combine with water resource mismanagement to cause chronic water shortage in most villages, including Donsin, during the dry season.

Agriculture in Burkina Faso is characterized by a diversity of crops of which sorghum, millet, maize and peanut are the main food crops and cotton the main cash crop. The lands are often intercropped in traditional small holdings under different soil and water management systems, compounding yield variability. Crop mixtures are used to insure yield security in the event of stresses such as drought, flooding and pest attacks. Agricultural production accounts for over one third of the Gross National Product (GNP) and is predominant in the Southern part of the country. It provides more jobs and income than any other sector.

Livestock accounts for about 3% to 5% of the GNP and is the predominant production activity in the Northern part of the country. Since 1973 Burkina Faso has been experiencing food insecurity as a result of worsening climatic and soil constraints, and improper resource management strategies. The production technology is predominantly traditional and rudimentary. Most of the production is for subsistence and the capacity to produce depends on land quality and availability.

The Donsin watershed is characteristic of watersheds in the central plateau of Burkina Faso and includes over 8,000 ha. It is located in the Sub-Sahelian Zone (350-600 mm/year), northeast of Ouagadougou and 18 km from Boulsa, the headquarters of the Namentenga Province. The rainy season lasts only 3 to 4 months. With average temperatures varying between 15°C (January to March) and 39°C (April to May) and the potential evapotranspiration often rising to about 2000 mm/year, water resources are quickly depleted, compounding water problems in the watershed.

Similar to other regions in the central plateau, the Donsin geomorphology is characterized by gentle undulating landscape with frequent bare surfaces. Soils are typically highly weathered, ferruginous, compacted and crusted on the surface. These soils are low in nutrient and organic matter content. In 1992, about 23% of the land in the Donsin area was considered degraded.

The vegetation of Donsin is predominated by grass and shrubs. According to inhabitants of Donsin, the vegetation of the watershed has changed considerably over the last 20-25 years. This was confirmed by comparative study of aerial photos from 1952 and 1990 (INERA, 1990). Forests have completely disappeared including trees like the "nere," *Parkia biglobosa* and the butter tree, *Butyrospermum paradoxum* subsp. *parkii*, that were socioeconomically important to the area.

Socioeconomic Context

The population of Burkina Faso is relatively young. It exceeds 9 million and experiences a population increase of 2.6% annually. Over 90% of the population derive their livelihood from agriculture and livestock activities. The social and economic development of the country depends on the agricultural sector which is characterized by small traditional family farms. The main sources of energy and building materials are wood and straw.

The local development process, which is primarily rooted in religious spiritualism has been greatly disrupted by colonial processes. However, several communities have maintained some of their basic customs. In Donsin, for example, land is managed by a land chief. Land chieftaincy is inherited from father to son as in the case of land ownership in families. Land is a common property which cannot be refused to anyone willing to farm it. Tree planting, however, is considered a definite appropriation criterion. This change in land allocation status due to tree planting has seriously constrained reforestation in some areas. Women benefit from the right to farm their fathers' land before they get married and have access to their husbands' land after marriage. However, contrary to urban areas where women enjoy the right to the land equal to men, in traditional areas land is never fully allocated to women because of divorces provided for by customary law.

Division of labor between men and women is well marked in Donsin. Women typically are responsible for child care, small animal husbandry, firewood gathering and providing the family with water. Men are normally responsible for field work, field tool making, domestic building, weaving, cattle breeding and leather handicraft. This division of the labor is undoubtedly a socioeconomic constraint to harmonious development. For example, with the degradation of natural resources and living conditions, men often become jobless, especially during the dry season. At the same time women, because of the highly social character of their task, overwork themselves.

The reduction of men's traditional workload during the dry season has resulted in increased hunting activities. Hunting is still practiced traditionally using non-selective methods and bush fires. These practices destroy biodiversity and contribute to rapid degradation of natural resources.

Men also gather wood for sale in order to generate income for the family. This practice also contributes to increased deforestation of the lands. While annual allowable cuts are estimated to only 103 x 10^5 m^3, the rate of local firewood use rises by 32% per annum despite a reduced reforestation (PANE, 1994).

Natural resource mismanagement is partly a result of the colonial legacy. The disruption of local management systems, especially the institutionalization of communally-owned property, may have resulted in some of the "tragedies of the commons" such as that observed in bush management (overgrazing, abusive wood cutting, poaching and bushfires). In addition, the introduction on colonial farms of cotton or soybean monoculture cash crops without sustainable soil fertility programs led to increased land degradation in many villages including Donsin. The situation has continued to worsen for a long period of time due to lack of leadership inherited from the colonial system.

The colonial period also was characterized by top-down decision making. Farmers' opinions were ignored, if not despised in the decision-making process. This lack of value afforded to farmers' practices and traditions inhibited entrepreneurship, innovation, and creativity of the local residents, contributing to economic stagnation and ecological deterioration throughout the country.

Finally, the lack of adequate infrastructures, such as schools, health centers, roads, water catchments and markets, combined with a rapidly growing population, have caused increasing poverty. These factors account for the high level of rural youth exodus towards the urban centers, thereby depriving the village of its prime work force. The lack of education is one of the greatest constraints to development and sustainable natural resource management.

THE CONCEPT OF SUSTAINABILITY

Among the numerous definitions given to the term "sustainability," we will consider that of Conway (1986) which states that "sustainability is the ability of a system to maintain productivity in spite of a major disturbance such as that caused by intensive stress or a large perturbation." This ability of the system to maintain its productivity requires not only a holistic understanding of natural resources and interactions, but also an ability to manage natural resources rationally. The World Committee on Environment and Development (1987) states that sustainable development "meets the needs of the present generation without compromising the ability of future generations to meet their own needs." For agricultural production specially, CIMMYT (1989) defined sustainable agriculture as the "successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources."

These three visions imply that a holistic management approach be adapted. That is, a management system that takes into account all the components that may be affected by decisions at various levels. As mentioned above, sustainable agriculture in Burkina Faso, including Donsin, faces numerous social, climatic, economic and political constraints. Therefore, indicators of sustainability within the context of Burkina Faso will need to address all these aspects.

CROSS-DISCIPLINARY INDICATORS OF SUSTAINABILITY IN BURKINA FASO

Social Indicators of Sustainability

People are an integral component of the ecosystem they live in. They are also the main resource beneficiaries and the main resource managers. How long people will enjoy the system depends on their level of understanding of natural resource interactions, the wisdom with which they approach their social and physical environment, as well as their level of humility which determines their ability to adapt to changes. Social indicators of sustainability as perceived in the context of Donsin are discussed below:

Traditional Knowledge and Values

Many traditional values pertaining to social relations and management of natural resources in Burkina Faso and in Donsin are based on religious spiritualism and oriented toward conservation. For example, natural reserves are considered, as are some animal species. Reviving these traditional beliefs and customs may help avoid the tragedy of the commons currently observed in the watershed. It also may enable the local community to become organized in such a way as to manage natural resources on a sustainable basis.

Gender Equity

The current division of labor between men and women can be traced back to the past where it was founded on logical social relationships. However, the change in living conditions during the course of history has created disequilibrium between the roles. Man has become consequently redundant and the woman workloaded. There is a need to readjust the gender-based division of labor so as to alleviate the woman's workload in order to permit her to spend more time on income-generating activities.

Social Peace and Harmony

There is agreement among the Donsin people that social peace is the starting point for sustainable development. Social peace involves harmony between the different social strata. It is also indicated by people supporting and obeying existing laws. Social peace allows for consensus building among various social groups in the process of solving development problems. Moreover, peace among members of the community allows concentration on new development activities rather than being diverted by security or survival problems (drought, conflicts, starvation). This is a prerequisite for participatory decision making in the community.

Participatory Decision Making by the Community in Solving Development Problems

Consensus building often is difficult to develop in Burkina Faso since the leadership rule by the village chief is authoritarian. Decisions made by a single person or a group of people can lack vision and/or be biased. Instituting consensus-based participatory decision making would be conducive to progress and enhanced sustainability.

Education of Children and Adult Literacy

Sustainability is impossible without proper education. The level of education of children ensures the continuity of development and sustainable agricultural practices. Literacy facilitates knowledge transfer. Therefore, a literate and educated population is favorably predisposed toward sustainable development.

BIOPHYSICAL INDICATORS OF SUSTAINABILITY

Biophysical indicators of sustainability relate to the basic natural resources from which man derives his happiness. The quality and sustainability of these resources greatly depend on the technologies used and the management systems. These indicators include:

Restoration and maintenance of soil fertility.

Restoration and maintenance of biodiversity.

In Burkina Faso and at Donsin, soil degradation is severe resulting in an imbalance between resources and the rapidly growing population. Any sustainable resource management program would require corrective action in regard to this imbalance. This imbalance may be partially alleviated through family planning. In addition, use of appropriate technologies in order to restore and/or to maintain resources at a level consistent with the population growth is required to enhance natural resource sustainability.

ECONOMIC AND SOCIOECONOMIC INDICATORS OF SUSTAINABILITY

No development can be sustainable if its economic aspects are not considered. Economic indicators are discussed below:

Accessibility to Market (Local, Regional, National or International)

Economic viability is important for a system to be sustainable. The more money a farmer makes while using sustainability-oriented practices, the better he/she will pay attention to the recommendations for enhancing sustainability.

Capacity of the Farmer to Adapt to Changing Market Conditions

Previously, when cotton generated income, cotton farmers were encouraged to adopt techniques to maintain soil fertility. In the past few years, cotton prices fell. As a result, interest in the soil conserving practices lessened, thus jeopardizing soil productivity in some regions. Farmers' ability to adapt to market conditions constitutes, therefore, another important indicator of sustainability.

Equilibrium Between Population and Resources

The carrying capacity of the ecosystem implies balance between the population and physical and economic limits of the ecosystem. Even if all the known sustainable practices were properly used, a reproductive behavior that ignores the carrying capacity of the ecosystem is likely to generate greater poverty and misery in the future. Family planning is a must to restore and/or to maintain a balanced population/resource ratio.

Land Tenure That Reconciles Customary Requirements and Needs for Agricultural Development

Changes in land tenure laws and practices are needed in order to better manage lands and to avoid frequent conflicts between agriculturists and pastoralists. These practices must be developed in such a way as to respect local customs.

Awareness by People About Basic Hygiene

Productivity greatly depends on the health status of the individuai. But health is an outcome of one's lifestyle and, one's level of hygiene. Hygiene levels also may be related to the emotional and aesthetic state of the population and to food avail-ability. The more the population is sen-sitized to basic hygiene, the healthier it is likely to be, and consequently, the more able it will be to engage in sustainable production activities. Awareness about basic hygiene is, therefore, an important indicator of sustainability.

INFRASTRUCTURAL INDICATORS OF SUSTAINABILITY

Infrastructural indicators of sustainability pertain to the quality and quantity of infrastructures including schools, health centers, water tanks, wells and training centers.

In Burkina Faso, lessons drawn from past experience indicate that agricultural production and development cannot be sustainable based on isolated thematic activities. This is because government resources are limited. Therefore, an integrated approach has been called for. The interdisciplinary combined with or interinstitutional approach promoted by SANREM can permit the saving of resources and, above all, the solving of problems in an integrated and durable way.

POLITICAL INDICATORS OF SUSTAINABILITY

Political indicators of sustainability include the following:

(1) Political commitments of those in power

(2) Stability and coherence of development programs that take into account sustainable national resource management

(3) Use of appropriate incentives to promote sustainability

Politics controls the development processes of the country. Private sector activity oriented to politics should encourage individuals, national institutions, NGOs, PVOs and international organizations to redouble their efforts and contribute to safeguarding natural resources.

PERSPECTIVES OF RESEARCH ON INDICATORS OF SUSTAINABILITY IN BURKINA FASO

The framework for participatory research of the SANREM site at Donsin has five principal research areas:

(1) Water resource

(2) Restoration and maintenance of soil fertility

(3) Animal management

(4) Management of non-cultivated land

(5) Human nutrition and health

Table 1: Indicators of Sustainability and Related Measurable Indices.

Indicators of Sustainability	Indices of Sustainability
Infrastructural Indicators	• Quantity and quality of infrastructure as compared to standard norms
Institutional	• Number of interdisciplinary and/or inter-institutional projects
Biophysical Indicators	• Classical methods
Economic and Socio-economic indicators	
• Access to market	• Proximity to market • Quality of roads
• Capability of producer to adapt to changing market conditions	• Wisdom (not measurable) • Diversification of production
• Family planning and birth control	• Level of understanding and adoption of the notion of balanced resources/population ratio • Extent of adoption of birth control recommended measures
• Farmer awareness of basic hygiene	• Body hygiene - Frequency of bath - Frequency of laundry - Frequency of house cleaning - Quality of house and or sleeping quarters • Food hygiene (Level and quality of the food) - Cleanliness of food - Frequency of dish washing - Food composition
Political Indicators	• Presence/absence of relevant legislative texts • Information, education and awareness programs • Capacity to mobilize resources (number of funded projects)
Cultural and Social Indicators	
• Social harmony and peace	• Number of marriages between social groups • Level of security
• Participatory decision making	• Number and types of decisions taken in a participatory way
• Literacy and training in sustainability	• Percentage of the population that is literate and/or trained in sustainability

The identification of indicators of sustainability within the program draws from these five areas. It appears that all the indicators of sustainability cannot be studied with the same ease as some are easily quantifiable and others not. Therefore, they have been classified below in order of decreasing ease of assessment:

(1) Infrastructural indicators

(2) Institutional indicators

(3) Biophysical indicators

(4) Economic indicators

(5) Political indicators

(6) Social indicators

To be properly assessed, these indicators would require that related measurable parameters be identified. It is suggested that these parameters be termed indices of sustainability. Table 1 proposes some indices for each indicator of sustainability.

CONCLUSION

Most of the current crop production systems in Burkina Faso are not sustainable. The combined effects of population pressure, deforestation and soils and water mismanagement are rapid soil degradation, and unsustainable food production and natural resource management. In recent years, sustainable agriculture and natural resource management have been identified as national priorities, making these concerns the focal points of government, non-government and international organization development activities throughout the country. SANREM CRSP entered into this scheme as a strong partner and innovator. The new sustainable development strategies, and specifically the SANREM approach, require a good perception of sustainability. This, in turn, requires an identification and survey of indicators of sustainability over time. This paper presented key indicators of sustainability as identified in the context of Burkina Faso. Indicators suggested in the present document were classified into social, biophysical, socioeconomic, infrastructural, institutional and political categories. Research envisioned in this area appears relatively easy for indicators with measurable indices such as the biophysical infrastructural and institutional indicators, but complex for social and cultural indicators.

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Minimum Data Sets for the Measurement of Sustainability in Agro-Ecosystems

Richard A. Carpenter*

INTRODUCTION

Sustainable Development (SD) has multiple meanings with roots in ecology (both "deep" and "shallow"), resources, carrying capacity, anti-technology, and ecodevelopment (Kidd, 1992). Operational definitions, and indicators of implementation achievement, are required if SD is to be anything more than an attractive, but empty, phrase. There are many substantial and varied ongoing efforts around the world to supply policy and decision makers with quantitative measures related to SD. The World Bank, the United Nations University, the United Nations Environment Programme, the Organization for Economic Cooperation and Development, the World Resources Institute, the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program, and the governments of Canada and the Netherlands are among the leaders in this work.

Most natural scientists working with managed ecosystems, such as agriculture, are skeptical about their capability to measure sustainability in biophysical terms, which are the essential foundation for all other parameters and values (Carpenter, 1994 a & b, Carpenter 1990, Carpenter and Harper, 1989). This paper reviews the generally unsatisfactory current state of the science of biophysical measurements. There are possibilities for improvements through selection of *Minimum Data Sets (MDSs)*; i.e., key characterizations of the condition of each ecosystem type that relate strongly to sustainability, and that can be used to evaluate, to monitor trends, and to predict in guiding real world management decisions.

The significance of this biophysical measurement capability for the success of the research in SANREM/CRSP is obvious.

SUSTAINABILITY DEFINED

Sustainability is whether the productive potential of a managed ecosystem site will continue for a long time under a given particular management practice.

A managed ecosystem is a fairly homogeneous region demarcated at its boundaries by changes in some biophysical characteristics; e.g., an upland agricultural area, production forest, lake, river basin, coastal zone, or island. Humans are in charge of the biosphere whether or not everyone approves. Nature is constantly changing, and we try to impose a constancy of production in order to have some security of food and other materials. Management practice is the intensity and type of technical and social input activities, e.g., energy, nutrients, genetic variety, harvesting procedures, and their planned variations over time. The productive potential relates to that quantity and mix of goods and services from the environment that is participatively chosen by the society that owns, or should control, the natural system.

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Sustainable development depends largely on renewable natural resources of air, water, soil, sunlight, and communities of plants and animals. The utility, or potential of these natural systems for producing goods and services, is what is to be continued, and enhanced. The absolute amount of production must be increased in order to maintain per capita flows since the human population is going to grow (or else the affluent must drastically, and improbably, reduce their consumption). These are the implications of sustainable development regardless of how arguments are settled about equities between or within generations, conversions among financial and natural capital, value judgments as to which goods and services are desired, or risk aversion as a function of economic status.

Indicators of sustainability being suggested by a number of groups are quite diverse The International Institute for Environment and Development offers a long list covering energy use, biological wealth, policy, economics, institutions, society and culture. But only one criterion of sustainability, "Renewable resources are increasingly used and harvested at rates within their capacity for renewal" seems to deal with the definition at hand (Dalal-Clayton, 1992). Other attributes of sustainability that are important must be based on an accurate picture of the biophysical production potential, as shown in Table 1.

Table 1: The Biophysical Foundation of Sustainable Development.

Ethical/Religious Considerations
Inter/Intra Generational Equity
Cultural Values
Political Objectives
Social Welfare
Economic Goods and Services
Biological Measurements
Physical and Chemical Measurements

HOW WOULD WE KNOW SUSTAINABILITY IF WE SAW IT?

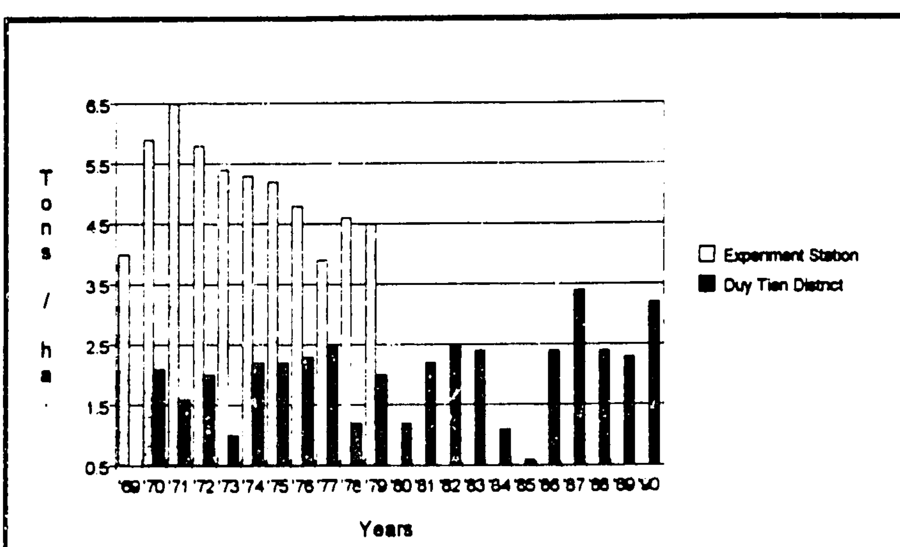
Sustainability is now an accepted, if vague, constraint on economic development. We certainly have the technological means to exhaust resources. Economically, even modest discount (interest) rates encourage exploitation to extinction in ecosystems where natural growth of the harvestable product is slow. Thus, sustainability must be achieved through some combination of *non*-techno/economic motivations. Some current suggestions are not helpful. The "precautionary principle," or its 30-year old predecessor "safe minimum standard," ask that whenever there is uncertainty about thresholds of degradation, exploitation be voluntarily reduced "to the extent that it is cost-effective or economically feasible." These formulations do not produce operating guidelines and simply require a value judgment by technocrats of the proper balance of risk between taking immediate gains and losing long term potential.

Managers are not waiting for new measures of sustainability, they need constant guidance. Most often, they use the economic returns from annual harvest yields, with suitable regressions to account for weather, pests, inputs of fertilizer, equipment, irrigation, etc., market demand, and other short term factors. But the economic calculus will not usually give a correct signal that the practice they are following is unsustainable. There are too many subtle, non-monetizable influences on any natural system. The kinds of decisions about agro-ecosystems that are made every year, with whatever information is available, include choice of soil conservation techniques, pest control, amounts of fertilizer and irrigation, and cropping patterns. It is difficult to establish whether the choices are cost-effective, much less whether they result in a sustainable system.

High harvest yields can mask loss of soil organic matter and nutrients, impending salinization and water logging from irrigation, pest resistance to chemicals, and strained social institutions, for example, through inequitable labor rates. Harvests vary considerably and the reasons are not always obvious. Figure 1 is based on data from experimental plots (high input, three crops/year) in Thailand and actual farms in Vietnam. The intensively managed Chiang Mai University experiment station yield dropped steadily with no obvious explanation until a boron deficiency was finally detected. The Duy Tien District floods and insect outbreaks occur frequently.

In developing countries rice harvests are often never quantified by measuring weight or volume but merely estimated and negotiated between farmers and buyers. False, low yields are reported when taxes or government shares are related to harvests. Much economically oriented information is available about agro-ecosystems but less is known about non-crop components such as soil organisms that ultimately affect sustainability. Faeth et al., (1991) note that "in the field, erosion-induced productivity changes are almost impossible to isolate and measure accurately."

Figure 1: Variation in Rice Field.



SUSTAINABILITY MUST PERTAIN TO HIGH YIELDS

Sophisticated measurements or indicators are not needed to find that a management practice is *un*sustainable when gross and obvious damage occurs to the environment; e.g., gullies in fields and salt on soil surfaces. Or, in contrast, it is easy to agree that, when an ecosystem is thinly populated by humans, relatively inaccessible, shielded from external effects, and lightly harvested, then it is probably in a sustainable condition. Sustainable agriculture, by any reasonable definition, is exemplified by many terraced rice systems, and by grazing, such as the sheep near Stonehenge. Sanborn Field at the University of Missouri at Colombia has grown grain crops for well over 100 years. But now, the majority of agro-ecosystems are intensively managed for a stable maximum annual harvest, mainly because of the urgent and basic human needs of people living nearby. In fact, yields from present farms must increase because of population growth and the unavailability of new lands for cultivation.

The fine tuning of these generally highly productive ecosystems is where sustainable development will have meaning or become an empty phrase. And yet, this is where ecological knowledge seems to warn of inherent problems. Holling (1973) notes that "[stability] .... emphasizes the equilibrium, the maintenance of a predictable world, and the harvest of nature's excess production with as little fluctuation as possible." But nature is cyclic at best and usually changing unpredictably but fundamentally, so that considerable inputs are needed to assure sufficient harvests, and these inputs themselves may not be sustainable. For example, in Vietnam "... rice farming is already very intensive and fully modernized. Farmers exclusively plant high yielding rice varieties (HYVs) and make heavy use of chemical fertilizers and pesticides. ... the best farmers in the north are already getting yields representing 80% of the genetic potential of the available HYVs. ...There is no yield gap to exploit in the Red River Delta." (Rambo, 1994).

The real costs of uncertainty due to inadequate biophysical measurement of sustainable practices are in two forms of management error:

(a) urgent demand may increase risk taking and drive over-exploitation that subsequently results in irreversible degradation or;

(b) conservative precautions may turn out to needlessly lower the intensity of inputs so that harvests are less than they could be, and some people are denied a portion of basic human needs. Precaution may mean unnecessary hunger or prolonged poverty; uncertainty can cut both ways.

MEASUREMENT DIFFICULTIES

Ecosystems are complex, constantly evolving, adapting, changing, and cause-effect relationships are often non-linear. Ecosystems are self organizing and, in a sense, their future is unknowable. Responses in nature to perturbations involve lags, thresholds, and rapid transformations from one stable state to another. Very long-term effects sometimes become evident only after the original cause is no longer evident and so explanation is confounded (Magnuson, 1990). For example, despite considerable knowledge of atmospheric chemistry and years of monitoring the gradual build up of CFCs, the appearance of the Antarctic ozone hole was a surprise. Only recently has forest management recognized the danger of building up accumulations of fuel on the ground through suppression of fires at the local level.

This fundamental uncertainty is at the root of the difficulties of monitoring and predicting sustainability but there are other, perhaps more tractable, problems as well. Ecological research has not emphasized large area investigations, and that scale (regions such as the American midwest agricultural heartland, large marine ecosystems, or the boreal forests) is most important in monitoring and predicting sustainability of management practices in economic development. What studies have been made of ecoregions or biomes have revealed some of the sources of natural variation. Mixtures of positive and negative feedbacks, each poorly understood, or perhaps not even known, make predictions difficult.

Agricultural production strategies that try to incorporate natural variation must be at large scales of time and space to allow the fluctuations to take place. Thus, they are more costly and politically more complex.

Measurement difficulties may be summarized as arising from: (1) ignorance about the structure and function of ecosystems, particularly at the regional scale; (2) unknown mechanisms of ecosystem response to stress; (3) natural variability (signal-to-noise ratio); (4) sampling and analytical errors under field conditions; (5) inadequate monitoring over space and time; (6) deliberate falsification of data for socio/cultural or political reasons; and (7) inadequate research on the linkage of natural and managed ecosystems.

Agro-Ecosystems

Evidence of the unsatisfactory state of sustainability measurement is found in the following examples:

"Historical references to degradation of agricultural lands and forests can be found in the writing of Plato and even earlier. Yet many centuries later, we are far from consensus as to the identity of a minimal but sufficient set of indicators by which to measure changes in the state of nature." (Rapport, 1990).

"... in no place can we claim to predict with certainty either the ecological effects of the activities, or the efficacy of most measures aimed at regulating or enhancing them. Every major change in harvesting rates and management practices is in fact a perturbation experiment with highly uncertain outcome, no matter how skillful the management agency is in marshaling evidence and arguments in support of the change." (Walters and Holling, 1990).

"In the area of understanding and evaluating environmental degradation in Africa, the following causes of uncertainty emerge. First, there is the problem of data-its scantiness, unreliability, irrelevance and ambiguity. Statistics are seldom in the right form, are hard to come by, and even harder to believe let alone interpret." (Blaikie, 1989).

The United States National Academy of Sciences advised the government in January 1994 that the ecological condition of Western range lands is so poorly understood, due to inconsistent and fragmented data, that a determination of how they should be managed cannot be made (Anon, 1994).

A Forest Service ecologist trying to regulate recreational uses says "We don't even know how abundant the resource is; are we picking 95% of the mushrooms? Are we picking 5%?" (Lipske, 1994).

No statistically significant change in the volume of water discharged by the Amazon river, or the amount of sediment delivered from the deforested Rondonia region, has yet been detected. A signal that deforestation has altered the hydrologic cycle or soil erosion in that basin is obscured by the high natural variability of rainfall, and the El Nino events explain most of the occasional trends in the noise that are evident in the hundreds of gauging stations (Richey, 1992).

Grazing Lands

These are the ecosystems where the tragedy of the commons is most obvious but even when the land and the ungulates have the same owner, it is difficult to set the right utilization rate. Pickup and Morton (UNU, 1992) describe a method using remote sensing in arid lands to separate grazing-induced changes in forage biomass from rainfall-driven variations. "Grazing gradients" are patterns developed because sheep and cattle graze out only so far from water sources, and the areas where the vegetation is consumed can be detected. If the grazing gradient does not disappear with the recovery of vegetation after large infrequent rainfalls, the land has been more or less permanently damaged. If recovery does occur once, it does not mean that practice at that site is permanently sustainable. Large, unpredictable fluctuations in rainfall, and explosions of weeds and mammalian pests may yet ruin the pasture. They conclude that for Australia, "meshing of wealth-generating uses of land with ecological sustainability remains an unachieved goal."

Lusigi (UNU, 1992) points out that African tropical range lands are not actually a managed production system but are responding to population pressures and political disruptions by shifting from a nomadic (plausibly sustainable) mode to a sedentary situation which is obviously rapidly degrading entire regions.

Opportunities for Improving Biophysical Measurements

The most important scale for managing (and therefore for measuring) sustainability is at the landscape or regional level of perhaps thousands to millions of hectares. Local harvest-related data cannot be aggregated to give the needed information. Land-use changes appear to be a fundamental cause of reduced ecosystem function and reduced sustainability of production of the goods and services desired. But ecosystems are naturally changing and adapting so that measures must discriminate effects of human activity against this background of change.

Over half the earth's surface has been transformed from its natural state by agriculture, forestry, urbanization, desertification, and other interventions. The altered landscape affects adjacent aquatic systems. One-third of the loss of species is ascribed to land-use change. For conservation, this implies that stringent restrictions on land use are necessary. The Society for Conservation Biology has outlined a vast system of core areas, corridors and buffer zones in the Wildlands Project for the United States. Attempted conservation of large fierce animals will require big reserves with big financial sacrifices as the plans for the Florida panther and the Yellowstone grizzly bears are proving. The collection and analysis of the biophysical measurements to support these plans is a formidable task.

One new measurement approach is to combine growing capabilities in remote sensing, geographic information systems, and landscape ecology. The product is a set of data depicting land use change that is practical, sensitive over time, and interpretable in terms of sustainability (O'Neill et al., 1994 and UNU, 1992). Map-like outputs readily communicate to decision makers about habitat coverage, ecotones, patch configuration, economic activity, water quality and vegetation.

Minimum Data Sets

Supporting these measurements of landscape composition and pattern, a selected biophysical data set could be established for the particular type of managed ecosystem under consideration. Site specific measurements (although individually unreliable for determining regional sustainability) can be gathered into status and trend reports. Integrating organisms and keystone species can be monitored; e.g., lake trout in Lake Superior. Biological indicator organisms, such as salt sensitive plants, will be important. The research and monitoring agendas of management agencies and scientific organizations are beginning to focus on the broader conditions of ecosystems that relate to their sustainable utility.

The Consultative Group of International Agricultural Research Centers has recognized that measurements are not available at the regional level to evaluate the extent to which agricultural practices degrade, maintain, or enhance the total ecosystem. Major research areas are the reversibility of degradation, thresholds of decline, and the biodiversity necessary for the future genetic base of agriculture. "Several quantifiable indicators taken over time can provide data along crucial dimensions that help to indicate the sustainability of most agricultural production systems. These include, especially, soil organic matter, soil acidity, crop yields or biomass yields per hectare, and net value added to production." (CGIAR, 1990).

Risser (UNU, 1992) suggests measures of range condition including biodiversity of plant species, peak standing crop, nitrogen content of foliage, and soil organic matter; see also the discussion of minimum data sets below. He proposes that the following values would indicate a sustainable situation: a high percentage (70-80%) of herbaceous cover species palatable to livestock; seasonal peak standing crop of $>300 g/m^2$; plant species diversity exp. (H^1) not <5.0; soil organic carbon in the top 20 cm. will be 3.0 kg/m^2 for sandy soils and 5.0 in silt-loam soils; and the nitrogen content of aboveground herbage is at least 0.6 g/100g dry biomass. These data might be difficult to obtain in developing countries.

A site with high "biological integrity" has little human influence and is able to withstand natural or human disturbances (US EPA, 1993). The components of an Index of Biological Integrity (IBI) are species abundance counts and ratios, water quality, habitat structure, flow regime, energy source, and biotic interactions. This is essentially a resilience measurement and, although valuable in protection and restoration management, does not relate directly to productivity. The TVA uses five indicators of the health of a lake or impoundment: algae, dissolved oxygen, fish species diversity, benthic diversity, and sediment.

Table 2 shows the categories of biophysical measurement that are relevant to sustainability in most managed ecosystems.

Table 2: Measures Relevant to Sustainability.

Surplus Production Available for Harvest
Land Use Conversion Rate
Biodiversity
Water Quality
Soil Erosion/Sedimentation
Precipitation Mean and Variability
Temperature Mean and Variability

Table 3 is an attempt to select a minimum set of data about environmental conditions in each type of managed ecosystem that would, taken together, inform management as to whether an ongoing practice was sustainable. This draft "minimum data set" derives from the United Nations University International Conference on the Definition and Measurement of Sustainability: The Biophysical Foundations, held in Washington in June, 1992 (UNU, 1992).

Further development by panels of experts and managers should lead to a consensus on measures and their critical values that could be standardized for collection around the world. Trial application in

Table 3: Biophysical Measurement Categories Relevant to Sustainable Managed Ecosystems.

Category	Agriculture and Forestry	Fisheries
Land Use Patterns	Rate of change into and out of present use Patchiness, connectivity, size of parcels	Spawning/nursery habitats changes
Production Harvest	Total biomass, usable harvest - all products Extent of pest damage and trends	Catch size & composition, per unit effort
Biological Diversity	Species abundance - crop, pests, predators, soil organisms	Top predator, keystone species
Water Quality	Pollutants, sedimentation, nutrients	Dissolved oxygen, toxics
Soil Properties	Erosion rate, organic matter, nutrients	Sedimentation rate
Atmospheric Composition	Acidic preciptation, carbon dioxide concentration	Toxic deposition, UV radiation
Climate	Precipitation and temperature - mean and seasonal variation	

the field for several years could bring refinements and establish statistical reliability. Eventually, a practical, and at least partial, approach to monitoring and predicting sustainability in these intensively managed ecosystems may result. Timely and relevant biophysical measures can support adaptive management with mid-course corrections, treating sustainable development as an experiment, which it most certainly is. Then the continuing international discussions and negotiations on other aspects of achieving sustainable development will be on a more firm and rational basis.

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A Hierarchical Definition for Measuring Sustainability: A Micro-Macro Approach

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INTRODUCTION

Measuring sustainability does not have a special meaning unless a particular set of actions are implemented to alter a given process. Such an intervention can be directed to correcting for a destructive agenda or to accelerating a process with the clear objective of producing a predetermined effect. In other words, the measurement of sustainability is associated with a program or activity designed for specific purposes, with a conceptual framework and a particular methodology. In most cases, procedures and working mechanisms are involved in those programs which include a set of interventions to make operational its objectives.

Conventional measurement methods applied to sustainability indicate an evaluation of the process at a given time and under particular circumstances that affect variables influencing such a process. Due to the permanent character of sustainability, a particular measurement in different points over time seems inconvenient, given the number of variables and conditions that must be assumed unchanged to perform valid comparisons. These situations justify the use of indicators as an alternative approach to monitor sustainability.

The methodological difficulties of selecting and measuring indicators of sustainability are complicated by the components involved in the development process. Sustainable development is not defined in a clear manner or in terms that have the same meaning for everybody. Nevertheless, sustainable development requires a framework that reconciles economic and social processes with biophysical and environmental dimensions that are components of human production and resource utilization activities.

The concept of sustainable development represents an operation focused upon accelerating a complex socioeconomic process with at least three characteristics: the process and its components do not decrease beyond a particular level, environmental factors do not decline beyond predetermined thresholds and future generations have access to a set of elements with qualities to yield equivalent utility as the ones the present generation obtains. When this concept is applied to the agricultural sector, it is usually related to less endowed population segments and involves changes in productivity, capital accumulation, social and economic equity, return to factors, rational use of natural resources, long-term production capacity, persistence and stability of ecosystems and agroecosystems as well as production and conservation patterns that correct present depredatory practices.

Different conceptual and working approaches are then required to design a methodology to measure and derive indicators to monitor sustainability of agricultural and rural development. The International Network on Farming Systems

*International Network for Farming Systems Research Methodology (RIMISP).

Research Methodology, RIMISP, intends to propose a methodological procedure that can be tested under diverse conditions. Given that RIMISP intends to generate and adapt methodology to the application of the systems approach to agricultural and rural development, this paper deals primarily with the discussion of a conceptual framework for assessing sustainability. The application of the systems approach to define a general method for deriving indicators of sustainability is then presented and proposed. This analysis is focused on the small scale farm subsector and evolves from a perspective of programs and interventions directed to produce changes to speed up socioeconomic process and allow for the insertion of small scale farmers into the national economics.

WHAT TO SUSTAIN?

In a strict sense, sustainability is a holistic concept that involves all human-nature relations. Even simple analyses bring together factors and processes that are important components difficult to ignore. As an example, one can argue that the problem of sustainability and the Latin American economic and political crisis are not separable concepts: the proportion of poor population, the financial unbalances, the wealth concentration, the restricted access to production factors and political instability are factors that limit the possibility of implementing development models that are sustainable over time. On the other hand, this economic and social situation affects subsectors of rural population in such a way that an excessive pressure is exercised on natural resources and production factors to ensure subsistence and acceptable family income. This process conforms a vicious circle that constrains the production capacity and marginalizes even more subsectors of population, creating an unsustainable production pattern and, affecting other environments by stimulating the mobility of unskilled labor to other economic sectors.

However, for practical purposes, the overall sustainable system can be broken down into components that are, in turn, major dynamic systems. The disaggregation of them allows the determination of sustainable issues or areas that are feasible for evaluating, modifying and measuring. These sustainable issues may be self-contained once it is accepted that "partial sustainability analysis" is a valid conception to approaching the problem of handling and measuring sustainability. Continuing with the former example, a program can be designed to alleviate the pressure on natural resources while increasing factor productivity to improve rural income through sustainable technology, access to production factors, value aggregation mechanisms and management training. In this example, "partial" sustainability would be a part of the overall program goal, taking into account that means to sustain production, accumulate capital and entering the input and product markets would be contemplated by the program.

The determination of sustainability issues creates the possibility of establishing priorities and estimating trade-offs among them. This is consistent with the practical capacity to intervene processes and systems through objective-oriented development policies and programs. In this sense, the partial sustainability and the programs attached to it are expected to improve some parameters within the selected sustainability issue, yielding a second best solution for the society as a whole.

Even under this relatively simplified conceptual context, sustainability remains as a complex multivariate matter that needs particular expressions for each issue involved in the notion. For the case of agricultural sustainable development, a minimum set of concepts that cannot be separated in practical terms can be determined and expressed in the following general terms:

$$ASD = f(Pt, Sp, Rdr, Ese, It/DP) \quad (1)$$

Where:

ASD	=	Agricultural sustainable development
Pt	=	Production and transformation of agricultural goods and services (capital formation)
Sp	=	Stability of production and productivity within a given agroecosystem
Rdr	=	Renewable resource degradation or resiliency
Ese	=	Equity in social and economic terms
It	=	Temporal (generational) permanence
DP	=	General development paradigm

This expression points out aggregated relationships that may take diverse functional forms, depending on the context in which each of those components are defined. Actually, some of the former components have been used to construct indexes to measure environmental sustainability.

In relation with small scale farmers and the rural poor of Latin America, sustainable agriculture development requires particular strategies to minimize degradation and that stress resiliency while increasing production in a way that farming becomes a competitive economic activity. In this setting, surplus appropriation, capital formation, appropriate technology, access to production factors and formal and informal training are imperative components to ensure fruitful results. In many cases, structural changes may be required to induce sustainable development. In all cases, adequate sectorial policies and estate participation are needed to support any direct intervention. Undoubtedly, the challenge of making small scale farmers competitive while making the system sustainable is paramount. This challenge is even more difficult in view of the inter-generational constraint: the present level of welfare is not enough for the next generation. Present conditions demand a better welfare level for future generations.

Institutional arrangements, sectorial policies and specific programs are usually oriented to dealing with smaller components of agricultural development. It can be said that agricultural development programs are, in general, regionally oriented. Once again, one can argue that the determination of what is to be sustained must keep relation with what is to be stimulated to inducing a change (in either sense: sustainable growth or/and agroecology resiliency). Public policies expressing society's interests, watershed management plans, agricultural development programs, natural resource recovering and management projects and fostering soil fertility and water quality efforts are but few examples of sustainability issues. The determination of an adequate conceptual framework and the design of instruments to make operational these issues so as to fit the minimum sustainable components, constitute a critical step to clearly define what to sustain.

DO WE HAVE AN OBJECTIVE SYSTEM FOR MEASURING SUSTAINABILITY?

Having defined a practical approach to determine what to sustain does not solve the methodological problems involved in constructing a framework and instrumenting measurement procedures. The multidimensional nature of the biophysical, political, economic and social phenomena and their interactions make up a complex and dynamic structure.

However, if the concept of sustainability is to be used as an underlying component of human interventions on the environment and ecosystems, a quantitative measure of sustainability is required. Moreover, there are at least two additional reasons for completing such a measurement: to make sustainability an operational concept feasible to become a guide for agricultural development planning and initiatives and, to set a baseline level from which the impact of interventions can be evaluated in relation with their effects on sustainability.

The literature is abundant with definitions and proposals to measure sustainability. Nevertheless, narrowing down the concept of sustainability and the issues to which it applies is not enough. An analytical framework to understand and make the system feasible of being measured is required.

An appropriate analytical method to understand the complexity of particular sustainability issues is the systems approach. The disaggregation of the system into components, the analysis of its structure and function, the identification of relevant interactions and the determination of a hierarchy to understand links and interactions with other system levels constitute basic elements to comprehend, effectively intervene the system and measure effects of induced changes. The application of this approach has been usually based on the identification of an objective system from which a hierarchy can be constructed, components and interactions can be identified and the analysis be completed.

The selection of an objective system will be determined by the nature and definition of the sustainability issue and the intervention designed to induce a change in the development process. However, regional development programs are not necessarily designed to produce effects in a particular system only. Very often, agricultural development programs originate changes in several nodes of the socioeconomic structure and implement interventions in a number of components that may correspond to different system levels within a hierarchy. In those cases, one can refer to a domain of application of the development program included in the sustainability issue, more than to an objective function.

On the other hand, measurements of the effects of a regional agriculture development program do not necessarily coincide with the measurement of sustainability of the development process. The domain to which the development program applies may not fit the domain in which sustainability is to be measured. This is possible due to the first and second round effects of some interventions and the task of reversing natural resources and environmental conditions, often associated with sustainability.

The former circumstances make it useless to pursue the determination of an objective system to concentrate the analysis and to construct a hierarchy on which the measurement of sustainability could be based. Efforts should rather be directed to determine an objective process on which the development program focuses interventions and from which sustainability elements can be distinguished.

This objective process will cross different levels of the hierarchy to which it belongs. Moreover, this process represents the backbone from which specific subprocesses, subsystems and variables to measure sustainability ought to be found. In this context, both the domain and the hierarchy must be mapped out in order to determine the focus to measure sustainability.

The absence of a specific objective system prevents the straight application of the general rule to construct a hierarchy: identification of a superior system (suprasystem) and an inferior system (subsystem) to understand the circumstances in which the objective system is contained and, at the same time, the major components comprised in the system under analysis. An objective process requires a hierarchy to include several levels that may provide information about the circumstances and components attached to such a process. Construction of a hierarchy becomes thus a procedure similar to the one used to construct a model. Impact possibilities (first and second round effects), constraints to induced changes, limiting factors to decision makers, direct relationships and interactions, resource endowments and availability are but some of the concepts needed to construct a hierarchy on which both development and sustainability are frameworked.

One alternative to constructing a hierarchy is to set the hierarchical levels and then include the processes and variables on which to focus the sustainability issues related to them. For example, one can relate agronomic sustainability or the maintenance of productivity over time with a field level system, microeconomic sustainability at the farm level, ecological sustainability at the watershed or landscape system and macroeconomic sustainability at the regional or national system. Nevertheless, this approach makes it difficult to relate sustainability issues to interventions involved in agricultural development programs, preventing measurement of the cause-effect relations that make measuring of sustainability meaningful. On the other hand, some interactions between hierarchical levels may not be captured by a hierarchical construction of this type. In this example, the ecological sustainability will be probably closely related to the economic performance at the farm level, markets at the regional level, wealth concentration and sectoral policies for natural resource use and preservation. If this is the case, setting the measurement of ecological sustainability at the watershed system level will forego valuable information on sustainability.

The discussed alternative of identifying the objective process helps to avoid the exemplified difficulties to relate direct effects and map major interactions. The challenge is, thus, the determination of the appropriate hierarchical scheme that captures the critical levels at which the major development instruments will be applied to accelerate the socio-economic process, determining the critical components and processes in which the effects of expected changes may influence sustainability. This hierarchy may include a diversity of levels, as many as needed to capture major interrelations, components and effects attributable to interventions at different point of the objective process.

A MICRO-MACRO APPROACH TO MEASURING SUSTAINABILITY

The former narrowing down procedure does not avoid complexity to measure sustainability. Regardless of the character of the objective process and the issue of concentration, sustainability within the context of agricultural development usually includes factors such as those incorporated in the expression (1). These concepts are difficult to operate and measure.

The construction of a hierarchy and the determination of major systems, components and points to demarcate effects constitute the bases for designing a method to measure sustainability. Following the systems approach, the characterization phase should include a measurement of the initial situation of the sustainable issue to be modified through the agricultural development program. This measurement is the baseline to which posterior measurements of sustainability must refer. The relation between the hierarchy and baseline measurement can be better operated by pointing out the processes and variables that should be measured at the time the hierarchy, components, function and structure are determined. Externalities originated by the agricultural development process must be considered as well.

Constructing a hierarchy means the application of both the deductive and inductive analytical approaches. Nevertheless, the application of either approach brings about different results due to the aggregation of systems and processes. Additionally, the domain of interventions does not necessarily coincide with the domain to which the concept of sustainability attached to those interventions apply.

The deductive approach starts from the macro prospective. It is comprehensive and includes a number of components that work together in determining sustainability of a given system. The deduction from general to particular tends to focus on levels that are susceptible of reflecting the macro variables at the lower levels of the hierarchy. In this sense, it will occasionally reach the farm and the cropping system level since these are system components that receive the effects of the macro variables through other variables and mechanisms (prices, input and output markets, access to production infrastructure services, etc.). This situation may not consider those levels that may be intervened by regional agricultural development programs. If this is the case, the deductive approach must either miss relevant hierarchical levels or be forced to include those levels that are not necessarily deduced by applying the deductive analytical approach.

The inductive approach, on the other hand, starts from the micro perspective and adds levels and components that are directly related to the micro system used as the initial step. For practical purposes, the initial system corresponds to the level for which interventions are planned in the agricultural development program. From this initial step, the construction of a hierarchy builds up by including the superior levels crossed by the objective process, relating both the development and sustainability domains (i.e., production-related components, conservation of natural resource, management of a watershed, etc.). A hierarchy constructed utilizing this analytical approach tends to be less comprehensive due to the production-oriented nature of its content. As a consequence, it is less inclusive in the sense that it very often incorporates detailed processes that are useful to the decision making process and points out processes and variables in which measurement is important to evaluate and monitor sustainability.

For the purpose of the hierarchical construction, it can be argued that the use of both analytical approaches is desirable in order to capture the micro-macro relations that influence most changes within the agricultural sector. Unfortunately, due to the level of aggregation and definition of systems and hierarchies, the simultaneous use of both analytical approaches does not guarantee a common domain of application. In this sense, the sum of the elements does not necessarily add to the total. Chances are that the variables used to define the system levels and the interrelations with either macro or micro variables result in a different hierarchy definition depending on the analytical approach used to complete such a definition.

For the case of stimulus and/or interventions stemming from regional agricultural development programs, most of the activities are carried out at the farm and watershed levels. This implies that most variables and processes to be modified are micro in nature and can be defined in a relative precise manner. Within this context, sustainability has a direct implication on the use of natural resources, factor productivity, variables determining the standard of living, wealth and capital formation though generations and, in general, the integration of target population into the national socio-economic process. The application of the deductive analytical approach to this particular example would start from a macro system such as the components of the level of living or the relevant national socio-economic process. Unless factor productivity levels are forced into the hierarchy, it is likely that agricultural output could be considered as a component of the standard of living. This would ignore specific variables and interactions to which the sustainability issue is closely related as well as particular measurement elements of sustainability.

Nevertheless, the former and other instances that can be exemplified do not preclude the utilization of the deductive approach to construct a hierarchy from an objective process. Actually, the utilization of either analytical approach will be determined by the level to which the regional development program has a direct intervention. This should be used as the starting hierarchical level. If this level were a macro system, the use of the deductive approach would be then mandatory.

As mentioned somewhere else, regional agricultural development programs are usually dependent upon a decision-making unit as an entry point to provoke a reaction of the development process to a stimulus (intervention). In most cases, the decision unit resides in the farm system (even in the case in which a particular policy or regulation is initially decided by higher instances in the hierarchy). If the intervention is to modify, in any way, the function or the structure of the farm system to produce a change in the farm output (regardless of its nature and units), the interactions within the corresponding hierarchy will have characteristics of the following kind:

Pfs = f(Ff, Foff, Mb, Cf, Pis, Pmv, BEfw, Acc, Ru/Pgs) (2)

Where:

Pfs = Production of the farm system
Ff = Set of production factors available at the farm level
Foff = Set of off-farm production factors
Mb = Variables representing management skills and business planning capacity (technical change)
Cf = Set of consumption variables and farm flows
Pis = Production infrastructure services

Pmv = Prices and market variables at local, regional, national or international levels
BEfw = Set of biophysical and environmental variables at the farm and watershed (regional) levels
Acc = Set of variables representing comparative and competitive advantages
Ru = Set of risk and uncertainty variables
Pgs = Set of general and sectorial policies

The relation of farm production with the independent variables includes endogenous and exogenous factors that belong to different levels in a hierarchy. In this example, field level factors (production inputs, available resources) are related to farm (decision-maker, services and consumption patterns), regional (markets, agroecosystem) and national levels (trading possibilities, policies). Sustainability of an improved farm production activity is thus related to the use of natural resources, flows and income, biophysical and environmental conditions and comparative and competitive advantages to delineate perturability.

On the other hand, if Pfs is the composite variable expected to increase and some independent variables are modified by the intervention program (i.e., Mb, Pis, Pmv, Acc, Ru and Pgs), the "micro" focus of sustainability is Pfs. In the same example, the objective process starts with the interactions of the variables related to the introduction of technical change and includes management and economic variables dealing with competitiveness in different markets under policies directed to support the insertion of farmers in the national economy. Under these circumstances, it is likely that the utilization of the inductive analytical approach (a micro-macro approach) leads to an appropriate hierarchy construction to contain the objective process.

However, as stated before, sustainable development is a systemic concept and, consequently, multivariate in nature. For this reason, sustainability of Pfs is probably not sufficient to put in place a development process that can be recognized as sustainable. Major components like those included in expression (1) must be also stimulated. Likewise, positive and negative externalities that are usually detected at different levels must be taken into account. Based on specific objectives and the instrumental planning of an agricultural development program, variables interrelating in each of those components can be identified as to desegregate as shown for farm production in expression (2).

SELECTING INDICATORS OF SUSTAINABILITY

Measurement of sustainability issues is a complex task. In fact, the methodological approach that has been discussed in this paper is just the framework in which actual measurement takes place. The use of specific tools and the construction of indices provide dimensions to sustainability constitutes a major methodological problem that has abundant literature references.

Given such a demanding procedure, it is worth considering that in most cases sustainability is not expected to present radical changes in the short run. Under these circumstances, an instrument to monitor sustainability such as an indicator may be useful, time saving and economically efficient.

An indicator is a tool for aggregating and simplifying information of a diverse nature into a useful and more advantageous form. It is a number or a quality that manifests the stage or condition of a given process or phenomenon. An indicator could be defined in such a manner that it either monitors levels of variables or processes to be contrasted with threshold values, or yield punctual values in order to monitor the behavior of the process into a defined context of expected reaction to an intervention. Different evaluations of an indicator can be used to understand tendencies and changes over time. Similarly, models to evaluate associated variables and processes and predict values of the indicator can be designed.

Indicators can be quantitative or qualitative. For practical reasons, quantitative indicators are easier to compare over time, but are less descriptive of the evolution and the conditions under which the behavior is determined than the qualitative indicators. Ideally, an indicator is a manifestation of a variable or a process easy to measure or describe. It should reveal the state of the variable or process in such a manner that a clear manifestation of changes over time (between measurements) can be gathered. In this setting, an indicator becomes critical as a warning once thresholds have been established.

A qualitative analysis of a process may lead to selecting a variable that indicates whether the process is following a path that induces to a non-sustainable stage. This type of analysis does not follow a predetermined model or analytical approach and requires no scale to evaluate the indicator. It rather concentrates on understanding the pattern and the tendency of the indicator as much as it represents the tendency of the process itself.

The determination of variables and processes on which sustainability is to be measured becomes a decisive step when selecting indicators. As a matter of fact, an indicator is a signal that manifests the state and evolution of a number of those variables and processes. In this sense, an indicator will evolve in a similar way that the objective process and the hierarchy do: simple and precise at the levels in which sustainability is directly affected by interventions and aggregated and more general at the levels in which sustainability is influenced by indirect and second round effects. Following the inductive analytical approach, it is possible to claim that, in general terms, for higher hierarchical levels, indicators of sustainability become more general. The more aggregated the system, the smaller the capacity of the indicator to specify a precise condition.

Methodological procedures for selecting indicators can be reviewed in the literature. As a practical approach, the suggestion of determining sustainability issues can be complemented by defining elements and describers prior to selecting indicators. Other methods can also be used for variables that have higher weight in explaining modifications in the objective process: response surfaces, factor analysis, canonical correlations or path analysis, among others. Indicators or even proxies can then be developed to monitor the most important variables. Composite indices to measure sustainability issues can be constructed as well.

Regardless of the methodological approach, it is important to keep in mind that no universal indicators exist. The determination of specific indicators will then respond to the nature of the analysis, the hierarchy constructed to understand the objective process, the baseline sustainability measurement and, most importantly, the nature and level of intervention through which regional sustainable development is induced. In this sense, no rule of thumb for selecting indicators of sustainability can be suggested.

A final word on the use of indicators is related to their validation in the field. This is an aspect closely associated with the nature of the sustainability issue and the induced change. Validation must be completed at least two levels: logical consistency with the hierarchy, relevant variables and initial measurement and pertinence of the information provided by the indicator. The latest view should be checked against model predictions, specific scenarios or any other method utilized to evaluate and/or predict the impact of the regional sustainable development program.

CONCLUDING REMARKS

The instrumentation of the concept of sustainability constitutes a methodological challenge that has several components and stages. The systems approach seems an adequate strategy to understanding, studying and determining mechanisms to measure sustainability. Nevertheless, the holistic nature of the concept, the characteristics of the phenomenon, the number of levels involved in the analysis and the dependency on external factors and processes, make it difficult to analyze sustainability as a matter independent from other components of a major system.

The discussion of the application of the systems approach to dealing with sustainability was limited to the rural sector and particularly to small scale farmers. Important methodological steps were analyzed and the need to adequate some of them was detected. In some cases, a reconceptualization to facilitate their operation is recommended. In other instances, an induced-oriented perspective is suggested. Some of these aspects are discussed in the following paragraphs.

For practical reasons, the analysis of sustainability is meaningful when attached to activities aimed at introducing changes in the agricultural sector, since it is the reaction to defined stimuli (either to improve a situation or to recover a degraded condition) what is important to measure. The concept of regional agricultural sustainable development becomes then an integral frame to accelerate the socio-economic process in such a manner that small scale farmers are better off within a sustainable track.

The general system in which sustainability is better depicted is broken down into major and dynamic components, according to macro policies and agricultural developments programs. Sustainability issues can be tailored around the objectives of regional development plans. Methodologically, a partial sustainability analysis of the sustainability issue can be completed aiming at obtaining a second best solution.

The determination of an objective system to facilitate the construction of a hierarchy was found inconvenient to analyze and measure sustainability within the context of agricultural development. Due to the multivariate character of the concept and the implications of interventions on sustainability, an objective process is proposed as the bases from which a hierarchy can be constructed. This objective process is closely related to the general and specific objectives of the sustainable development program that directs the sustainability issue.

Once an objective process is determined, a hierarchy should be constructed to map out limits, function, structure, processes and interactions among components and variables. Because of the characteristics of the objective process, the hierarchy transcends the classical level selection of the suprasystem and the subsystem. Instead, an open hierarchy is required. The analytical approach used to construct such a hierarchy could make a difference, depending on the level of aggregation and the level at which the interventions of the agricultural development program are directed. Based on experience, a suggestion to utilize the inductive analytical approach from a micro prospective is proposed. However, there exist instances in which the use of the deductive analytical approach is required.

Measuring of sustainability is required if this concept is to be used as a guide to adjust regional agricultural development programs. A baseline, critical variables to be evaluated and thresholds for selected variables are needed for monitoring and comparisons purposes. The evaluation should concentrate on those critical variables, processes and components on which the effects of interventions are expected to touch sustainability. These evaluation points are determined by examining the objective process and the corresponding hierarchy. No measurement procedure can be established a *priori*, but some standard statistical tools could be used to determine most important variables.

Monitoring of sustainabilty can be accomplished through the use of indicators. Those indicators should be determined through a similar process utilized to construct the hierarchy, keeping in mind that the more aggregated the level, the less specific the indicator. Indicators of critical variables and processes can be qualitative or quantitative and it is not possible to determine in advance a general indicator or a general rule to do so. Finally, it seems important to validate indicators before a process is set to monitor a sustainability issue.

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Agricultural Policy Analysis and Planning The Use of Indicators to Assess Sustainability Within K-2

J.T. Tschirley*

INTRODUCTION

In many countries, both developed and developing, the process of policy making and planning in agriculture is far removed from what happens on the land. Many policymakers are unaware that their decisions, such as to subsidize pesticides or provide price guarantees for a commodity crop, affect how rural people use their land. Errors of omission or commission in the policy making process lead to degradation and loss of productive potential that may well have been unintentional but nonetheless undermines economic development.

SUSTAINABILITY ANALYSIS IN K-2

K-2 is a toolbox (not a model) that will allow policy analysts and planners to connect the results of economic analysis to social and biophysical conditions in a coun-try or a district. It will allow the formulation of scenarios of sustainable development and compare the results of weak or strong sustainability assumptions on key elements of the rural sector.

The K-2 program consists of the following modules:

Demography
Macroeconomy
Demand and Supply Accounts
Commodity Chain Analysis
Price Policy
Investment
Labor
Nutrition
Crop Production
Animal Production
Forestry Production
Land Resources
Sustainability Analysis

The system will allow users to insert data within a flexible data framework based on indicators derived from the K-2 database. The sustainability indicators will be assembled from projections and analyses in the other K-2 modules.

Scenario building is a central part of the K-2 process. Each scenario simulates specific policy and planning objectives over a given period. Based on choices made throughout the construction of the scenario, the user can incorporate strong or weak sustainability objectives for each of the three components of the module - economy, social setting, natural environment.

An important objective of K-2 is to use the scenario to identify tradeoffs between economic growth, social equity and environmental protection. Neo-classical economics supports the view that the most effective path toward sustainable development in the poorest countries is through maximizing production. Unfortunately, the natural sciences are less accommodating to such a strategy if it means sacrificing, even over

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the short term, bio-diversity, forest resources, soil nutrients, vegetation and so on. Policy analysts and planners need to be aware of tradeoffs between rates of growth, distribution of benefits, and maintenance of biological and physical systems.

The second objective is to promote transparency in the decision-making process. In other words, a decision to accept a high level of soil erosion in order to maximize short-term production should become the basis for dialogue whether the additional production, on a specific site and over a defined time period, is worth the degradation. In most developing countries, such relationships are not established and dialogue is not yet part of the policymaking process.

An earlier version of the toolbox was called CAPPA. It already has features for indicators that assess the impact of policy and planning decisions in socio-economic terms: for example, active/inactive dependency ratio, changes in private income *per capita*, average calorie/protein intake compared to a nutritional baseline. In K-2, these indicators will benefit from more disaggregated analysis (e.g. by region and by subsets of the population).

During 1992-93 FAO defined the biophysical, social and economic indicators that could be incorporated in K-2. From a list of over 200 indicators, we then selected the key, measurable indicators to be incorporated into K-2. Initially, longer lists of indicators were thought to be unmanageable. This question is now being re-examined in the light of the data constraints in many countries to allow maximum flexibility in using available data.

To promote wide use of K-2, it is probably better to accommodate a larger set of indicators that does not force the use of data of lower quality simply to make the system function properly. On the other hand, a larger set of indicators increases the complexity of the sustainability module by several orders of magnitude.

In 1994 we began work with IIASA and the Free University of Amsterdam on the analytical design and structure of the sustainability analysis module, and the algorithms for the analysis. This will be followed by a testing stage in a few countries during 1995.

While many difficult questions remain to be resolved, the following present particular challenges to incorporating sustainability analysis in K-2.

SPECIAL CONCERNS IN SUSTAINABILITY ANALYSIS

Income Distribution

Although economic efficiency (i.e. maximizing income through careful allocation of production factors) is a primary objective, many governments also place at least a nominal priority on social goals such as equity and poverty reduction. Unfortunately in economic analysis this element is treated as a "before" or "after" condition based on a development program intended to address employment or land tenure or some other element of income distribution.

Social benefit/cost analysis (SBCA) can be used to provide information on the net benefits of various interventions by income class or region. Although they are somewhat subjective, weights can be assigned to benefits and cost involved with these same groups, to favor the poorer, disadvantaged groups.

A third strategy would be to set boundaries or limits on the distribution of benefits to different groups. Projects or activities within the limits (i.e. the benefits accrued to wealthier groups or districts) would receive more favorable consideration.

Inter-Generational Equity

Most development projects have time horizons that are relatively short when viewed in the context of sustainability and use discount rates that favor consumption or use over the short-term. However, the impacts of these same projects are often felt over a long period of time.

For example, the incentives provided in the Brazilian Government policy to develop cattle ranches in their sub-tropical forest areas in many cases result in operations that endured only 3-7 years with the forest cover being cut. The immediate indirect benefits from the forest, not to mention future values were discounted to a level of zero value.

Nonetheless, efficient allocation of resources and assessing present vs future values, within the sustainable development concept, is essential to maintaining social welfare. Thus, one challenge is to "use the right discount rate". For financial analysis the cost of capital is one measure but for economic analysis there is the need to incorporate a social function representing the importance the government attaches to non-economic factors such as providing for future generations. This could result in low or negative discount rate that favor future consumption over that of the present.

Option values, the portion of cost that are paid today to retain an option on the use of a resource in the future, are yet another technique analysts can use to consider trade-offs between the various dimensions of sustainability. This "risk premium" is closely related to the topic that follows.

Irreversibility and Incrementalism

Like many words today, the term "irreversibly damaged" is commonly used in referring to land degradation. This is especially true in the case of arid rangelands (desertification) and the wet tropical forests (deforestation). Although often overused, the concern about policies and related projects that cause irreversible change is valid and must be addressed in sustainability analysis.

There is no single method in economic analysis to address irreversibility. In addition to the option value method, analysts and planners can attempt to value the costs and benefits of delaying an activity that may have an irreversible element. The value would be represented by the information gained by the delay. This could be positive if an alternative technology were applied that would cost more but avoid the negative irreversible impacts.

Opportunity cost analysis can be another measure of options available to analysts and planners to avoid or mitigate the worst irreversible impacts.

Incrementalism is perhaps the most insidious problem viewed by development practitioners. It occurs when a series of individual seemingly innocuous activities that, taken collectively, result in net negative social or environmental impacts. Examples are the removal of "just sand" from around coral reef areas or cutting of "just 5%" of a large forest area.

There are few planning tools for addressing this problem. However, geographically referenced information systems, and extending short- and medium-term scenarios over longer time periods can be useful in avoiding incrementalism.

Risk and Uncertainty

These factors can enter into sustainability analysis in several ways. "With and without" scenarios are one of the most common. However, an important step is to transform uncertainty, where probabilities are not known, into risk, where one can assign weights (subjective though they may be) to derive expected values for the occurrence of the most or least favorable outcomes.

Sensitivity analysis (i.e. changing assumptions about several key variables and preparing new scenarios) is another option. This can be used to place boundaries on the sustainability analysis by preparing optimistic and pessimistic scenarios.

Risk and uncertainty can also be managed by the use of thresholds and safe minimum standards. In many cases these are well established for land resources and take into account soil type, climate, topo-graphy, crop requirements and vegetation cover.

Collecting the Information

The cost effectiveness of collecting information is a major consideration for most developing countries. Although considerable work has been carried out on environmental indicators and statistics, little of it has been useful to developing countries in on-the-ground application, either at farm or district level, or in national decision-making. In deciding how and when to initiate indicator programs the following criteria should be considered:

Cost/utility
Timeliness
Level of disaggregation
Measuring versus estimating

Indicators must arise from data and information at the national level or lower. Lacking a solid foundation, global indicators are reduced to being used by narrowly-focused special-interest groups to promote their cause, but add little to improved policy-making, even if the indicators are accurate.

The bottom line for many decision-makers or concerned citizens is often "Are my (or my constituents') environmental conditions improving?". This may mean special areas of interest such as biodiversity, climate change, pollution, land degradation; or employment, income, cost of living, food security, health, or access to resources.

Sustainable development indicators, while less exciting than the global environmental ones, are far more important to the developing countries. For example, those needed by the Ministry of Agriculture include soil quality, use of inputs, terms of trade, access to food, employment, income distribution etc.

The work started with K-2 can provide reference points for national and district-level performance indicators for SARD (Sustainable Agricultural Research and Development) in Agenda 21 by building, from a sub-national basis, the information and data required for sound decision making.

FUTURE WORK TO BE UNDERTAKEN

An important future task in policy analysis and planning for sustainable agriculture is aggregation of data below national level to represent the re-aggregation of data into an agro-ecological-zone format which takes into account climate and soil conditions. On this basis, the current and potential social and economic constraints can be better assessed in the context of population-supporting capacity. Although some of this work has been undertaken in a few countries, it lags far behind the need. An agro-ecological-zone-based information system could also benefit from incorporating information on waterlogging and salinity, loss of forest cover, presence of plant and animal genetic material, and prevalence of vector-borne disease all of which factor strongly in sustainability analysis.

In 1995 FAO will begin work on guidelines for collecting and using indicators related to sustainable agriculture and rural development. The focus will be on assisting countries to collect and use indicators for monitoring, evaluation and hopefully, better decision making. The guidelines will concentrate on the:

Concept of and methods for constructing indicators;

Use of indicators, i.e. what they represent;

Sources of data and means of collecting them;

Frequency of data collection and compilation;

Disaggregation of data.

Of paramount importance is the need to ask a few questions before initiating programs for sustainability indicators:

(1) Will the indicators lead to better understanding or decision making on an important development issue? In other words, don't confuse indicators with action, they are only a tool for making better decisions.

(2) Who is the target audience? Local communities, national, sub-national, global?

(3) Do the indicators, collectively reflect the three components of sustainability. i.e., the economic, social, and environmental dimensions? Are they interpreting accurately and weighing the values fairly?

(4) Are the priorities clearly defined as regards sustainability? For example, the need to collect rural-based indicators for rural economies. For poorer countries economic growth may be a better measure of sustainable development than environmental protection.

CONCLUSIONS

Although FAO is an important source of global data and information on land and natural resources in developing countries, demands (arising from improved technology and access to it) for better analysis and presentation in formats conducive to decision making require major adjustments in the way we have used information in the past.

For example, based on analysis of previously existing fisheries data and information, it was discovered that the mechanized portion of the fishing industry, mostly in industrialized counties, is subsidized to an amount of nearly US $22 billion per year. When viewed in the context of dramatic declines in yield of preferred species, increased reliance on shoaling pelagic species (the supply of which is unstable), excessive fleet capacity and fishing gear (much of which is non-selective) these findings have led to a review by a number of countries to consider how their policies could be adjusted.

Thus, in addition to indicators that are collected and analyzed regularly, there is considerable scope in the agriculture, forestry and fisheries sectors for special, one-off analysis that lead to important new findings or different interpretations that can focus the attention of policymakers on issues of importance.

OTHER RELEVANT ACTIVITIES IN FAO RELATED TO INDICATORS

EcoZone

EcoZone is a knowledge-based computer software programme for use in identifying environmental issues related to agricultural sector development projects. It uses an agro-ecological-zone approach matched against a specific type of development activity, such as irrigation, crop production, aquaculture, livestock or forest production. The scenario is then exposed to a hierarchical set of potential impacts, the majority of which are related to biophysical. The programme consists of three parts.

EcoZone Impacts, indicate the major potential environmental impacts that could result from development activities in each agro-ecological zone.

EcoZone Workshop allows up to nine groups in a training workshop to enter their own rules about the environmental impacts of development activities. The programme automatically combines the rules of the different groups and allows a limited amount of interactive analysis.

EcoZone Control allows the user to create empty books and to enter rules and information about a particular country or region. In this way, a library of books containing specific information can be built over time.

EcoZone is a good training tool for indicating field data requirements to identify impacts. The indicators it generates can be used for comparing different development project scenarios. Some expansion of the hypertext portion of the programme took place during 1993 to expand the technical documentation and guide the user through the system. However, the quantitative analysis needed to arrive at reliable project-level indicators will require further effort.

Annex 1: Environmental Impact and Sustainable Indicators for K-2.

Forestry Production Module	Data Available From	Mode of Calculation
Resource:		
Area and volume of forest resource	1	K
Area and volume of forest resource per capita	1,3	K
Ratio of area in natural forest to total forest area	1,5	K
Percentage of industrial forestry land	1	K
Percentage of environmental (watershed, biodiversity) forestry land	5	R
Area in forest plantations	1	K
Percentage of forest area protected	1,4	K,R
Ratio of original forest cover to current forest cover	1	K
Suitability for fuel wood production	4	K,R
Outputs:		
Total round wood production	1	K
Fuel and charcoal production	1	K
Industrial round wood production	1	K
Value of non-wood forest products to wood products	2,5	K,R
Income per hectare of forest land	2,3	K,R
Watershed protection	2	K,R
Forest degradation	1,2	K,R
Reforestation	2	K
Deforestation	1	K
Erosion rate	2,5	K

Data Available From: Mode of Calculation:

1. = FAO statistics U = Unknown
2. = Country K = Known
3. = K-2 R = Research work needed
4. = AEZ
5. = Unknown
6. = IUCN

Annex 1: Environmental Impact and Sustainable Indicators for K-2.
(Continued)

Land Resources and Water Module	Data Available From	Mode of Calculation
Land:		
Land area per capita	1,3	K
Urban area	1,3	K
Protected area	4	K
Percentage of each biome protected	4	K,R
Wetland area	4	K,R
Wetland per capita	3,4	K,R
Land suitability by broad categories	4	K
Potential land productivity	4	K
Area with no physical and chemical soil constraints (AT1)	4	K
Erosion status, rate	2,5	K
Water:		
Annual internal renewable water resource	1,2	K,R
Annual internal renewable water resource per capita	1,3	K
Annual withdrawals	4	K
Annual withdrawals per capita	4	K,R
Total withdrawal as percentage of water resource	4	K,R
Sectoral withdrawal	3,4	K,R
Sectoral withdrawal as percentage of available resource	4	K
Seasonal water flow	4	K
Water quality	4	K

Data Available From:
1. = FAO statistics
2. = Country
3. = K-2
4. = AEZ
5. = Unknown
6. = IUCN

Mode of Calculation:
U = Unknown
K = Known
R = Research work needed

Annex 1: Environmental Impact and Sustainability Indicators for K-2.
(Continued)

Forestry Production Module	Data Available From	Mode of Calculation
Resource:		
Area of freshwater bodies	1	K
Length of coastline	1	K
Exclusive economic zone	1	K
Length and area of coral reefs	6	K
Length and area of mangroves	6	K
Aquaculture potential	1	K
Coastal pressures	2,5	U
Vessel size	1	K
Fishing effort	1	K
Number of people employed in commercial fishing	1	K
Number of people employed in artisinal fishing	1	K
Total marine catch	1	K
Total inland catch	1	K,R
Total aquaculture production	1	K
Catch in relation to maximum sustainable yield	1	K,R
Value of fish catch	1	K
Value of aquaculture production	1	K
Destruction + degrad. of coastal ecosystems (reefs, mangroves, seagrass)	2,5	U

Data Available From:
1. = FAO statistics
2. = Country
3. = K-2
4. = AEZ
5. = Unknown
6. = IUCN

Mode of Calculation:
U = Unknown
K = Known
R = Research work needed

Annex 2:

WAICENT

The World Agricultural Information Centre is a corporate database, supported by two distinct components: FAOSTAT containing statistics and FAOINFO mostly text files. WAICENT is designed to reduce information redundancy and improve consistency and availability, especially to outside users. Both systems are composed of subsystems to guide users in accessing information. The development and maintenance of both the corporate database and its feeder systems are managed centrally, but the FAO technical units are responsible for data entry, validation and processing.

FAOSTAT will bring together time-series data from 210 countries and territories in real time on population, agriculture, fisheries and forestry, as well as data on trade flows, the World Census of Agriculture, and food consumption.

So far, ten FAO information sets have been identified for inclusion in FAOINFO. The system will include internationally-accepted food standards, pest and disease distribution, and monthly forecasts on global production, trade and stocks of staple foods.

When it becomes operational, WAICENT will provide member counties with efficient and economical access to FAO information. While the task may seem to be relatively straightforward, it has been found, in practice, to be very complex. After four years' work, the Centre is expected to begin operating during 1993.

STATISTICS

AGROSTAT-PC, already in existence for some years (and subscribed to by WRI and numerous other organizations), is a set of 12 floppy discs (available in English, French and Spanish), providing statistics collected since 1961 on population, land use, production, agricultural inputs, trade, food balances and forest products. It is updated annually.

FAO is gradually strengthening the environmental components of its fertilizer and pesticide statistics to reflect environmental and sustainability aspects. In the past, statistics on fertilizer use by crops were assembled and published separately by FAO, the International Fertilizer Development Centre (IFDC), and the International Fertilizer Industry Association (IFA). These groups now issue a joint publication based on the results of their individual surveys. Of particular interest are the issues related to input-output balances of plant nutrients in soils, which can be a good indicator of soil fertility and production potential.

In striving to improve international pesticide statistics, FAO has cooperated with the EEC to facilitate reporting by countries. Data are collected on pesticide consumption and trade values for all major classes of pesticides (insecticides, herbicides, fungicides, bactericides, plant growth regulators and rodenticides) in 30 to 40 countries. As this system is refined, it should yield a more accurate view of the kinds and quantities of pesticide being used in agriculture, and where pesticide management programs should focus their attention.

WORLD CENSUS OF AGRICULTURE

Every ten years, FAO coordinates the preparation of a World Census of Agriculture. The Census is not carried out simultaneously in all countries, but allows the use of data from national censuses taken on either side of 5 years from the target date (e.g. the 1980 programme would include data from the period 1976-1985). Recognizing the wide range of economic and statistical development, the Census encourages each country to develop and implement a census tailored to its unique situation.

There are numerous other information systems in FAO such as the Agro-Ecological Zones project (AEZ) and the related Population Supporting Capacity analysis, the Africa Real-Time Environmental Monitoring and Information System (ARTEMIS) and the Global Information and Early Warning System (GIEWS) many of which are useful in carrying out environmental or sustainability analysis, but have not yet been exploited for this purpose.

Bringing SARD Down to Earth: Challenges for the Development Community

Charles M. Benbrook*

INTRODUCTION

Between 1988 and 1993 food security, as measured by FAO's Aggregate Household Food Security Index (AHFSI), dropped 14.9% in Peru and rose 17.7% in Burkina Faso.

The AHFSI shows that food security declined in three-fourths of 93 developing coutries between 1992 and 1993. Data compiled by FAO and reported in AGROSTAT shows that stocks are tightening, per capita cereal production in Africa is declining, and per capita income in the Low Income Food Deficit countries of Africa has declined for 6 years in a row.

The seeds of civil disorder in Somalia and Rwanda had little to do with sustainable food security. But the consequences of civil disorder on food security can be swift and dramatic. These two relatively small countries (combined population in 1992 less than 16 million people) have imposed a major drain on global food aid and humanitarian resources. The U.S. government has already pledged $470 million since April to address the Rwanda crisis -- a monthly rate of expenditure roughly equal to USAID hunger and poverty alleviation development investments worldwide.

Watch out for Kenya and Nigeria, with combined population of 127 million. Signs of trouble are emerging. Both fall in the "low" category in terms of AHFSI levels. Kenya suffered a serious drought in 1992/1993, leading FAO to warn "Without a major donor response, Kenya faces a major food crisis in mid-1994...". In 1987/1988 food aid accounted for 70% of total cereal imports. Access to land is highly skewed -- the 20% of landholders with the largest holdings control 84% of the land, the poorest 60% control just 4.8%. Between 1978 and 1987 the wages of agricultural workers fell, reflecting the number with little or no land.

Civil unrest in Nigeria is rising, where over 35 million rural people live below the poverty line. Smallholder farmers produce 90% of staple crops yet control about 71% of the arable and permanent crop base. Arable land per member of the agricultural population has fallen from 0.76 hectares in 1965 to 0.43 hectares in 1988 -- 2.5 times the average percentage decline in 114 developing countries studied by IFAD in its rural poverty report. Nigeria's population is likely to almost double between 1990 and 2010, pushing land per agricultural worker even lower. As the commercial sector takes over more and more land, the quality and amount of land per farm household will fall further and food insecurity will rise, unless new employment opportunities emerge in rural areas.

Food security is tenuous; food aid accounts for a trivial share of caloric intake, the country draws on its oil wealth to purchase foodstuffs on the world market. What

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will happen if oil prices or demand falls, or if there is a disruption in exports, or if another drought, pests, or civil disorder push these countries over the brink? How much food aid might be needed? What could be done to stabilize food security?

Botswana has announced a shift to food security as the priority goal in shaping policy, as opposed to achieving self-sufficiency. This change was driven in part by the consequences of drought in 1992/1993. Variability of production is high, caused by the nation's location on the continent, just south of the sub-humid zones where rainfall is more predictable. Between 1988 and 1993, there was a 16.6% decline in AHFSI values. What lessons can be learned by studying trends in various food security indicators across these African countries?

MOVING AHEAD IN IMPLEMENTING SARD

Throughout the development community program managers and field personnel are sold on the concepts behind SARD. The importance of sustainable food security is self-evident. Needs among the poor and landless are compelling on every continent and growing more obvious each month, despite encouraging progress on many fronts in many regions.

People are ready to pursue new sorts of projects, encouraged by successes like FAO's Indonesian rice IPM project and the UNDP-funded soil conservation project in the Machakos District of Kenya. Donors are eager to support change. The new leader of UNDP, Mr. Gus Speth and of FAO, Mr. Jacques Diouf, have highlighted food security as institutional priorities. Both have spoken forcefully and thoughtfully on the need for and nature of change.

Then why, many wonder, are things changing so slowly and indecisively? Why has Chapter 14 of Agenda 21 produced so much paper and talk, and so little action on the ground? One answer is clear -- far too few people can explain how a well-designed SARD project in 1995 should differ from an "old" paradigm project, circa 1985. Some can and their voices are gaining prominence. Will resources follow?

Embracing SARD as a goal is easy; achieving it in the real world is difficult, especially in countries where poverty, resource degradation, civil unrest, misplaced priorities, and/or policy are actively undermining its building blocks. SARD requires a realistic amount of productive land and water per person (or a sustainable source of income to purchase food on world markets), human skills, the motivation to work (and rewards that match effort), confidence that one will be able to harvest a crop once it is planted, and access to genetic resources and technologies adapted to a region's soils, climate, pests, and markets. Shortage of any of these essential ingredients threatens the utility of them all.

The essential elements of a SARD project that will distinguish it from most past agricultural development projects are:

- Participatory design and governance

- Farmer involvement in field work and training

- Agro-ecological approaches to sustain soil fertility and manage pests and diseases

- Diversification in all phases of farm management and in the establishment of new economic enterprises and employment opportunities

These elements must be creatively woven into all projects. In the past most of these elements have been absent, or at best tangential. Rarely have donors, action agencies, and program managers consciously sought to promote synergism across and among these elements, and backed intent with resources. Promoting and focusing this synergism on priority community needs is the heart of the new paradigm.

UNDP'S SFS/SARD INDICATORS PROJECT

The purpose of UNDP's Sustainable Food Security (SFS)/SARD Indicators project is to build analytical and decision-making capacity. To be of value, this capacity must help people in the field, government ministries, and action agencies work together in identifying needs, promising initiatives, and ways to monitor progress.

Our efforts have been driven by recognition that answers and insights of practical value and consequence are needed now. People in food deficit nations lack the luxury of time to develop more comprehensive data sets and sophisticated analytical methods, despite the clear need for both.

FRIEDEL'S CHALLENGE

My UNDP colleague Friedel Mallinckrodt has stated many times an important sentiment. There is much work to be done, so many needs remain unmet. Time is short and resources limited. Better data, more studies, and SFS/SARD indicators, by themselves, will feed no child nor stop the burning and loss of biodiversity.

It is not enough to excel analytically, pushing ahead the frontiers of knowledge. This is not an academic exercise. We must think creatively and act decisively in incorporating indicators into routine decision-making processes, and not just in UNDP headquarters or when UNDP country resident representatives sit down with action agencies and government agency staff to map out plans of action. Everyone needs to get into the act.

SFS/SARD indicators should serve as the building blocks of a new ruler used to monitor needs in the field and regions, trace problems to their roots, and measure success, or the lack thereof, when a project tries to overcome some constraint to SARD.

A ruler is useful only if people believe in it. There must be collective acceptance of its validity and reliability. People must also gain confidence that SFS/SARD indicators will be used appropriately at different levels, and fairly in identifying needs, allocating resources, and judging success. Methods to apply SFS/SARD indicators in real world decision-making must be embraced by farmers and NGOs, action agencies and government ministry partners, and finally on the ground, by the people who must decide -- this is the path to SARD, this is not -- and then move along it, overcoming obstacles that will inevitably arise.

Both in developing and applying SFS/SARD indicators we have to work smarter and quicker, directly involving those that are in a position to make SARD happen on the ground. Many people and organizations will need to work together more fluidly. Data-sets, analytical methods, and results will need to be shared, especially with people close to the action in the field. Action agencies need to work with funders and NGOs to develop common approaches in using indicators to --

· Establish baseline conditions, highlighting those trends that must be reversed to assure sustainable food security

· State project goals in terms of desirable changes in baseline indicator values

· Link project activities to concrete progress that can be monitored by tracking changes in agreed upon indicators of project success

· Capture the degree of participation and farmer involvement in projects, which at this time in the evolution of SARD, should be viewed as an end in itself

UNDP is convinced that there are important insights waiting to be discovered, and that such insights should drive the operationalization of SARD. UNDP views the development and use of SFS/SARD indicators as a key component of capacity building -- in this case, the capacity to thoughtfully pursue SARD.

STATUS REPORT

The UNDP Sustainable Food Security/ SARD Indicators Project started about 6 months ago. We have just scratched the surface in compiling the data-set and are just beginning to apply it to real-world needs and issues. The extent of data that is available is surprising, although it is spread all over and needs to be compiled and synthesized. This is a role UNDP will try to fulfill, with the help of many others.

Much additional data needs to be incorporated in the data-base, such as the important and very interesting socio-economic data in the twenty-odd tables that appear in the IFAD rural poverty report; macro-economic and trade data in the World Bank's "World Tables" series; and, the unique data on forests and rangeland, land and water use and quality, and biodiversity in the World Resources Institute data-base.

SFS/SARD indicators work will need to go on for many years, in partnership with FAO, IFAD, the World Bank, and U.S. AID, with help from CG centers and scientists in national systems, and with the active input of political leaders, community organizers, farmer organizations, and NGOs. The sensitive eye of many is needed because, when analyzing macro-level indicators, it is as easy to be fooled as it is enlightened. Results need to be cautiously interpreted and rigorously checked by real world experts.

The SFS/SARD indicators data-set is a tool. To have value it must be used. It can be drawn upon in developing baseline statistical profiles of a country or a region, or assessing policy and institutional issues across countries. It provides a mechanism to pull together data on a country available from various international sources, coupled with easy access to analyses carried out by others, like FAO's AHFSI and IFAD's Food Security Index.

Down the road, the FARM and SANE projects, and SANREM project country profiles should be developed and refined. The database could be a useful resource in using FAO's K2 software for program planning at the country level. The results of UNSO's desertification indicators project surely will find their way into the SFS/SARD database. Other institutions could add value, such as CIAT's hillside indicators project and results from the food security model developed by the Bureau of Humanitarian Relief/U.S. AID, now being field tested in Jamaica and Honduras. But for the indicators "whole" to exceed the sum of its analytical parts, new mechanisms will be needed to foster communication world-wide and across many levels, and to fund new partnerships and foster unselfish collaboration.

"ROUND II" E-MAIL CONFERENCE

To start addressing this need for networking and cooperation, UNDP is sponsoring a "Round II" E-mail teleconference. This key component of the SFS/SARD Indicators Project actually begins today, and will build on SANREM's January 1994-April 1994 teleconference, which was so capably run by Bob Hart of INFORUM. Fortunately, Bob has agreed to continue as an active participant and manager of Round II. UNDP is pleased that the SANREM project will join as a co-sponsor of Round II. The active involvement of the SANREM staff will help assure a growing network and direct linkages to many people working in the field.

INDICATOR APPLICATIONS

So what should Botswana, or Bangladesh, or Peru do to promote food security? What lessons can be learned from the experience of other countries? Where and how should governments invest their resources to promote sustainable food security through SARD?

In the context of developing its next 5 year plan, suppose the government of Botswana asks UNDP and FAO to help it identify what it might do to most efficiently promote food security. A team of in-country experts, nationals, and NGO representatives is given 4 months to provide suggestions. Where might they go for insights and answers?

Even a cursory analysis of FAO, IFAD, and the UNDP indicators data-base yields one clear conclusion -- some African countries have made solid, surprising progress in improving food security, as measured by everyone's food security indices, while others have slipped badly. Understanding why could lead to possible lessons to apply in shaping a strategy for Botswana.

Malawi is one of the countries that has a positive record in improving food security, despite a very high percentage of its population living in poverty. Malawi ranks 83 out of 114 countries in IFAD's food security index (with number 1 the most food insecure), yet it is ranked number 6 in the integrated poverty index (only five countries are poorer). Why is this largely rural, agricultural country, among the poorest in the world, able to do relatively well in assuring secure access to food?

A quick review of UNDP's "Fifth Country Program: 1992-1996, Smallholder and Agricultural Productivity", and relevant parameters in the SFS/SARD database and various FAO and IFAD reports places Malawi's accomplishments into perspective. First, 55% of Malawi's farm families have less than 1 hectare of land, and of these 76% are headed by women. Maize occupies 95% of the land on these small farms, and yields are very low -- over 70% less than experimental yields.

Malawi has one of the most even distributions of income in any country in the world. The ratio of the income of the richest 20% of the population, to the poorest 20% was only 4.9 in 1967-1968. In Kenya, income has moved steadily and significantly from the poor to the rich; this ratio rose from 3.2 in 1961 to 23.2 in 1976. Whereas in Botswana it has moved in the other direction, from 37.7 in 1969-1971, when food security was relatively low, to 23.6 in 1985-1986.

Trade and food aid flows can also account for changes in food security. Figure 1 shows trends in Botswana and Malawi in two parameters in the SFS/SARD database: land per capita and reliance on cereal imports, 1961-1990. As recently as 1982 imports played a very modest role in meeting Malawi food security needs, but have become steadily more important. From 1980 to 1992 cereal imports grew more than ten-fold, with food aid accounting for almost 85% of the increase. In just a decade food security in Malawi has become highly sensitive to the ability of donor nations to maintain food aid flows. Difficult times may lie ahead; even simple analysis using the indicators database can help raise flags and estimate what might be needed under various plausible scenarios.

Another factor that might explain part of Malawi's success is land tenure. While 90% of the population is rural, and virtually all considered "functionally vulnerable", less than 8% of the country's 6.8 million rural residents were "landless" in 1988. Landlessness is much higher in many food insecure countries, and is a dominant factor in several Latin American countries. But clearly in Malawi, further population growth could push large numbers of farm families from barely adequate to chronically inadequate levels of food security.

PERPLEXING DIVERSITY IN LATIN AMERICA

Food security problems are not limited to the African continent. Latin America is a continent of extremes. Access to land, the distribution of wealth, input levels per hectare, and employment opportunities are highly skewed. Figure 2 presents the trends in UNDP's food security indicator III for Colombia, Ecuador, Honduras, and Peru. Differences are striking and raise obvious questions -- steady progress and relative stability in Colombia; the dramatic decline in the 1970s in Peru; the marked difference in the performance of neighbors, Colombia and Ecuador.

Figure 2 requires some explanation. We have incorporated in the SFS/UNDP database several measures of food security, and in the months ahead will develop others. Three indices have been calculated, with single values for progressive five year periods, 1961-1965, 1966-1970, and so on. Food Security I (FS I) is the "Adequacy of Caloric Intake", or per capita caloric intake divided by 2,300 calories. The value of this index changes relatively less dramatically than others, and can fall close to 1.0 in food deficit countries. (If average per capita caloric intake is less than 2,300 calories, a significant number of people are no doubt suffering from chronic malnutrition).

Food Security II differs from FS I by incorporating the impact of average cereal yield variability in each five-year period; the greater the variability, other things equal, the less secure the food supply. Food Security III, shown in Figure 2, adds a further adjustment to FS II, for self-sufficiency in cereal production relative to cereal consumption. The higher the degree of self-sufficiency, the greater the upward adjustment in FS III relative to FS I or FS II.

Figure 1: Land Per Capita and Reliance on Imports - Botswana and Malawi

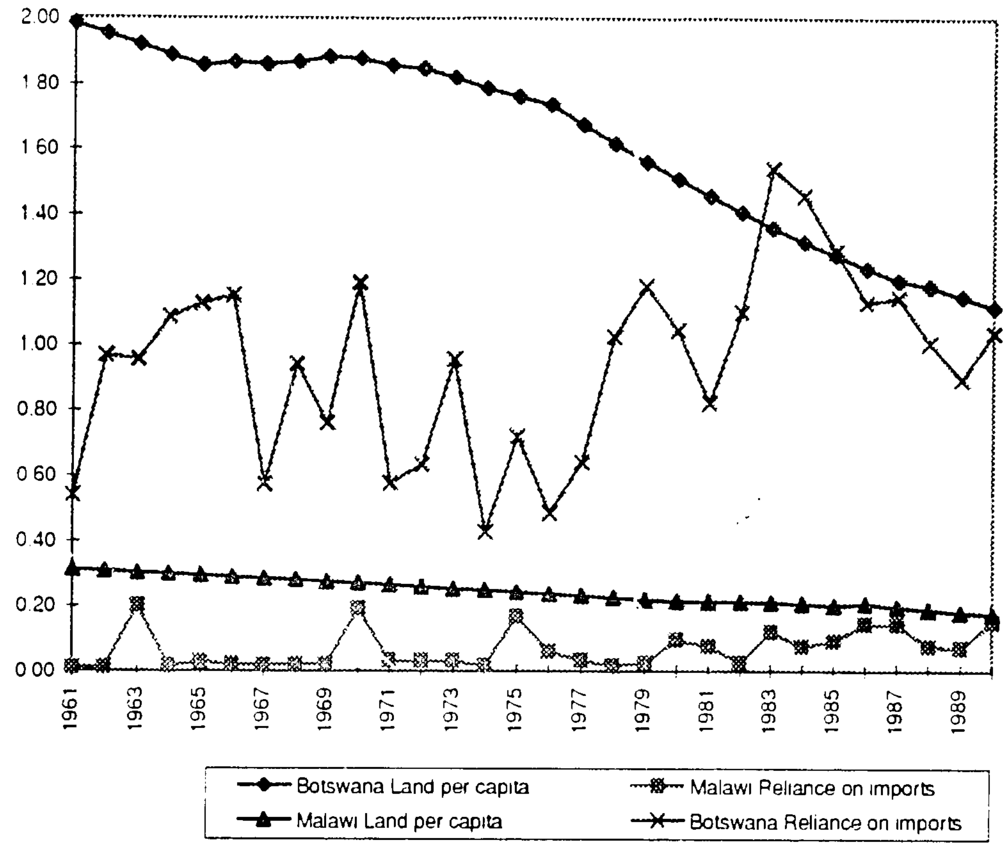
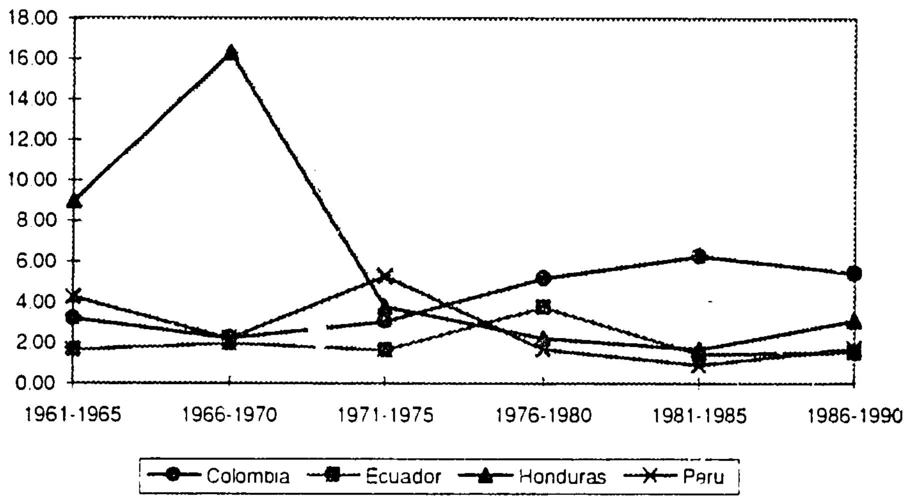


Figure 2: Food Security III - Colombia, Ecuador, Honduras, Peru



FS I, II, III are much simpler than either FAO's AHFSI or IFAD's food security index. Many other indices should be developed and studied. None is inherently right. We present the results of FS III in four Latin American countries to provide some perspective regarding the importance of two factors in the adjustment of FS I, the adequacy of caloric intake. The adjustment factors are cereal yield variability and self-sufficiency. All three food security measures are plotted for Ecuador in Figure 3, and for Indonesia in Figure 4.

Clearly in Ecuador, adjustment for cereal yield variability has a much bigger impact on food security index values than adjustment for self-sufficiency. Also, it is clear that the formulas underlying these indices accentuate excessively the importance of yield variability. When calculating ratios and percentages funny things can sometimes happen with data; much work is needed to develop the best ways to capture and understand trends in the data, and to array the data and indicators in ways that will help people study key relationships between different parameters.

Other indicators point toward a unique and powerful dynamic in Latin America -- growing reliance on imports for food energy and export crops for income. The use of chemical intensive technologies is on the rise; the volume of pesticide sales in Argentina grew 9.3% between 1992 and 1993, with expenditures rising even faster, 17.1% to $406 million. Colleagues in the field will need to collect more detailed data so that estimates can be made of the portion of pesticides applied to different crops, and for export crops. Other data will be needed to capture the benefits of agro-ecological approaches to crop production, such as the ratio over time of the value of crop production to expenditures on pesticides, or trends in crop yield variability.

ANALYTICAL STRATEGIES

One way to coax insights from SFS/SARD indicators is to compare countries that perform very differently despite many similarities. The linkage of poverty and food security is one of the most critical. Yet many relatively rich countries are struggling to feed their people, while some very poor countries seem to have found ways to sustain surprisingly high levels of food security.

Table 1A in IFAD's excellent 1992 report The State of World Rural Poverty ranks 114 countries according to their food security index values, as well as per capita GNP. A last column in this table shows the difference in rank between these two indices. Amazingly, in 11 countries there was a 50 or greater positive difference in rankings (food security ranking exceeding per capita GNP ranking by 50 or more). These are a set of relatively poor nations with reasonably secure food supplies. But in 6 countries, there was a 92 or greater negative difference in rankings -- countries where there is a huge gap between income and food security rankings.

Why? Answers could lead to important insights. The role of land tenure and distribution of wealth needs to be assessed; vulnerability to natural disasters (climate, pests, floods) that affect agricultural production is no doubt a factor, as is the level of pressure on land resources; reliance on export crops and levels of indebtedness may be important, as may various production, input, pricing, and trade policies.

Figure 3: Food Security I, II, III - Ecuador

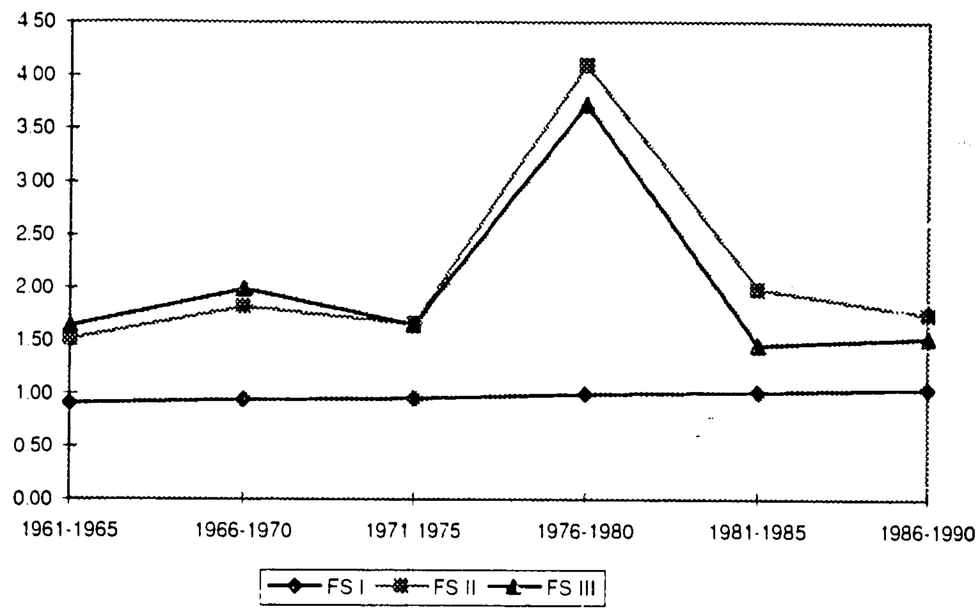
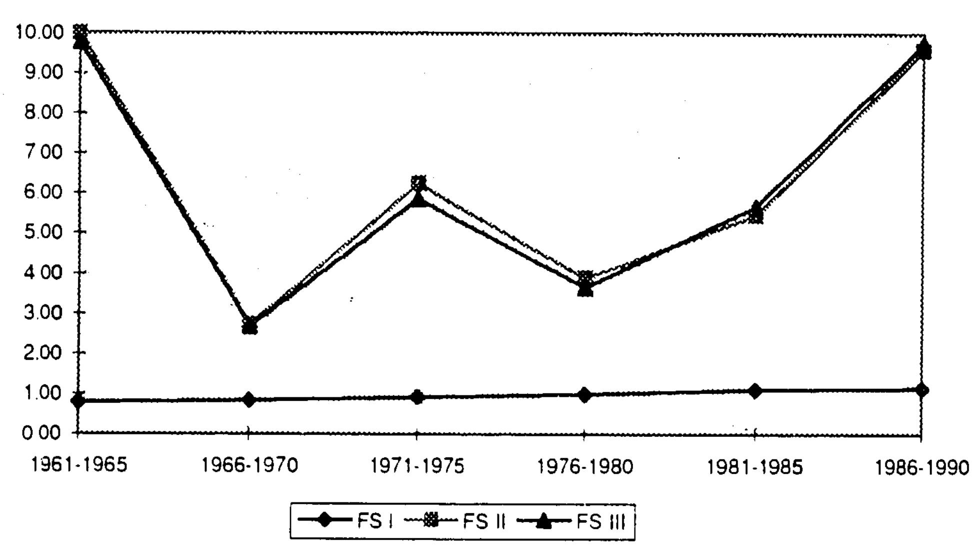


Figure 4: Food Security I, II, III - Indonesia



MONITORING TRENDS AND IDENTIFYING THRESHOLDS

Monitoring SFS/SARD indicators over time can serve as a part of an "early warning system". Each year as basic data-sets are updated, a standard set of indicators could be estimated for all countries. The focus should be on changes in trends and on countries that seem to be approaching critical values in certain parameters. There are, for example, threshold values for certain ratios -- people to land, fertilizer per acre, and the percentage of the rural poor who are landless. Above such threshold values food insecurity would be expected to rise.

Other, typically higher thresholds might serve as indicators of the prospect of civil unrest. One wonders whether the Chiapas uprising could have been foreseen, given the steady growth in the portion of land in the region controlled by large cattle ranches who drove peasants from land they had traditionally occupied. If we develop such thresholds, and through their application find a country approaching some precipice, will the development community have tools and resources to make a difference?

FAO, USAID and other agencies have developed a number of early warning systems and models which strive to detect food insecurity problems before they reach crisis proportions. Existing methods are designed principally to detect food production problems caused by pestilence, unrest, or climatic variability. But other factors are increasingly worrisome -- resistance to pesticides, exhaustion of soil fertility, the closing of markets, shortening of slash and burn cycles, the loss of genetic diversity, water quality degradation, and forced migration.

A broad set of indicators needs to be monitored annually, with statistical methods designed to highlight inflection points and recognize critical threshold values. Indicators can also be used to study the implications of various projects or policy reforms, such as a major dam project or an IMF structural adjustment program, or of a major change in knowledge, skills, and technology.

A WORLD FULL OF CHANGES

A recent report by FAO, Assessment of the Current World Food Security Situation and Recent Policy Developments (March, 1994), is full of important facts, insightful reviews of the impacts of policy changes, and insights, some gained from study of trends between 1988 and 1993 in the Aggregate Household Food Security Index (AHFSI). It also explains why food insecurity is going to remain a plague of mankind for decades, embracing more and more people despite steady global progress in many measures of food production and economic well-being.

Some findings in the report cry out for further analysis, with a focus on implications in the design and implementation of SARD projects:

- Staple food production -- major cereals, pulses, and roots and tubers -- declined 4% from 1992 to 1993; cereal production fell 4.4% in this period.

- The cereal harvest in Northern Africa dropped 7% in the last year, yet recovered dramatically in sub-Saharan Africa -- rising 21% over the drought-reduced 1992 level.

- In sub-Saharan Africa, despite recovery of aggregate production, localized shortages are acute in many areas.

· In 1991/1992, food aid accounted for 37% of the food imports to Low Income Food Deficit countries in Africa, more than double the global average for LIFDCs.

· Global food aid is projected to decline from about 15.1 million tons in 1992/1993 to 11.4 million in 1993/1994 -- a 25% drop in just 1 year! (Rwanda will no doubt have an impact on this estimate.)

· Food aid increased household food security by 12% to 18% in several African countries in recent years, and by as much as 24% in "critically low" food security nations (AHFS Index values of 65 or less). Even so, food aid was insufficient to raise any country's AHFS Index value from the "critically low" to "low" categories (AHFS Index values between 75 and 65).

· Between 1992 and 1993, per capita cereal production declined an average of 2.2% in 31 of 70 LIFD countries.

· The one-year decline exceeded 5% in 9 African LIFDCs.

· Between 1986/1987-1991/1992 per capita cereal production declined more than 5% in 20 LIFD countries in Africa.

· Total global inventories of cereal stocks down 14% by end of 1994 from 1993 levels (366 million tons to 316 million).

· Rice stocks down 12% -- third consecutive year of decline.

· Global cereal trade in 1993/1994 down 7% from 1992/1993; prices trending upward, especially for higher quality grades.

· Export price of U.S. maize up 26% in 1 year; long grain rice price up 73%; Thai 100 B grade rice price up 38%.

This FAO report is full of important examples of how policy changes in the developed world can whiplash the developing world. In 1993/1994 global coarse grain production dropped 80 million tons, or 9%. "Virtually all of the reduction was in the U.S." and was driven by a combination of bad weather and supply control policy. Ratification of the NAFTA agreement is expected to substantially alter the flow of foodstuffs into and out of Mexico, with implications throughout Central and Latin America. Political and social changes in Mexico, coupled with NAFTA, could thrust Mexican agriculture into a period of dramatic change. The stakes will be high on all sides of Mexico's borders.

Another example -- substantial increases in Japanese rice imports are pushing global rice trade volume to record levels and is placing strong upward pressure on prices and food aid stocks. Is the opening of the Japanese rice market temporary or permanent? Where will supplies come from? If from southeast Asia, what impact will increased exports have on household food security?

Lets not forget GATT in the context of food security needs in chronically food deficit nations. According to FAO --

"The projected consumption growth implies further growth in net imports from the developed countries, which may reach about 160 million tons in 2010. This would impose hardship on those developing countries which cannot easily finance increased food imports. It is, therefore, reasonable to foresee a continued role for food aid for a long time to come. It is in this context that the provisions made in the Final Act of the Uruguay Round, for attenuating the effects of an eventual rise in world market prices on the least developed and net food importing developing countries, and for creating conditions of food security stocks and continuation of food aid flows, assume particular importance."

CHANGING POLICIES

Worldwide there is a trend toward less government involvement in setting prices and subsidizing the cost of inputs, particularly fertilizers and pesticides, coupled with opening of markets. What will happen as a result? Will hoped-for environmental benefits follow?

Policy reform is leading to increased producer prices in several Asia countries -- the support price of wheat is up 20% in India, rice up 17%; wheat price up 11% in Pakistan. What will this do to access to land, fertilizer and pesticide use, and the ability of the poor to maintain caloric intake and dietary diversity?

To lessen environmental problems from continuous rice production and diversify diets and income sources, the Indonesian government is pursuing a broad-based diversification strategy. How effective will the various policy reforms be? Will the increasing price and demand for rice in Japan overwhelm other policy changes? How can indicators be used to monitor diversification's impacts on household food security and dependence on chemical inputs?

The Zimbabwe government has accelerated implementation of the Land Acquisition Act, which will provide small scale farmers 5 million hectares of land -- one-half the holdings of large commercial producers. Vietnam is now granting farmers much firmer long-term land tenure rights -- 20 year renewable leases for annual crops, and 50 years for perennial crops. What impact on sustainable food security will these significant changes in land tenure policy have? How can indicators be used to monitor consequences and draw lessons?

SPECIAL CHALLENGES

A major challenge of SARD indicator methodology is establishing the conceptual foundation for a hierarchy of indicators which accommodates diverse perspectives and analytical applications. An adequate conceptual foundation will assure that insights gained at one level promote greater insight and utility at other levels of analysis.

The conceptual foundation for such a hierarchy will include a set of scientific and statistical premises, concepts, and organizing principles which allow the accuracy of macro-level indicators to be tested and improved through insights gained from micro-level studies. In addition, insights gained at the macro-level regarding the interplay of policy, markets, trade and technology will help inform studies done at the field, community or landscape levels.

Micro-level indicators are needed to study factors shaping sustainability of agriculture and food industry activities in a community, village, or across a set of farms. Field level indicators will evolve from, and strive to capture much more complex relationships shaped by real world forces -- biological, physical, social, and economic. Assessment of interactions among these forces will be a special challenge at all levels of study.

Two areas will require special attention. Distributional and gender issues are fundamental to the concept of sustainable development, as are participatory approaches. Capturing these factors in indicators raises both process and methodological issues. Three areas will need special effort: gender/labor/income; level, consistency, and quality of diet; and, access to resources, especially land and animals.

Developing countries typically lack the resources to carry out rigorous statistical surveys large enough to get at gender and distributional issues. Special methods must be devised and tested. FAO incorporates one such method in its AHFSI in order to adjust per capita caloric consumption data to reflect spatial and temporary variability across households. This method needs to be studied by others, as does the nuts and bolts of IFAD's food security index. Comparable strategies will be needed to adjust other indicators. For example, the "pressure" indicator, arable land per farm family, needs to be adjusted, particularly in Latin America, by subtracting land controlled by plantation-scale operations growing crops for export. Adjusting this and other macro-level indicators to reflect reality in households and communities will require open dialogue, creativity, and patience.

Several other special and pressing issues were brought to the table by participants in the "Round I" conference and will be explored further during "Round II". A sample follows --

- Communities/landscapes where the preservation of biodiversity requires attention at the forest margin/agriculture interface.

Stabilizing land use in forest margins is critical to slowing movement into virgin forests. Special issues arise here -- land tenure, migration, watershed management, subsidies for logging/cattle ranching. Creative approaches are needed to measure/monitor these factors.

- Downstream impacts of agriculture in watersheds near urban centers and coastal fisheries, including public health, costs of services, and fishery productivity.

Indicators are needed at the watershed level to measure the bio-physical vulnerability or stability of a watershed, taking in the political, social and economic forces. Sometimes governments are forced to choose among competing industries, as now the case in Ecuador where adverse impacts of pesticides on larval shrimp have linked the interests of the banana industry and shrimp producers.

- Countries or sub-regions where structural adjustment and/or trade flows have forced or may force changes affecting food security and/or agricultural sustainability.

Indicators must be developed to capture the consequences of loan packages, policy changes and regional or international trade agreements on regional production patterns, terms of trade, biological diversity and food security, reliance on external inputs, and income shares and levels across social groups.

- Pest management systems and reducing pesticide related environmental and human health effects.

Pest management systems are a "leading indicator" of whether a farming system is moving toward a sustainable, biologically based pattern of land use and agronomic practices. Any farming system/region where pesticide/fertilizer inputs have risen steadily over the years in volume and cost per unit of output will be difficult to sustain biologically or economically. Pesticide/fertilizer input measures must also be correlated with other measures to explore relationships between input use and overall patterns of production, trade, income and resource distribution.

SUMMARY

The world is growing smaller and the pace of change accelerating. Development institutions struggle to keep up with political upheavals and policy reforms. Ethnic and civil strife drive home how vulnerable people really are, and how difficult and costly crisis intervention is. Perhaps in a few years that is all the development community will be able to handle. If so, we will move closer to free-fall down a long, slippery slope.

Ways are needed to detect where problems are most likely to arise and the best way to avoid them while there is still time to act thoughtfully. Sustainable food security is an outcome of a series of choices. No country or region, or institution is in complete control of its food security destiny.

A collective partnership to develop and apply SFS/SARD indicators is one way to bring people together in order to define a common path toward SARD. We need a path that will be embraced with equal enthusiasm and creativity by people and politicians, donors and institutions, and above all, a path open to all.

Indicators Linking National Policy and Local Sustainability: Approaches by the USAID Agricultural Policy Analysis Project (APAP)

David Wilcock[1] and Richard English[2]

Indeed, agricultural sustainability -- though broadly recognized as important -- is given little weight in economic policy making. No commonly employed indicators measure it, no accepted conventions value it and no widely accepted definition describes it. If agricultural sustainability is considered at all, it is an afterthought (Faeth, 1993, p.1)

INTRODUCTION

The Agricultural Policy Analysis Project III (in its 11th year of operation)[1] is pleased to be participating in this conference on "Indicators of Sustainability." The purpose of this paper is four-fold:

- To examine the question of indicators of sustainability in the context of the project's mission of providing policy analytical and training services to USAID (United States Agency for International Development) field missions and the national governments with whom they work and to central bureaus of USAID/Washington;

- To review work conducted in the previous five years of APAP II that is relevant to the relationship between national agricultural policy and the sustainability of natural resources and man-made production systems at the sub-national level;

- To indicate likely directions for APAP III work on sustainability in the next few years; and

- To participate in the methodological debate on how to devise useful, operational indicators that can be used by USAID and cooperating national governments in the promotion of sustainable agroecological and socio-economic systems at the sub-national level (local, watershed, river basin, etc.).

DEFINITIONS OF SUSTAINABILITY

In 1987, the World Commission on Environment and Development highlighted natural limits to world-wide trends in resource utilization and called for an alternative developmental strategy that "sustained human progress not in just a few places for a few years, but for the entire planet into the distant future." The Commission's Bruntland Report defined this sustainable development as one that "meets the needs of the present without compromising the ability of future generations to meet their own needs." The Bruntland report articulated the growing realization among the governments of the economically developed world that present levels of per capita natural resource consumption "cannot possibly be generalizable to all currently living people, much less future generations, without liquidating the natural capital on which economic activity depends" (Goodland, 1993, p.1). Since

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[2]Sustainable, Water, Agriculture and Resource Management Group, Development Alternatives, Inc.

then, donor agencies, international NGOs, development professionals and developing country governments alike have been attempting to quantify and operationalize the concept of sustainable development in an effort to formulate more environmentally sound and socially equitable development strategies.

There is considerable debate over what constitutes "sustainable development."[2] This debate was brought sharply into focus by the recent SANREM/CRSP electronic conference on Indicators of Sustainability. In his summary of the proceedings, Bob Hart notes that approaches to sustainability and the methods for measuring sustainability will vary depending on both what an agency or institution deems in need of being sustained and the perspective (e.g., macroeconomic, community development or farm production system) that analysts apply to the subject (Hart, 1994, p. 3).

As we will describe in more detail below, the perspective of the USAID APAP project is agriculture and natural resource policy analysis with the aim of strengthening the capacity of donor and host government development institutions to formulate and implement rational and coherent policy. It is useful here to briefly review the sustainability literature, to suggest the approach(s) to sustainability that APAP might embrace and to begin to suggest the types of indicators that would demonstrate and monitor the impact of national policy on local-level sustainability.

The approaches that are used to define sustainability in the current literature can be grouped in the following four categories. This categorization is by no means definitive, nor are the approaches categorized exclusive; the approaches are, in fact, interdependent.

Environmental emphasizes the biophysical dimensions of sustainability and the interrelated nature of human and natural ecosystems. This approach stresses the productive use of natural resources such as soil, groundwater, biomass and species diversity in ways that do not deplete, contaminate or otherwise degrade the usefulness of these resources for present and future generations (WRI, 1992, p.2);

Economic emphasizes natural resources as capital goods that provide a flow of economic benefits over time. This approach recognizes that economic activities can lead to the degradation of biophysical resources and that this degradation must be taken into account and alleviated if future generations are to have the same or higher levels of welfare as the present generation (WRI, 1992, p. 99; Schuh and Archibald, 1994, p. 18);

Social emphasizes the human dimensions of sustainability and the importance of widespread public participation in the management of natural resources to promote the equitable access to, and use of, those resources. This approach holds a stable population, universal education, opportunity for employment, universal health and reproductive care and the establishment of gender equality as prerequisites to equitable development (WRI, 1992, pp. 3, 5-6; WRI, 1994, p. 43); and

Technological emphasizes efficiency in productive processes that minimizes nonrenewable consumption of energy and natural resources. This approach advocates the rapid introduction of "clean" technology to developing countries to prevent the degradation and depletion of resources and promote improvements in production (e.g., biotechnological advances in food production) and processing of economic goods.

Underlying all these definitions is the concern that formal and informal institutions and policies that govern the transfers of assets to future generations are adequate to ensure basic standards of human welfare in the long run (Norgaard, 1993, p. 3).

As we noted above, the focus of APAP is agricultural policy. So let us turn the discussion from sustainable development to a set of its essential components, *sustainable agriculture*. Sustainable agriculture has its own array of definitions, but these are perhaps best summarized by Luther Tweeten:

> *Sustainable agriculture emphasizes natural resource conservation and the prudent use of synthetic chemicals to ensure safe and adequate supplies of food and water for the well being of both current and future generations. Sustainable agriculture envisages agriculture as part of an interdependent farm, agroecological, institutional and socio-cultural system (Tweeten, 1993, p. 34).*

The concern among donors, development agencies and host governments for agricultural sustainability is linked to the desire to promote food security and improve the welfare of rural populations to come. The main tools of sustainable agriculture are policy and agrarian reform, public participation, income diversification, land conservation and improved management of inputs (UNCED, 1992, pp. 2-3). From the perspective of policy reform, analysts are concerned with the impact that monetary and fiscal policy, agricultural input subsidies, agricultural trade barriers, output pricing, land tenure, natural resource management policy and socio-economic equity all have on the transfer and application of sustainable agricultural technology and practices.

For the purpose of this discussion, we concentrate on two dimensions of agricultural sustainability as defined by Tweeten: the farm production system and the agroecological system.

Sustainability at the farm production level is determined by prices, the technologies available to farmers and the impact of these technologies on the natural resource base. Technologies generally include practices to control pests and weeds, to manage and maintain soil fertility and soil moisture and other means of resource conservation. In a given agro-economic context, farmers may employ one set of production technologies to maximize profits from the land over the short-run. In another context, farmers may accept some limitations on short-run profits to ensure longer-run productivity of their farms and the natural resource base on which that productivity depends. In the U.S., practices aimed at promoting longer-run resource conservation more recently have been termed "environmentally sound agriculture" (Tweeten, 1992) or "alternative agriculture," but major government-sponsored programs, particularly in the area of soil conservation, have been operating for 60 years since the "dust bowl" era.[3]

Sustainability at the level of the agroecosystem is linked to concerns for the health and regenerative capacity of the air, water, soil, forest and climate that supports food production. From the national/regional perspective to the perspective of the family farm, the impact of poor resource management are well known. These include: *soil erosion and loss of soil fertility* from overgrazing and inappropriate cultivation practices; *soil waterlogging and salinity* from excessive application of irrigation water; *contamination of food and water supplies* from the unmanaged application of agrochemicals, animal waste and saline soils; *deforestation* from the overharvesting of food, fuelwood and fodder as well as clearing for farm land; and *loss of biodiversity* from increases in land-use intensity and static farm production regimes that tend toward monoculture.

MODELS, CASUAL RELATIONSHIPS AND INDICATORS OF SUSTAINABILITY

For the purposes of this paper, we will introduce our discussion of indicators through the use of a simple conceptual framework represented in Figure 1. Essentially we are interested in how:

(1) Basic resource endowments, supply and demand conditions (prices), institutional factors, the range of production/marketing technologies available and specific politically-determined policies affect

(2) The behavior (or conduct or practices) of farmers, foresters, fishermen and others who use the natural resource base to produce a range of marketable (or consumable) products which, in turn, affects

(3) The state (health, sustainability) of the natural resource base.

In this "model" we are essentially looking at the relationship among national level policies (laws, investment programs, etc.), prices, behavior in resource use and the state or "health" of the natural resource base (these are the core relationships for us - they are represented more prominently in Figure 1). However, we also emphasize that the context within which these core relationships exist varies dramatically from country to country. Among the most difficult country circumstances to deal with are when great material poverty combines with natural scarcity (shortage of land, for example) to put enormous pressure on the use of that scarce resource. The reader will also notice the following:

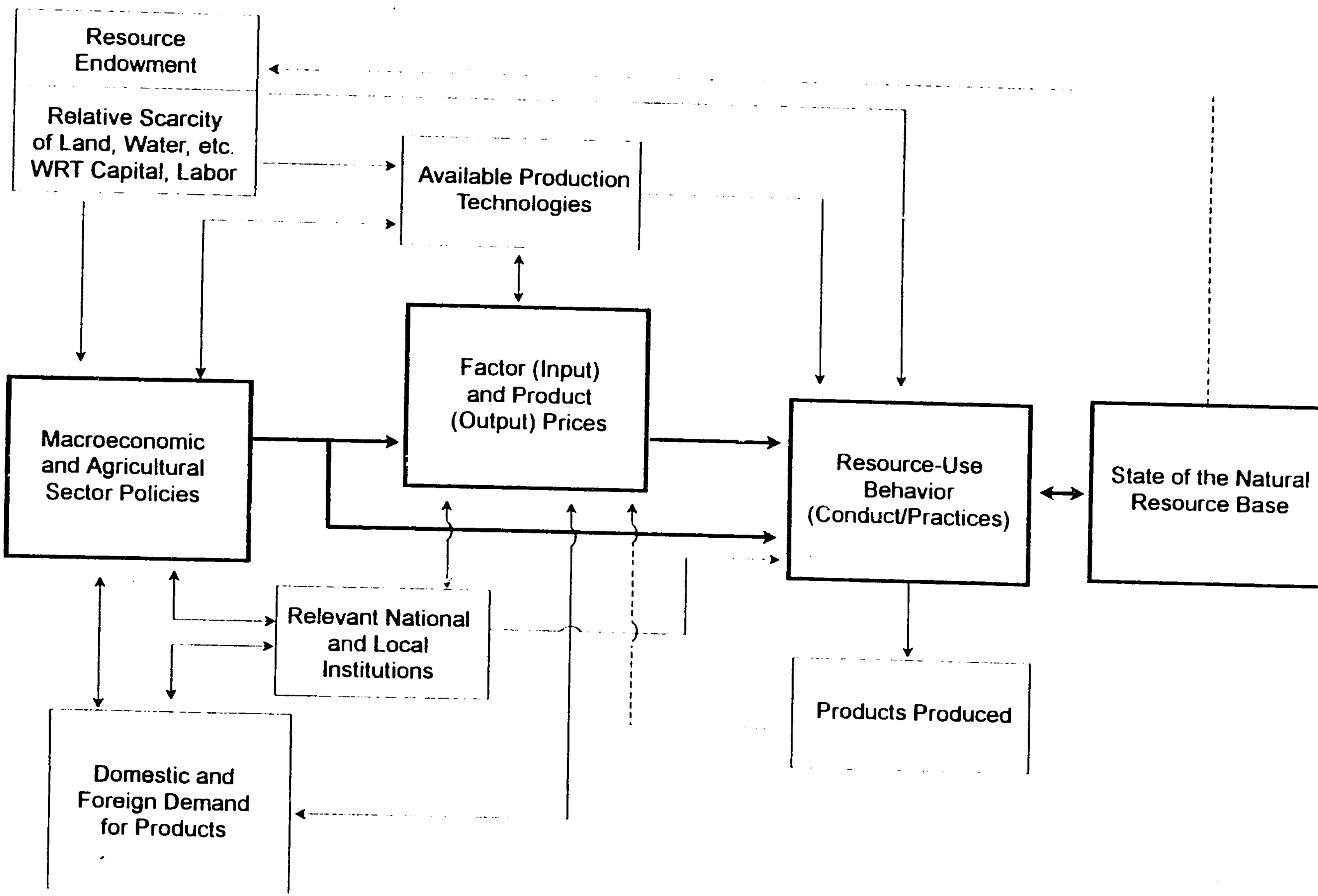
- The arrows in our model imply dynamic processes (with feedback loops) rather than static relationships;

- The heads of arrows imply potential causal relationships, but we ignore all the practical difficulties in determining causality;

- In violation of standard practice in economics, we have not "collapsed" all of these relationships to supply and demand relationships since that would leave us with only two indicators, price and quantity.

In our simple conceptual framework we can talk about indicators in all dimensions of the implied relationships - baseline conditions, in policies and related institutions, in producer behavior and in the measurement of the state of the resource base. Some indicators may be binary in nature (presence or absence of a particular technology), ordinal (a continuum of weak to strong forest protection laws) or fully quantifiable (tons of soils lost to the average hectare of cultivated hillside, income, yields, etc.) In addition to knowing whether the natural resource "problem" is being "solved," we are also interested in the measurement of change in the behavioral relationships and

Figure 1: Policy, Prices, Resource-Use Behavior and Other Factors Affecting Agro-Ecological Sustainability



how well we understand those relationships. The more the relationships become formalized into a mathematical model, the more "indicators" simply become "measured variables."

As the title of this paper indicates, we are interested in the relationships between national policies and the socio-economic and natural resource sustainability of alternative systems for using natural resources at the local level. For certain natural resource problems, national policies are central to finding solutions; in others, they are marginal or totally unimportant. Getting "policies right" (or "prices right") is not always the answer to every problem. But it is right often enough to justify systematic consideration in the context of efforts by multidisciplinary teams.

The list of the types of policies that, over different time frames, can have a substantial impact on the use of natural resources, is a long one. Attempts to develop taxonomies of the universe of relevant policies are inherently arbitrary, but the results are useful in conveying the wide range of what might be covered. Johnston, in the first draft of *The Green Book* (APAP II No. 406)[4], provided an analysis of relevant policies in the following categories:

Social:
- Macroeconomic
- Population
- Indigenous Peoples
- Labor

Resources:
- Land Tenure and Use
- Water and Watershed Management
- Energy
- Environment

Agriculture:
- Crop Agriculture and Livestock
- Forest Management
- Coastal Zone Management
- Protected Areas and Wildlife

The policies that often have been given the greatest attention by development economists (as evidenced by their prominence in many structural and sectoral adjustment reform programs)[5] are those that fall under the macro and crop agriculture categories. These include:

Macroeconomic:
- Monetary policies (money supply, interest rates)
- Credit policies
- Tariff and trade policies
- Exchange rate policies
- Export promotion polices
- Fiscal management (including debt financing and debt-for nature)

Crop Agriculture and Livestock:
- Product pricing controls and supports
- Input subsidies (credit, chemicals, machinery) and price controls
- Direct government marketing of inputs and products
- Regulation of pesticide and herbicide use
- Livestock policies, price controls and government services

Whether specific policies are an important part of a perceived unsustainable resource use problem must be determined on a country-by-country basis. For example, in Morocco analysts have recently become concerned with the degradation of fragile rangeland soils due to an expansion of dryland cereals production. There are rangelands that are often only used for seasonal livestock grazing which are very important to Morocco's landless rural workers of farmers to expand into marginal areas. These high, stable prices are due to a combination of policies - high, state-controlled domestic cereal prices, government control and subsidy of marketing costs and corresponding high rates of tariff protection against imported cereals. While contributing to meeting a stated government of Morocco objective of greater cereals self-sufficiency, cereals production is most likely not a sustainable use of the more marginal pasture lands and may not be sustainable from a political economy point of view due to excessively high consumer prices. Changing this interrelated set of policies would have a significant impact on reducing pressure on some of the country's most fragile agriculture lands.[6]

OBJECTIVES OF USAID APAP AND THE NEEDS OF ITS CLIENTELE

As stated in the USAID project design document (the "project paper"), the APAP III project is intended to provide support to USAID missions and their host-country organizational counterparts (governmental and otherwise) to achieve the following "project purpose":

> The purpose of APAP III is to assist host-country decision makers in identifying issues and resolving problems concerning agricultural policy, especially issues relating to market performance, equity and agricultural/environmental sustainability (USAID, 1993, p. 13).

More generally, USAID is putting major emphasis on assuring that the activities it funds in LDCs will contribute to "sustainable development characterized by economic and social growth that does not exhaust the resources of a host country" and that "enlarges the range of freedom and opportunity, not only day-to-day, but generation-to-generation" (USAID, 1994, p. 4). USAID is also an organization that, for at least the past twenty years, has formally required that all of its projects develop objective measures or indicators of projects meeting their stated objectives and goals, although these objectives have not always included sustainable human and ecological systems. It indicates that it will meet these high standards through "integrated country strategies" developed in "close cooperation with host governments, local communities and other donors" (USAID, 1994, p. 6). The current strategy document goes on to more detail on how the overall sustainable development objectives will be accomplished in the program areas (referred to as the "new four pillars") of:

Environmental Protection;

Building Democracy;

Stabilizing World Population Growth and Protecting Human Health;

Encouraging Broad-Based Economic Growth.[7]

In operational terms, the primary clientele of the APAP III project are USAID country resident missions and the national governments with whom the missions work and the AID central bureaus in Washington. The needs of that clientele concerning natural resource management issues and particularly the relationship between national policy and sustainable agriculture at the local level, involve the sequence of steps involved in problem identification and remediation:

· **Identification** of issues and problems in production systems that involve the utilization of the country's natural resource base;

· Country-specific **enumeration** of macroeconomic and sectoral policies involved in the identified problems and **diagnosis** of the nature of the causal relationships between existing policies and institutions, as well as the specific resource-use behavior that is giving rise to the identified problem. To be effective, this step must employ, to the maximum extent possible, tne **participation of all groups with a significant stake** in the problem (stakeholders). As is well known, this is not always easy for host governments to do on their own;

· **Analysis** of available information and design of **remediation strategies** at the appropriate geopolitical level and specific **projects** (often experimental or pilot projects) to implement those strategies;

· Implementation of project activities, including systems to **monitor and evaluate** progress in meeting remediation and sustainability objectives.

The needs of a given country, with respect to the steps above, obviously depend on "environmental consciousness," the extent of previous work in issue identification, problem analysis and past attempts at finding operational solutions. We can either start from the beginning or join the process somewhere in the middle.

Indicators of sustainability become relevant at different points in the analysis of the causes of problems and in the design, implementation and monitoring of solutions. Since we are looking at indicators in a process that may alter the streams of resulting economic benefits for the different groups involved, the indicators inevitably have a strong political content, regardless of their scientific objectivity or precision. Thus, one of the key operative questions becomes, "**whose indicators count?**"

It is within this context that we will examine previous APAP work on policy and sustainable agriculture and begin to define the types of activities that can be undertaken by the project in the next several years.

WORK TO DATE ON AGRO-ECOLOGICAL SUSTAINABILITY ISSUES BY APAP PARTNERS

Even though it was originally not one of the declared themes of APAP II (1988-93), the project did a substantial mount of work in the development of applied methodologies for the assessment and analysis of agricultural and macroeconomic policies most directly affecting natural resource utilization. In this section we review this work and its implications for indicator development.[8]

NATURAL RESOURCE POLICY INVENTORIES IN LATIN AMERICA

Between 1989 and 1992, APAP II conducted a series of natural resource policy inventories in six Latin American countries: Belize, Honduras, El Salvador, Costa Rica, the Dominican Republic and Guatemala.[9] The policy inventories were seen as a first step in understanding the existing policy environment and the political, economic and social context that circumscribes and determines natural resource management in the countries of the region. To provide this essential background information, the policy inventory entailed a set of standard tasks:

· Identifying all policies and laws from both the public and private sectors at the regional, macroeconomic and local levels which affect natural resources (including those pertaining to the economy, commerce, agriculture, forestry, energy, industry, etc.);

· Identifying institutions and agencies (both governmental and non-governmental) that create and implement such policies;

· Conducting a qualitative assessment of the impacts of each policy on economic growth and the natural resource base in both the short- and long-run; and

· Analyzing the interactions of these policies, discussing significant gaps in the current policy set and determining principal policy alternatives for a policy agenda.[10]

In terms of the "natural resources scope" of these inventories, five broad subject areas were covered in each:

· Sustainable agriculture;

· Forest production;

· Management of water resources (including watershed management policies);

· Management of wild lands and biodiversity; and

· Management of coastal and marine resources (included under water resources in some inventories).

The inventories themselves employed a fairly standard format across countries that included the following components:

· An overview of the main **natural resource issues**;

· An analysis of the national **policy environment**, including political, economic and socio-cultural factors (includes asset distribution and access factors as well);

· A description of the main **institutions** and their interactions affecting natural resource use and management (across the subject areas such as sustainable agriculture) and questions of institutional coordination across policy issues;

· An assessment of the key **natural resource policies** (including international and regional agreements, macroeconomic, sectoral and subsectoral policies; and

· An identification of major areas for **future research**.

The main purpose of this sort of inventory or action plan is to establish a baseline for policy analysis. The natural resource problems and issues in a given country must be first assessed at a general level so that they can be put into some priority ranking. If this has been done and there is a sufficient degree of national consensus that something should be done about a certain number of natural resource problems, then it is possible to move on to more specific kinds of actions.

GENERAL APPROACHES TO POLICY AND SUSTAINABILITY ISSUES

After the completion of the six country natural resource policy inventories, an APAP II team worked on developing a series of cross-cutting summary lessons from these experiences. This resulted in a publication in two parts entitled *The Green Book*. The first part (APAP II No. 406) summarized and analyzed the wide range of policies that directly affect natural resource use in the six countries. The standardized analysis considered the "likely impacts" of making improvements in a given type of agricultural policy (such as the pricing of irrigation water) on output growth, welfare and resource conservation.

The second part (APAP II No. 407) was a "Manual for Conducting a Natural Resource Policy Inventory" that was based on the lessons from having done this in six countries. Of particular importance were two aspects. One is the approach to the inventory in five steps:

- Problem identification
- Policy identification
- Institution and stakeholder identification
- Policy assessment (including direct impacts and interactions among policies)
- Identification of policy alternatives and research priorities

The second important contribution is the authors' insistence on looking at the inventory as a process and one that would be proportionally strengthened (both qualitatively and in terms of political ownership) by encouraging maximum stakeholder participation.

The material in these two volumes has been further developed and substantially revised. The revised version of *The Green Book* (in three volumes), available from Abt Associates, is even more focused on the process of conducting an inventory and how the results can be used to construct a participatory action agenda for change.

METHODS: USE OF THE POLICY ANALYSIS MATRIX AND COST BENEFIT ANALYSIS

The third area in which APAP has undertaken work on natural resource sustainability has been in analytical methods. Two papers were written under contract to APAP II in 1991. In the first, Corry and Monke explored using the Policy Analysis Matrix (PAM) for evaluation of options concerning policies that affect natural resources utilization (APAP II No. 334).

The heart of the PAM method are commodity-specific, input-output process budgets, generally constructed at the farm level. Two matrices of input and product prices are then elaborated. The first matrix contains current prices paid and received by farmers and marketers (called "private prices"). The second matrix is composed of "social prices" which involve the valuation of input and product prices at their "social value" which may vary from current nominal levels. The input-output relationships in the farm budgets are multiplied by the two sets of prices, allowing the analyst to compare individual profitability with social profitability.

In applications of the PAM to date, the social value has involved correcting current prices to account for potential distortions introduced by subsidies, restrictive marketing and import policies, etc. Analysts have emphasized correcting the valuation of internationally tradable commodities, with the implicit assumption that the international (or world market) price is more appropriate (or less distorted) than the current price. However, it is also possible to alter the current price matrix to more completely represent resource values. This can involve using higher prices for some inputs (e.g., irrigation water priced at its real value or fertilizer prices stripped of their subsidies). A second method of changing the results of the PAM analysis is to change the technologies embodied in the process budgets to ones that use a different input mix or different relationship with the natural resource base to produce a given output.

As in other economic approaches, the key task is the process of deriving alternative values (prices) for inputs and outputs from the production process. When the natural resource base is taken explicitly into consideration, the task becomes one of deriving present values that represent the discounted future value of a resource entering into the production process now.

In the second, Pagiola elaborated an approach by which the PAM method could be combined with more standard cost-benefit analysis, again to examine options between pairs of policy choices (APAP II No. 336). These statements of theoretical use of the PAM were followed by an excellent application of the method to assessing the trade-offs in alternative stocking rates for both cattle and wildlife on Zimbabwe ranches (APAP II No. 362). A time dimension (future value of resources) was effectively built into the analysis by replacing some prices with net present values.

In addition, great emphasis has been placed in APAP training work in making the PAM easy to understand, to apply to real world problems and to explain to non-economist decision makers. Gotch and colleagues at the Food Research Institute at Stanford University have developed a hands-on, computerized, agricultural and natural resources policy analysis training program (APAP II No. 12) that could be easily modified to treat natural resource sustainability issues. At this point, the PAM can be more easily used than other approaches, such as the more comprehensive "total welfare" approach suggested by Schuh and Archibald (1994). We note, with great interest, the incorporation of the PAM into the set of analytical tools in the FAO K2 methodology (Maetz, 1994, see also Tschirley, this volume) and its "sustainability module." The challenge for any of these approaches is to move now to operational testing at the country level.

INDICATORS OF SUSTAINABILITY IN PAST APAP WORK

We have seen that APAP's work on natural resource sustainability questions to date has largely been at the inventory/diagnostic stage with some additional work done preparing analytical tools that can easily be adapted to work on real world problems (e.g., at the assessment stage). The project, like other organizations, has contributed to a heightened awareness of the importance of agroecological sustainability and helped spell out some of the key causal relationships that underlie what are considered to be unsustainable resource use practices in specific countries.

The APAP II natural resource policy inventories, when identifying key problem areas, have identified indicators at the policy and behavioral levels (to use our conceptual framework in Figure 1) which are strongly associated with resource use patterns that have been identified as non-sustainable. The identification of a non-sustainable natural resource use problem, in itself, involves the use of some type of indicator or group of indicators, however "impressionistic" or "seat-of-the-pants," that showed that country X's forests were disappearing at an alarming rate or that soils in a given region were now too poor to produce crops formerly grown, etc.

As field projects or activities, sponsored by AID and other donor groups or by concerned stakeholders themselves, increase in number, it is time to focus on specific field situations like those being monitored by the SANREM project. This implies that some indicators will be made more concrete, will be measured and will be used to address the success of actions undertaken (for remediation or otherwise).

FUTURE DIRECTIONS

When Indicators Are Needed: Serving the Current and Future Needs of APAP Clients and Contributing to an Evolving Methodology

With the exception of having some say over its relatively limited core funding, APAP is a demand-driven project. Its agenda of activities is largely determined by the expressed needs of its primary clients, host country governments and USAID field missions. Thus, in this section we spell out a potential set of activities which may fit the funding priorities of a number of the mission programs or which may be pursued with the project's core funds. There is much work to be done in building more sustainable agroecological and socio-economic systems in countries around the world.

As we indicated above, the first steps in examining the relationship between national policy and the sustainability of local production and resource-use systems is to promote an official awareness of the sustainability issues. Once the national political process has determined its most serious natural resource sustainability problems, efforts to more carefully diagnose and measure critical system interactions can begin. This process has been under way over the past decade as many countries have undertaken resource inventories and produced "environmental profiles," "national conservation strategies" and "environmental action plans" (Turstall and Van der Wanson, 1992). Indicators become important as projects focus on specific problems, either in the design or the implementation of projects.

From a donor point of view, we are at the beginning of the implementation phase. USAID is in the midst of implementing projects that are concerned with the relationship between national policy and agroecological sustainbility in Honduras (the PROMESA Project) in the Gambia and in Madagascar (the KEPEM Project) among others. A number of countries are beginning to implement projects as part of their Environmental Action Plans. Indicators of performance and impact on the natural resource base are critical.

OPTIONS FOR FUTURE APAP III WORK IN POLICY AND AGROECOLOGICAL SUSTAINABILITY

APAP III, over the next several years, has a number of good opportunities to participate actively in work focused on the relationship between national policy and local sustainability. These will come in the following four areas:

Problem Diagnoses and Policy Inventories: APAP III collaborators are ready to do this kind of work, particularly in countries where this has not been done recently or where it has not been done in a manner useful to USAID missions and national governments they work with. This would undoubtedly involve use of the new version of *The Green Book*, where the main task involves working with local stakeholders to convert the general statements in the source book (Volume 1) into statements that apply specifically to that country. Our comparative advantage is in the analysis of policy and how policies affect production and resource use at the field level. There would seem to be good opportunities to undertake this work in several subregions in Africa. We would welcome collaboration with technical scientists better equipped to deal with the complexities of physical processes. In some countries there is still substantial need for the use of these exercises as part of overall environmental "consciousness raising." *The Green Book* approach has proven to be a very useful participatory approach towards this end.[11]

Analysis and Modeling Efforts: Once basic inventories and problem identification have been completed, there are substantial opportunities to work with host country personnel (generally in ministries, universities or other specialized agencies) to undertake the field research needed to begin to systematically analyze the policy/resource use relationship. The tool that we feel shows particular promise to use initially is the **Policy Analysis Matrix** (PAM) methodology. This will require some supplementary efforts to effectively incorporate "correct" resource pricing (pricing that helps ensure that the next generation of resource users has equivalent access to the resource in question) into the analytical method. We are also eager to work collaboratively with other organizations on this applied research. For example, some of the university partners in APAP III would be good "beta sites" to give the FAO's K2 modeling system rigorous field testing and to assist in the design of improvements. It is critical that this analytical work be done in continual collaboration with scientists and analysts from the host country in order to ensure maximum training of local personnel and development of institutional capabilities.

Technical Assistance in Project Design and Implementation: Through its capability to enter into "buy-in" contracting arrangements with USAID Missions, APAP III personnel are available to assist in the design of projects looking at the policy/resource use relationship. In addition, it can provide short-term assistance to existing projects or special mission efforts to develop measurable indicators of sustainability. For certain problem areas, it is vital to develop these indicators and employ them in a baseline assessment so that remediation efforts can be scientifically monitored. There would be two broad subject matter areas where this type of assistance can be undertaken: (a) looking at the relationships between macroeconomic policies and natural resource use in the agricultural sector (example: exchange rate policy reform, changing patterns of crop and livestock profitability and changing patterns of soil erosion and fertility decline in the CFA countries of West Africa) or (b) looking at a narrower set of relationships between specific agricultural policies and the natural resource base (see the Morocco example above on page 5).

Methodologies for Resource Valuation: As we discussed above, putting resource use questions into an economic analysis framework often involves deriving prices where markets are not well established or where they generally fail to adequately capture notions of a discounted value for the future use of that stock of resources. The valuation problem is a complex one, often with technical or scientific dimensions. The likely approach of APAP III would be to undertake a core project of "intelligent borrowing" that would gather and digest this specialized technical work (a very good example is Lal. 1994) and put it in a form more easily accessible to those who have to use it in their explorations of alternative price structures for today's resource use in agricultural production. The resulting product might be a "Natural Resource Valuation Handbook" (geared to economists and other social scientists) to be published in the project's methods and guidelines series.

At the aggregate level, a related national policy question is the explicit incorporation of use rates of renewable and nonrenewable resources into national income accounting. Efforts in this direction can certainly help in building greater awareness of the connection between the health of the natural resource base and longer-run national prosperity.

ENDNOTES

1. AP III is funded by USAID's Bureau for Global Programs, Field Support and Research (the "Global Bureau"). The prime contractor is Abt Associates of Bethesda, Maryland. The authors of this paper are employees of Development Alternatives, Inc., one of the core subcontractors in project implementation.

2. Pezzey (1992, pp. 55-62) provides a list of 60 definitions from his review of the literature.

3. Many of the practices that comprise alternative agriculture (see below) are widely employed by subsistence farmers throughout the world. These practices are *alternative* to practices that have become conventional in the commercial agriculture of the developed world (e.g., the heavy reliance on agrochemical inputs and mechanized farming) and, to some extent, to developing countries that have adopted the "Green Revolution" technology to boost food production.

World Resources Institute (1992, p. 100) defines alternative agriculture as "practices such as crop rotation, reduced tillage or no-tillage, mechanical/biological weed control, integration of livestock with crops, reduced use or no use of chemical fertilizers and pesticides, integrated pest management and provision of nutrients from various organic sources (animal manure, legumes).

The National Research Council (1992, p. 27) defines alternative agriculture is any system of food or fiber production that:

- Systematically incorporates natural processes, such as nutrient cycles, nitrogen fixation and pest-predator relationships, into the agricultural production process;

- Reduces the use of chemicals and fertilizers with the greatest potential to harm the environment or the health of farmers and consumers;

- Makes greater use of the biological and genetic potential of plant and animal species;

- Improves the match between cropping patterns and the productive potential and physical limitations of agricultural lands in order to ensure the long-term sustainability of current production levels; and

- Emphasizes improved farm management and conservation of soil, water, energy and biological resources.

4. APAP II publications are listed in the bibliography by their publication number rather than by author.

5. In terms of indicators, the World Bank's recent analysis of the relationship between policy reform and national economic performance in 29 countries (World Bank, 1994), offers an interesting methodological discussion of attempting to measure "sound macroeconomic policy" in a comparable manner.

6. It is of interest to note that although USAID and the World Bank have been funding cereals policy reform work in Morocco for the past ten years, consideration of the negative environmental impact of these reforms has only recently entered into the process of "policy dialogue" with the government of Morocco.

7. In order to achieve these objectives more efficiently, AID has recently reorganized many of its development personnel into a "global issues bureau" whose main subdivisions ("centers of excellence")

reflect the above four main program areas. (In the new AID structures, projects supporting agriculture and agricultural policy -- such as APAP and the SANREM CRSP -- come under the Office for Agricultural and Food Security in the "Center for Economic Growth").

8. APAP II also conducted six field studies focusing on investment policy toward irrigated agriculture.

9. This work was conducted under funding provided by the USAID/ROCAP Regional Environmental and Natural Resources Management (RENARM) Project.

10. From the common preface to all the country inventories.

11. A computer-based pedagogical tool that also looks to be very promising in terms of environmental consciousness-raising is ECOZONE, a Windows-based environmental training program that focuses on the relationships between national policies and local consequences. This program is in the final stages of development by the Training Section of the FAO Policy Analysis Division of FAO/Rome.

12. These documents may be purchased for the cost of reproduction from the APAP III, Abt Associates, Inc., Suite 600, 4800 Montgomery Lane, Bethesda, MD 20814 (Tel: 301-913-0500).

13. A totally revised and expanded version of "*The Green Book*" is scheduled to be available from Mr. Johnston at Abt Associates in September, 1994 (preparation of this version is being funded by two USAID projects: the Washington-based DESFIL II project and the Central America regional USAID/ROCAP RENARM project).

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Volume II: "Learning Spreadsheets and Analyzing Aggregate Data"

Volume III: "Natural Resource Policy in a PAM Framework"

Volume IV: "Agricultural Policy Analysis Using Market Level Models" (written with Leigh Bivings)

Volume V: "Social Equilibrium Analysis Using Market Level Models" (written by Timothy Josling)

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Principles and Practices for Implementing Participatory and Intersectoral Assessments of Indicators of Sustainability: Outputs From the Workshop Sessions

Summarized by
Barbara C. Bellows

INTRODUCTION

The goal of the workshop was to draw upon the wide range of expertise and experience available from the conference and workshop participants in order to develop guidelines for the identification, assessment, and use of indicators of sustainability within the SANREM CRSP and by other individuals, institutions, and organizations concerned with issues of sustainability in agricultural and natural resource management. The workshop sessions were not developed to provide a "shopping list" of indicators appropriate to different disciplines and locations. The organizers of the conference and workshop agreed that other programs with specific disciplinary or location-oriented mandates have or are in the process of identifying and cataloguing these indicators and assessment methodologies (for example, Campbell et al., 1990, Corson, 1994; Hamblin, 1992, Henninger, 1992; Lal, 1994; Symth and Dumanski, 1993; World Watch Institute, 1994). Instead, the workshop sessions were designed to describe processes for identifying and using indicators of sustainability. Stated objectives for the workshop sessions included identifying 1) how technical and participatory processes can be linked in the assessment and enhancement of sustainability, and 2) how micro level (field, household, intracommunity, community, watershed) and macro level (region, national, global) factors of sustainability interact.

Indicators developed through this workshop process would be both sensitive to the local biophysical and socioeconomic conditions and responsive to a global perspective. Indicator identification and assessments would involve innovative methodologies for linking indigenous and exogenous assessment methods, qualitative and quantitative information, and short-term necessities with long-term aspirations. Processes also would seek to empower participants and increase their benefit options by enhancing dialogue and information exchanges among community sectors, development workers, researchers, and policymakers.

The workshops were divided into two sessions. During the first session, participants addressed the following issues:

- Social, economic, and biophysical perspectives of sustainability and associated indicator assessment processes.

- Intersectoral processes for identifying, assessing, and using indicators of sustainability.

- Processes for developing indicators based on a combination of technical/exogenous and experiential/indigenous information.

- Participatory processes for identifying, assessing, and using indicators of sustainability.

· Frameworks for analyzing and aggregating information across hierarchy or system levels.

During the second session, the local context for indicator development was addressed. These sessions focused on the three primary locations for SANREM CRSP activities: the Philippines, Burkina Faso, and Ecuador. Work groups also examined indicators from the U.S. farm perspective and global indicators of sustainability.

All work groups used holistic approaches to address their topic questions. These integrated discussions produced overlaps among workshop results. To produce a more coherent presentation, results from the workshop sessions were combined in this summary. The combined workshop results are divided into six sections:

(1) Perspectives of Sustainability and Criteria for Indicator Development

(2) Creating an Enabling Environment: Participatory Interactions

(3) Creating an Enabling Environment: Interdisciplinary Interactions

(4) Participatory and Interdisciplinary Processes for Identifying and Using Indicators of Sustainability

(5) Frameworks for Indicator Analyses

(6) An Indicator of Sustainability Assessment Methodology

Finally, specific indicators for the Philippines, Burkina Faso, Ecuador, U.S. farms, and global assessments are presented as appendices.

PERSPECTIVES OF SUSTAINABILITY AND CRITERIA FOR INDICATOR DEVELOPMENT

Each of the work groups initiated their discussions by presenting definitions and identifying perspectives of sustainability from a range of disciplines and sectors. The basic definition of sustainability presented by work group members was the ability to persist and endure over a long time period that can be measured across generations. Sustainability is characterized by an increase or maintenance in output or performance which is attributable to processes that afford a system stability, flexibility, and resiliency. Sustainable systems are also dynamic. Components may be lost or changed while the system remains sustainable. A new species can substitute for an extinct species. Technology can substitute for natural resources. Economic relations can substitute for social relations. Social systems will change as human values and attitudes change.

Sustainable Development

When work group members used sustainability to describe development, this word connoted human systems existing in harmony with the natural environment. Sustainable development was defined as socioculturally acceptable, economically viable, and environmentally sound. Sustainable development also balances short term needs of people and requirements for environmental integrity with the protection of the long term diversity and resiliency of human, biological, and geophysical systems. This balance is context specific and highly dependent on internal and external factors.

Differences in perspectives of sustainability arose among work group members regarding *what* persists and endures, *how* short and long-term balances among social, economic, and environmental objectives should be achieved, and *whether* sustainability is a priority objective. Biophysical scientists tended to focus on resources and biological production. They considered sustainability as a consequence of maintaining system integrity and continued existence. But, they did not agree on which components and subsystems needed to be sustained or to what degree technological inputs can or should substitute for natural processes. For economists and social scientists, sustainability of specific agricultural and natural resource factors was not considered a societal requirement, but an option. Economists argued that farmers, consumers, and other stakeholders will choose sustainability only if the trade-offs with other preferences and values are not too large. Sociologists and anthropologists considered sustainability as one among several important personal and social objectives. Temporal perspectives of sustainability also differed among sectors. Researchers prefered assessing sustainability within the context of long term trends or cycles while development workers, familiar with the short-term crises of survival encountered by the community members they serve, considered some actions directed toward sustainability as an unrealistic luxury.

Qualitative and Quantitative Assessments

Different perspectives of sustainability affected *what* criteria work group members considered necessary for indicators of sustainability and *how* indicators were identified and used. **Economists and biophysical scientists generally prefered indicators that can be quantitatively measured and statistically analyzed while social scientists advocated the inclusion of qualitative and value-oriented factors as indicators.** Quantitative indicators are useful for predicting, monitoring, and evaluating change. Qualitative indicators describe requisite conditions that lead to socially just, empowered communities and a more stable (sustainable) society. Analytical indicators provide guidelines for the development of technologies or policies. Experiential indicators identify changes in resource and social conditions and denote interrelationships among these changes.

CREATING AN ENABLING ENVIRONMENT:PARTICIPATORY INTERACTIONS

Work group members emphasized the importance of community involvement in the identification of indigenous and experiential indicators and in the assessment of both local and research-based inidcators. They stressed that participant involvement in indicator identification and use must entail involving end-users in all stages of indicator of sustainability development including:

(1) the identification of indicators and associated assessment processes,

(2) participation in the assessment of indicators, and

(3) decision making regarding how indicator results will be used in project or policy formation.

Participatory indicator identification and use should be conducted as an integral component of program development that establishes a conducive environment for participatory involvement. In addition, workgroup members noted that indicators of sustainability are but by-products of a development process that includes dialoguing about problems, defining options, and seeking alternative solutions to an array of problems.

Understanding Social Complexities

Participatory involvement in research and development programs requires the development of trust between project coordinators and program participants. Prerequisites for the establishment of this sense of trust include understanding the social complexities of communities, using sensitive communication skills, appreciating culturally-based perspectives and values, and committing the program to give priority to processes and activities that have meaning and usefulness for the participants.

Creating a Level Playing Field

"Farmers" or "community members" are not homogenous.[1] Social scientists in the work groups emphasized that social complexities among social groups must be acknowledged in program development. They stressed that the "community" consists of sectors defined by gender, age, access to resources, type of farming practice, etc. They also noted that differences among community sectors, often rooted in social, historical, and political traditions, have created an "unlevel playing field" among sectors. Project personnel who seek to establish a level playing field for project development must be sensitive to the cultural barriers and perceived power-structure relationships among the community sectors. This sensitivity entails acknowledging rather than ignoring who are the power brokers and who are the disenfranchised. Projects must explicitely acknowledge who may be positively and negatively affected by changes proposed in project activities. Project consistency and integrity then requires personnel to critically assess the ability of local organizations to reflect the perspectives of relevant community groups. If community "representatives" are not identified carefully, program development may adversely affect interactions among community sectors while participation in program development by the relevant sectors may be constrained.

Role Reversals

Workgroup members from the sociological, anthropological, and development sectors argued that sensitive communication skills for participatory development involves role reversals. **Researchers must be willing to learn and farmers must be allowed to teach.** Role reversals mean that end-users are primarily responsible for directing discussions and defining program priorities. The work group members acknowledged that achieving role reversals will require attitude changes among both researchers and participants. Researchers and facilitators working with community members must be patient, have a long-term commitment and relationship to the area, and have an open mind regarding the interpretation of program impacts. Facilitators must be good listeners, sensitive to all sides of the issue, able to develop trust, and willing to take the time required to develop important consensus decisions. Researchers and development workers must be able to identify and work with informal community leaders who already have the trust of the community. These community leaders can serve as intermediaries among community sectors or between researchers and community members to help articulate the needs and interests of the relevant community sectors and to encourage their long term commitment to the program. Although sensitive communication skills and motivated intermediaries will facilitate open and equitable program development, it may not be possible to reach all community sectors or to develop a completely level playing field.

Values and Perceptions of Stakeholders

Workgroup members stressed another requirement of sensitive communication. **Program stakeholders must be given respect for their own definitions and perceptions.** As much value must be accorded to resource classification systems based on indigenous or spiritual knowledge as those based on technical knowledge. Work group members provided examples of how community sectors describe resources within the context of their culture. The word "profit" may encompass non-monetary as well as monetary benefits of an enterprise. The classification of trees in a culture may have less to do with the characteristics of the trees and be more reflective of the quality of the soil where they are found. To facilitate the integration of perspectives from all sectors, work group members recommended that discussion concepts and project objectives be clearly translated using the terminology and precepts of each sector or discipline.

CREATING AN ENABLING ENVIRONMENT: INTERDISCIPLINARY INTERACTIONS

Dialogues

Throughout the work group sessions, participants stressed that the formation of interdisciplinary and intersectoral relationships requires establishing and maintaining trust among all stakeholders. **Open and transparent dialogues are essential for maintaining trust.** Dialogues should be open to the entire range of project stakeholders including community sectors, farmers, researchers, development workers, and policymakers. Trust among sectors during the process of dialogue depends on maintaining a transparency of agendas and motives and a level playing field among all participants in the discussion. Dichotomies between donors and clients should be minimized or eliminated and political leaders should have no greater voice than other community members. Throughout the dialogue, it is critical who asks the questions and what questions are being asked.

Dialogues for Asset Identification

During program initiation, dialogues can set the stage for intersectoral negotiations by identifying each organization's sectoral and disciplinary perspectives of sustainability, visions for program development, primary motivating factors for program involvement, and constraints to program involvement. Work group members recommended using flexible, on-going, and open-minded discussions to allow stakeholders to identify commonalities among their interests. They then could negotiate mutually-acceptable agendas that reflect the goals of each participating sector. **Dialogues can identify the assets of each stakeholder and the best contribution of each member to the program.**

Costs and Benefits of Collaboration

Collaboration within intersectoral programs should capitalize on the identified resources and expertise of each sector. **For each sector, the type of involvement should be appropriate to their interests**

and abilities while the level of involvement should be related to the level of benefits they obtain. Work group members from the development perspective emphasized that throughout program activities priority should be given to activities that have meaning and usefulness for the participants. The short-term survival needs of community members must be addressed simultaneously with the long-term objectives for natural resource sustainability. Similarly, the long-term development of trust between researchers and community members should not be overlooked in the process of fulfilling short-term research objectives or development needs.

PARTICIPATORY AND INTERDISCIPLINARY PROCESSES FOR IDENTIFYING AND USING INDICATORS OF SUSTAINABILITY

Participatory Principles

Work group members identified a range of participatory activities for identifying and assessing indicators of sustainability. These activities range from the identification of indigenous or experiential indicators to assisting researchers in the assessment of exogenous, scientific indicators. They noted that participatory involvement is premised on open dialogues between researchers and community members. It is also premised on the direct involvement of participants in the identification of indicators, the design of indicator assessment methods, and the development of visionary processes that relate indicators to positive action.

Due to differences in cultural history, economic status, and social relations, different social sectors will claim different perspectives of sustainability and advocate the use of different indicators. Different approaches to sustainability will benefit or victimize different sectors of society and different indicators will have meaning and utility for different participants. In the assessment of indicators, different sectors will have different capabilities or time frames for involvement.

Indigenous and Experimental Indicators

Workgroup members defined indigenous or experiential indicators as predictors used by community sectors in their resource use practices or reflect experienced changes in environmental or socioeconomic conditions over time. **Indigenous indicators of sustainability encompass all the complex interactions encountered by resource users and are specific to their social and ecological environment.** These indicators also incorporate the felt needs of the relevant community sectors and reflect their attitudes and values. Work group members emphasized that community-based indicators may be quantitative as well as qualitative. The baselines or measurement methods of the qualitative indicators may be culturally defined. Members stressed that to not acknowledge the analytical basis of of some indigenous indicators may demean the potential of these indicators.

Workgroup members presented several examples of how indigenous indicators can be identified through participatory processes including discussions, inventories, drawings, and cross-landscape visits (Table 1). According to workgroup members, these participatory methods can effectively facilitate the elaboration of non-leading, open-ended questions about indicators of sustainability. This information will permit comparisons of indigenous and technical knowledge and perceptions and permit the development of intersectoral indicators.

Benefits to Participants

Workgroup members provided several examples of benefits participants obtain from involvement in the assessment of research-based indicators of sustainability. Participation by community members in assessing exogenous or technical indicators can enhance their awareness of changes in their environment and motivate action to address these changes. Processes associated with participatory assessment can foster trust and cooperation between community members and researchers. Participant interest in indicator identification processes will be facilitated through intersectoral interactions that help participants understand and appreciate their relationship to the natural environment.

Continuing participation by resource users in indicator assessments requires analysis methods that are easily communicated, simple to perform, inexpensive, utilize local resources, and are compatible with their time schedules. The availability or unambiguous assessment results at critical times allows resource users to monitor improvements and take corrective action regarding resource use. Incremental reviews will also assist the program in ensuring the timely delivery of results and allow for the implementation of mid-term corrections in program activities.

Research-Oriented Indicators

In contrast to indigenous indicators, workgroup members noted that **scientific or research-oriented indicators of sustainability are global, disciplinary, and quantitative.** Criteria for technical indicators include being reliable, replicable, representative of system variability, and free from bias. Comparability of information across time and locations requires that scientific indicators should be based on reference points. Historical values and natural systems can serve as analysis baselines while target values and threshold levels provide positive and negative reference points, respectively.

Disciplinary Perspectives

Workgroup members acknowledged that sectoral groups will enter into the indicator development process as representatives of their sector's perspective. The identification of indicators within an interdisciplinary program, therefore, will originate from a disciplinary perspective and move to an integrated perspective.

Interdisciplinary Integration

Disciplinary indicators allow for the assessment of discrete, focused information (Tables 2 and 3). Interdisciplinary programs should facilitate the combination of these discrete disciplinary perspectives into interdisciplinary indicators. These indicators should reflect interactions and associations among environmental conditions, resource-use practices, market factors, and social relationships. Interdisciplinary interactions involved in the indicator identification process should catalyze the formation of creative analysis methods and enhance understandings of system level processes.

Proxy and Surrogate Indicators

Proxy and surrogate indicators can help translate between technical methods and farmers' experiences. Proxy indicators represent system inputs that can serve as predictors for impacts. The percent of soil coverage during critical rainfall events can serve as a proxy indicator for erosion losses. Surrogate indicators represent processes that either have an indirect or no apparent rela-

Table 1: Participatory methods used in identifying indigenous or experiential indicators of sustainability.

Participatory method	Factors identified by the method
Participatory rural appraisals (preliminary)	· agricultural and natural resource use practices · changes in resource use and resource quality over time changes in demographics, social interactions, economic processes, and interventions within the locality
Oral histories of community members (detailed)	· values and attitudes associated with resources · perceived impacts of the identified change processes · perceived resource-use options
Resource inventories	· changes in resource use and resource quality over time
Resource use flow charts	· natural resource types, flows, and availability to social groups
Time use calendars	· agricultural practices, food supply, health conditions, rainfall, and labor variations during the year · critical times for resource use
Estimates of time and motion	· time spent in reproductive and productive activities and distances traveled to accomplish these activities
Mapping by community members	· resource locations in relation to access by social groups · natural resource types and resource flows
Drawings by community members	· attitudes towards resources
Community-based discussions	· current and prior resource use practices and socioeconomic interactions · justifications or perceived reasons for changes
Farmer conducted research	· adaption of technical information to accommodate the economic conditions of the household and the environmental conditions of the farm · indigenous farming and natural resource use practices
Farm visits	· differences in resource quality, resource use practices and socioeconomic interactions on different farms and across the landscape
Ground truthing of technical and policy indicators	· comparisons of community perceptions with technical information · relationship of exogenous indicators to the felt needs and perceptions of community sectors

Table 2: Socioeconomic indicators of sustainability and associated variables and conditions (state indicators) and predictors of unsustainability (pressures, stressors).

Indicator aspects or dimensions	Variables or conditions[1]	Predictors of decline[2]
diversity	· range of employment opportunities and/or income sources · multiple market outlets. · multiple crops/species (plants and animals). · a valuing or recognition of diverse types of knowledge · multiple social groups (ethnicity)/gender balance	· monoculture · limited markets · economic vulnerability · loss of IKS[3] and diverse farming systems
interdependence/ self-reliance	· capacity to increase access to resources · variety of activities within community · interdependence, "community cooperation." · linkages between production, consumption and marketing. · self-reliance of community/region.	· increasing dependence on outside, paternalistic aid · factional dissension · increasing reliance on expropriation
equity/social justice	· intracommunity access to and control over resources · access to leisure time · participation by all groups in decision-making · division and returns of labor · equal security, protection	· asset concentration or monopolization · elitism · discrimination
resilience (stable and flexible)	· variability of income · variability of population · low level of stress on productive resources.	· out-migration for income generation · lack of food security · monoculture · feelings of apathy and desperation · limited sources of employment
productivity/income	· income over time relative to needs over time	· rising population · declining income
capital assets	· natural resources (land, forests, water, etc.) · manufacture capital (machine, housing, technology) · human and social capital (skills, norms, trust, shared values, etc.)	· depletion of natural resources · decrease in savings · decline in community networks of reciprocity and trust
health and nutrition	· water quality · nutritional level · food availability · preventive medicine · access to primary care	· increasing dependence on curative medicine · loss of IKS
education	· cultural appropriateness · equal access to education by gender and social class	· loss of IKS (breakdown of intergenerational transfer of knowledge)
policy/governance	· community participation · merger of environment and economy in policy decision-making, design and implementation	· breakdown in local or traditional institutions (i.e. spiritual, value systems, governing, etc.)

[1] These are some possible variables and conditions of aspects of sustainability. This is not an exhaustive list.
[2] Predictors are defined as thresholds, stressors, threats, or vulnerability.
[3] IKS = indigenous knowledge systems

Table 3: Biophysical indicators of sustainability.

Soil			
Chemical quality	Physical quality	Biological quality	Quantity
fertility salinity alkalinity	water infiltration water holding capacity structure	rate of organic matter decomposition diversity of food webs presence of beneficial soil microorganisms	erosion

Water	
Quality	Quantity
Temperature pH Coliform, dissolved oxygen Toxins Dissolved solids	Droughts Flooding Flow patterns

Flora and Fauna	
Biodiversity	Productivity
Species composition and distribution Species competition Adaptability	Biomass yield Disease prevalence and resistance population dynamics

Atmosphere	
Biological quality	Physical quality
Biological contamination Odor Particulates	Global warming Humidity Visibility Particulates

relationship to the change processes under assessment. Changes in planting practices or crop varieties used may be a surrogate indicator for declining rainfall dependability while increased time spent weeding may be a surrogate indicator for decreasing soil fertility.

Intersectoral Integration

Workgroup members stated that the role of intersectoral indicators is to bridge between indigenous/experiential and analytical/technical information. By reflecting both the felt needs of the resource users and priority research concerns, **intersectoral indicator assessments can mutually validate indigenous and scientific knowledge.** Experiential information can provide local validation or ground-truthing for technical or policy-based information. Technical analyses of indigenous practices or community perceptions can "validate" common knowledge and guide technology and policy development.

Integrated, participatory programs require a combination of qualitative and quantitative indicators of sustainability. Workgroup members stressed that the indicator identification process can facilitate the formation of linkages among sectors and disciplines. This process can also help promote "learning" by farmers and scientists and challenge accepted understandings of how systems work. Researchers can stimulate global awareness among community members by sharing with them technical or off-site information such as satellite images or policy information. Community members can assist researchers in understanding interactions between biophysical and social processes by involving them in cultural rituals or describing indigenous resource classification systems.

Intersectoral Indicator Criteria

Workgroup members emphasized that within an intersectoral program, all indicators do not need to satisfy a predefined list of criteria in order to be considered valid. **Indicators should satisfy the criteria considered important by those implementing or using the indicator.** Table 4 lists indicator criteria and primary indicator users for various roles or uses of indicators of sustainability. The interrelationship among these three factors is illustrated in Figure 1.

Types of Intersectoral Indicators

According to workgroup members, interdisciplinary programs depend on a variety of indicators. Visionary indicators, based on experiential changes and felt needs, can stimulate critical communication and enable stakeholders to understand the consequences of actions. Process-oriented indicators can motivate action by providing individuals with choices in how to act or respond to information and change. Multidimensional and interdisciplinary indicators can elucidate the inter-connectedness of sociological, economic, biological, and physical forces. Indicators that serve as departure points can be used to set goals based on future expectations while indicators that monitor change processes can expedite regular course correction. **Above all, indicators must provide useful, meaningful information and results.** Meaningful interpretation of indicator results requires an understanding of the context of the area, the method of assessment, and the indicator reference points.

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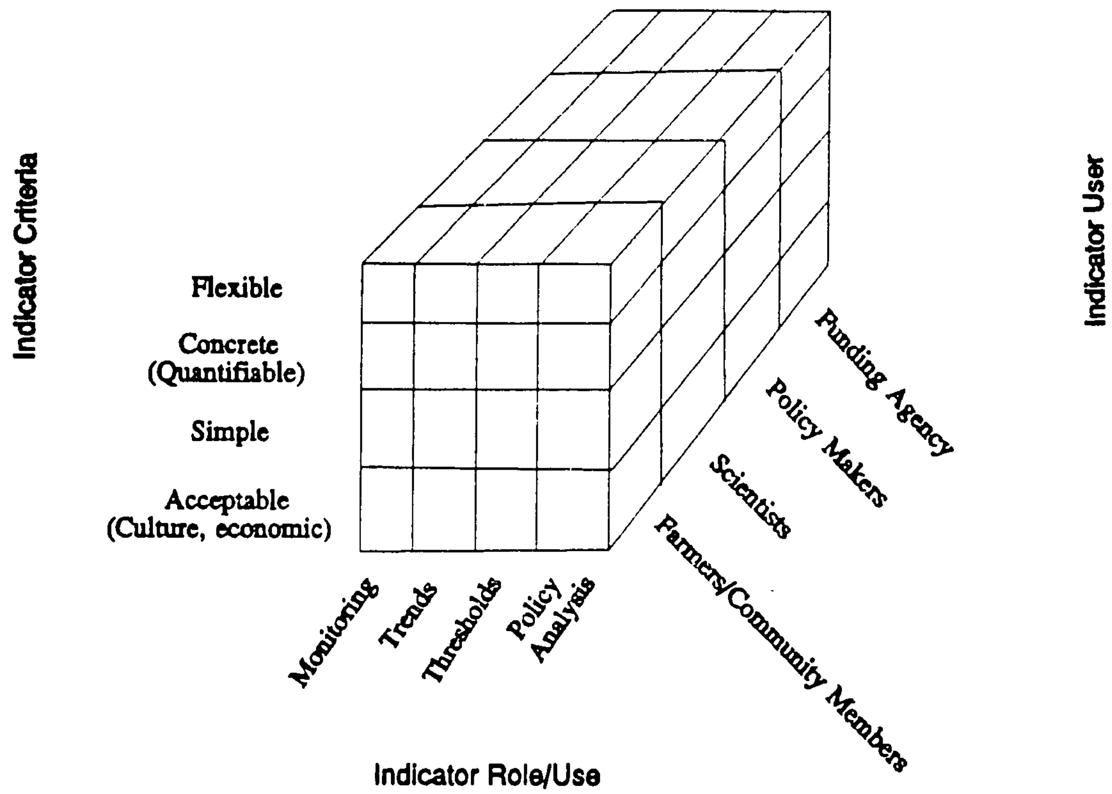
Table 4: Relationships among indicator uses, indicator criteria and primary indicator uses.

Role or use of indicators	Indicator criteria	Primary indicator user
Predict outcomes	Valid, reliable Replicable Sensitive to change	Economists Policymakers Funding agencies
Determine research and development agendas	Measurable Integrative/Multidisciplinary Sensitive to change Cost effective	Researchers Program managers
Identify appropriate technologies	Measurable Integrative/Multidisciplinary Sensitive to change	Researchers
Monitor trends	Measurable Incremental Sensitive to change Simple to assess Replicable	Economists Policymakers
Monitor and evaluate project/program activities	Measurable Incremental Sensitive to change Low signal to noise ratio Replicable Cost effective	Policymakers Funding agencies Program managers
Measure change in relation to a threshold, baseline, or goal	Measurable Sensitive to change Low signal to noise ratio Replicable	Researchers Funding agencies Program managers Development workers Community members
Identify interrelationships	Compatible Flexible Understandable	Researchers Development workers
Serve as images or guides regarding impacts of alternative actions	Understandable Simple to assess Integrative/Multidisciplinary Pedagogic Sensitive to change	Social scientists Development workers Community members
Be departure points to *understand* rather than to *define* something	Understandable Accessible Simple to assess Integrative/Multidisciplinary	Social scientists Development workers Community members
Motivate changes in attitudes and actions	Understandable Sensitive to change Integrative/Multidisciplinary	Development workers Community members
Communicate information regarding changes	Flexible Integrative/Multidisciplinary Understandable Simple to analyze	Policymakers Development workers Community members
Develop policies and conduct policy analyses	Integrative/Multidisciplinary Understandable	Policymakers



FRAMEWORKS FOR INDICATOR ANALYSES

Workgroup members described three types of frameworks are used in the analysis of indicators of sustainability:

(1) frameworks for analyzing causal relationships among indicators,

(2) frameworks for classifying indicator resolution, and

(3) frameworks of assessing indicators across hierarchy or system levels.

Causal Relationships

Frameworks for analyzing causal relationships are used to delineate processes and forces interacting across the landscape and over time. Various terms have been proposed for describing these interrelationships. The causative force of a change condition is referred to alternatively as a "stressor" indicator (Campbell et al., 1990) or a "pressure" indicator (Henninger, 1992). The baseline condition of the environment is described by "state" indicators. The direct impact of the stress forces is described by "exposure" indicators while "response" indicator refer to the environmental or social reaction to the impact. Workgroup members noted that since degradation and agradation forces interact in spirals, these designations are not static: upslope migration may be a "response" to land degradation downslope but a "stressor" for deforestation upslope.

Resolution Frameworks

The identification of specific, measurable indicators is facilitated through the use of classification hierarchy frameworks. These frameworks identify indicators through incrementally increasing the resolution of the factor under assessment. Workgroup members provided a biophysical and a socioeconomic example of how this framework may be used (Table 5).

Hierarchy or System Frameworks

Workgroup members represented sectors working at the field, farm, household, community, regional, national, and global levels. They agreed that information on indicators of sustainability can be identified, assessed, and used at all these hierarchy or system levels.[2] The type and focus of indicators developed at each system level will differ. Indicators are developed more inductively at the micro or less extensive system levels and more deductively at the more extensive system levels. Localized processes dominate at the less extensive system levels. Factors and processes that flow across boundaries, such as information, economic interactions, and pollution, dominate at the more extensive hierarchy levels.

As the geographic extent of systems change, so does the time scale for assessments. Changes occurring at more extensive system levels exert a more profound impact across the landscape than changes at the less extensive hierarchy levels. Changes at the micro level are experienced more rapidly and directly while changes at the macro level have an indirect and delayed impact. Workgroup members agreed that this difference in temporal and impact dynamics of change processes has implications for monitoring indicators across system levels. Assessments undertaken at the more extensive system levels may be insensitive to changes occurring at the field or household levels while assessments at the less extensive levels may be distorted or confounded by the indirect impacts of changes occurring at the global, national, and regional levels. Assessments across system levels will be most closely related at systems adjacent by only one or two levels.

Table 5: Indicator identification through the use of a classifiction hierarchy framework.

Hierarchy Level	Biophysical Example	Socioeconomic Example
Element	Soil	Farm
Property	Productivity	Profitability
Descriptor	Soil Fertility	Net Income
Indicator	Percent Organic Matter	Percent of Income from Off-Farm Labor

Workgroup members noted that historically information on economic and social trends has been collected and aggregated based on political boundaries: municipality, state/province, region, nation, and global. As governments and international organizations began collecting environmental data, this information was also reported according to political demarcations. Environmental processes, however, are not defined by political boundaries. The boundaries of a watershed, a desert, or a rainforest may lie either within a larger political unit or extend across political boundaries. Differences in boundary characteristics and demarcations (Table 6) can confound intersectoral comparisons of indicator information across system levels.

Sociopolitical and biophysical data should be collected and aggregated according to their appropriate boundaries. Until appropriately collected information is available, workgroup members recommended using innovative methods for disaggregating information to common units.

Hierarchy theory states that as the geographic extent of the data changes, the grain of data also changes. While some data can be aggregated across hierarchy levels, other data assumes a different category of information as the system level changes. Table 7 illustrates how categories of information describing soil quality and economic sufficiency may change as the extent of the system changes.

Table 6: Boundary demarcations within socio-political and biophysical systems.

Socio-political	Biophysical
plot	field
household	farm unit
community sector	agroecosystem
municipality	watershed
province	bioregion
nation	island/continent
global	global

Table 7: Changes in the category of assessment information as affected by changes in system level.

System level	Soil Quality	Economic Sufficiency
field/plot	depth of the topsoil	cost of inputs/crop yields
farm unit/household	% of land with severe erosion	farm profitability
watershed/municipality	sediment flows in and out of the watershed	availability of crop at the local market
bioregion/province	% of vegetation cover during critical times	regional sufficiency in locally produced crops

Participatory frameworks for the assessment of information across system levels depends on information being integrated from the least to more extensive geographic units. This "bottom-up" assessment starts from the resource base and then links to socioeconomic data as analyses move across system levels. Workgroup members noted that **as the spatial and temporal dimensions used in the assessment of indicators changes, intersectoral interactions will also change to reflect the capabilities of each of the sectors.** Resource users and development workers will guide assessments at the field, household, community sector, and community levels. Workgroup members said that researchers need to be able to think globally but act locally in assisting community sectors to perceive changes across the landscape and across the more extensive system levels. In this manner, analytical information can be linked to or correlated with experiential information and local information can be integrated into policy-making processes.

AN INDICATOR OF SUSTAINABILITY ASSESSMENT METHODOLOGY

Workgroup members recommended an iterative process for the identification of indicators of sustainability within interdisciplinary, participatory programs.

This process involves three stages of activities:

(1) identification of indicators by societal groups,

(2) review of indicators by other project stakeholders, and

(3) revision of the reviewed list of indicators based on negotiations among stakeholders (Figure 2).

During the implementation stage, identified indicators will be further assessed for appropriateness for local conditions, compliance with appropriate criteria guidelines, and ability to lead to or motivate practical actions.

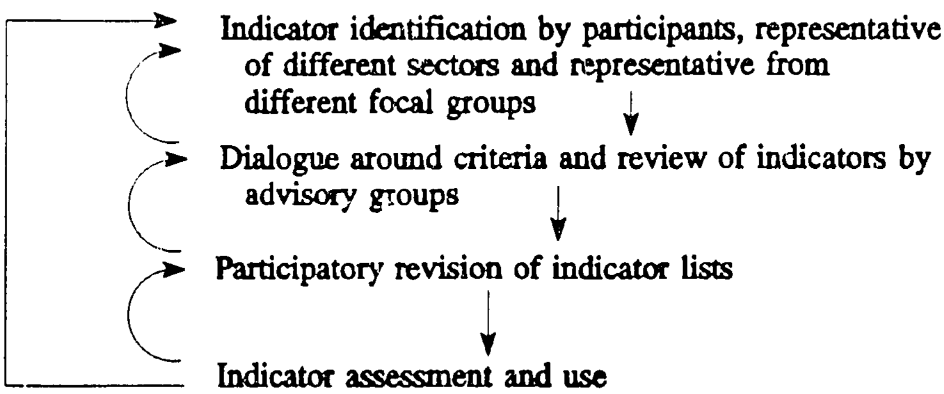
Indicator Identification

Indigenous and experiential indicators can be initially identified using participatory rural appraisal methods (including rapid rural appraisals and participatory landscape/lifescape appraisals). These indicators would then be reviewed sectorally and collaboratively by all project stakeholders. Sectoral reviews would involve each of the project collaborators reviewing these indicators according to their own perception of sustainability and indicator assessment criteria.

Research-Based Review Process

According to the processes outlined, research reviews would include comparing the community-based information to information from other sites and other system levels. Secondary information from more extensive system levels would permit researchers to identify external stressors on the environment as well as determine off-site impacts from site-based activities. Literature reviews of programs conducted in other areas would allow for the comparison of locally identified indicators with those identified in other locations. These comparisons would permit the formulation of theories regarding indicator interactions and relationships. Predictions regarding the potential impacts of change processes could also be developed. Comparisons between

Figure 2: Intersectoral processes for identifying, testing and applying indicators.



local and external indicators will also permit the identification of of any critical discrepancies or inconsistencies. Iterative processes involving participatory methods would then link these research-based comparisons to community-based dialogues. Finally, through awareness-building discussions, global perspectives can be related to the perspectives of the community sectors and expanded lists of indicators and indicator interactions can be developed.

Development-Oriented Review Process

Development-oriented reviews of indicators can ensure that the identified indicators are appropriate to the environmental conditions of the site and relevant to needs and capabilities of participants. These reviews should examine indicators within the web of system-based interactions. This entails that these reviews should examine both productive and reproductive processes, address trade-offs between regional environmental and local economic concerns, and balance long term and short term objectives.

Stakehold Negotiations

The process of integrating sectoral indicators into an intersectoral "vision" should serve as an invitation to dialogue. This dialogue process would be initiated by asking all stakeholders to identify indicators that reflect their sector's "vision or dream" of an ideal environment. Based on these visions, stakeholders would discuss perceptions of sustainability and negotiate program agendas. **Linking indicators to a program agenda based on a shared vision of sustainability will insure that indicator assessments will be conducted as an integral component of program development.** Indicators approved for implementation should be meaningful and relevant to all stakeholders and capable of guiding the formation of consensus decisions regarding community action, management options, and policy changes. Indicators should underline the trade-offs among environmental, economic, and social issues. Acceptable indicators should also simplify rather than confound communication about complex ideas.

Indicator Assessment

Collaborative implementation of indicator assessments depends on the development of assessment methodologies that are understandable and useful for all sectors. Factors to be considered in the development of indicator assessment methods include: sectoral involvement in indicator assessments; the system levels at which assessments will be conducted; and the level of resolution that will be used in the assessments. Analysis methods identified should conform to the criteria appropriate to the sectors undertaking the assessment. Responsibility for conducting assessments should be consistent with the capabilities, interests, and potential benefits of the sectors conducting the assessments. For example, the workgroup examining biophysical indicators identified appropriate soil erosion assessments for each sector (Table 8). Participatory assessments should stimulate capacity building among community sectors and enhance their options for implementing changes. Integration of information across sectors and system levels depends on processes for effective information collection and accessible channels of communication.

Table 8: Appropriateness of soil erosion assessments as affected by sectoral involvement.

Farmer	Researcher	Policy-maker	Funding Agency	Assessment method
E	G	P	P	Visual - rills, turbidity of run-off water, gullies, soil color
G	F			Stick in the ground
F	E			Total suspended solid
F	F-G			Erosion plots
P				Soil horizon
G				Vegetation/pedestal formation
P	E?	G-E	G-E	Simulation/modeling (USLE/WEPP)
P	G-E			Remote sensing
F				Sediment deposition

Where E, G, F and P represent:
- Excellent
- Good
- Fair
- Poor

· regarding the ability of the sector to conduct each assessment, or
· the usefulness of the assessment to the sector conducting the assessment

Indicator Use

Ultimately, the analysis and use of indicators of sustainability should be linked to action and the establishment of a conducive environment for sustainable thinking. Some workgroup members stated that **sustainable thinking involves changing attitudes, values, and the "rules of the game."** For resource users, whether they be small-scale farmers or multinational industries, it involves adopting new attitudes towards land stewardship. From the household to the board room, it involves changing societal relationships. Within the research community, it involves changing the academic rewards systems and accepting innovative tive research methodologies. At the policy level, indicators should foster institutional changes that encourage rather than discourage equity, long term planning, and environmental stewardship. Economic paradigms that measure attitudes toward production and consumption and promote profit stabilization are needed. The realization of sustainable thinking is nurtured by interactive processes including networking, conferences, and dialogues. **But it requires that each participant in the dialogue be willing to assume responsibility for furthering negotiated objectives.**

ENDNOTES

1. Throughout the remainder of this summary the terms end-users, resource-users, community members, and participants will be used to refer to people living in the locality of the project site. These terms are used with the implied assumption that each term refers to a diversity of social and cultural groups.

2. The word system rather than hierarchy is used throughout the remainder of this summary to describe interactions involving different levels of spacial extent. The terms higher and lower hierarchy levels are avoided since these terms may be interpreted to imply that more extensive systems are more important than less extensive systems.

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Appendix A. Indicators of Sustainability for the SANREM CRSP/Philippines site (Lantapan, Bukidnon)

Factor to be assessed: Continuous encroachment on forest land

A. Environmental Indicators (Impacts)
   1. Change in forest land area across the landscape
   2. Change in natural resource condition (soil, water, vegetation, animals, etc).

B. Social Indicators (Exposure impacts)
   1. Time consumed in wood collection
   2. Availability of alternative livelihood
   3. Level of malnutrition
   4. Loss of indigenous (ancestral) land to migration

C. Social Indicators (Pressures/Stressors)
   1. Population pressure
   2. Length of stay

D. Economic Indicators (Pressures or Impacts)
   1. Family income (level of poverty)
   2. Type and equity of labor arrangements
   3. Level of dependency on external inputs
   4. Economic control by financiers

Factor to be assessed: Economic control by financiers

A. Environmental Indicators (Impacts)
   1. Water quality degradation (e.g. chemicals)
   2. Soil quality degradation (e.g. chemicals)
   3. Declining crop yields
   4. Increasing encroachment on forest lands

B. Socioeconomic Indicators (Impacts)
   1. Family breakdown
   2. Sacrificed children's education
   3. Labor availability for the farm
   4. Family nutrition
   5. Off-season employment
   6. Temporary migration for off-season employment
   7. Health impacts from pesticides/reduced access to clean water

C. Socioeconomic Indicators (Pressures/Stressors)
   1. Number of channels of finance and volume
   2. Access to in kind loans and other economic exchange interactions
   3. Access to transportation

Appendix B. Indicators of Sustainability for the SANREM CRSP/Burkina Faso site (Donsin)

Factor to be assessed: Impact of livestock holdings

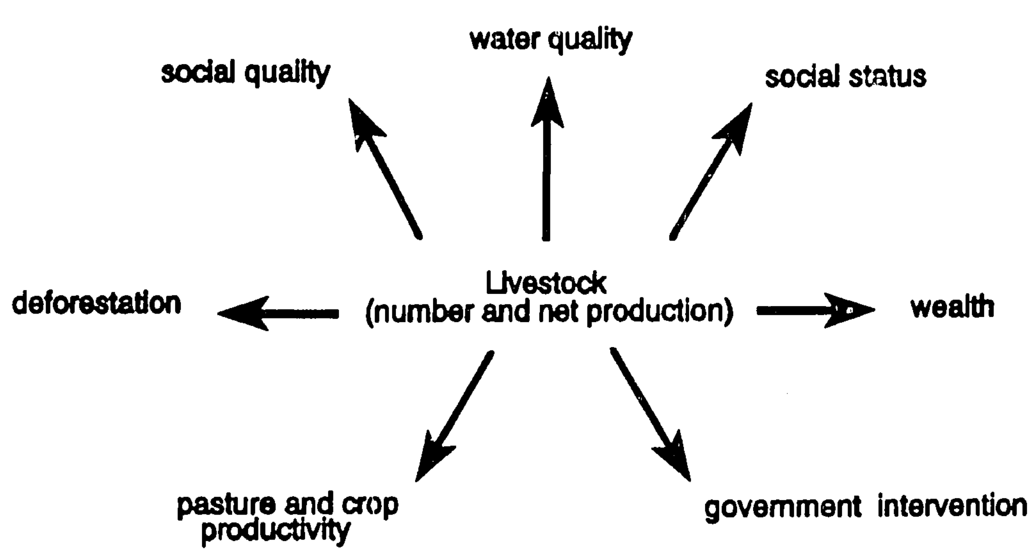
A. Environmental Indicators
  1. Soil fertility
     a. Manure additions
     b. Removal of nutrients as fodder
  2. Biodiversity
     a. Impact of grazing on plant diversity
     b. Impact of soil compaction by livestock on plant diversity
     c. Deforestation due to fodder gathering
  3. Water contamination by livestock

B. Social Indicators
  1. Availability of food/protein for members of relevant community sectors
  2. Access to uncontaminated water
  3. Social status: based on the number and type of livestock owned
  4. Gender relationships: based on ownership and management of different types of livestock

C. Economic Indicators
  1. Economic security: based on the number and type of livestock owned
  2. Time spent and distance traveled to get water and fodder

D. Policy Indicator
  1. establishment of government-run veterinary programs to assist farmers

Figure 3. Livestock as an Indicator for Burkina Faso



Factor to be assessed: Presence or loss of wild animals

A. Environmental Indicators
   1. loss of wild animals associated with a loss of natural resources including trees, fruits, medicinal plants, and other edible plant sources.

B. Social Indicators
   1. presence of wild animals assured availability of food from hunting
   2. presence of wild animals presented a threat to domestic animal production
   3. loss of wild animals and natural resources associated with a breakdown in social institutions and resource management practices

C. Economic Indicators
   1. loss of wild animals and natural resources associated with an increase in the time required to gather fuel wood and food plants

Indigenous indicators for Burkina Faso

1. Pasture quality based on:
   types of species
   combination of species
   frequency of appearance of some species

2. Soil classification based on:
   types and frequency of insect species
   types and frequency of weed species

3. Favorability of weather for agriculture based on:
   rainfall incidence and seasonally
   yearly variations of rainfall
   type of insects that appear before a rainfall
   intensity and combination of insects appearing before a rainfall
   presence of hail at the beginning of the rainy season

Appendix C. Policy and Program Indicators of Sustainability for the SANREM CRSP/Ecuador Site

A. Institutional changes
- change has to build on the historic roots of the community
- changes have to tap into existing organizations
- work has to be undertaken to foster changes in the "rules of the game"
- to help the community meet its needs
- to meet SANREM's goal in the area of policy changes

B. Capacity building
- networking (linking with partners and with other organizations that work in similar sites in Ecuador).
- Leveraging resources from outside organizations

C. Developing enabling relationships between researchers and community sectors
- community members take responsibilities in project development
- community members fully participate in decision making
- SANREM researchers play the role of facilitators and sources of alternatives and information (economic alternatives, educational information regarding the value of conservation for beneficiaries).
- sharing of information and research results among sectors

D. Incentive creation
- replacement of negative policy incentives with incentives that lead to sustainable use of natural resources

E. Creating a lasting presence:
- replicablity of program results in other areas of Ecuador
- strengthening ability of local institutions to effect improvement in people's lives

Appendix D. Social and Economic Indicators of Sustainability for U.S. Farms

A. Social Indicators
   1. Social condition/quality of life of the farm family
      a. Ability of the farmer to take time off from the farm
      b. The "gripe level" of the farmer
      c. Interest in having children remain in farming

   2. The level of urban community involvement or support for the agricultural community
      a. The expression of community support for people when they have problems
      b. The level of population growth in the rural area

B. Economic Indicators
   1. How well the farm is being maintained
      a. equipment maintenance
      b. condition of farm buildings

   2. Availability of co-ops or other alternative marketing outlets
      a. The number of co-ops in the area and their longevity
      b. The number of farmer's markets in the area and their longevity
      c. The diversity of markets in the area
      d. The location of markets in relation to the farms
      e. The level of control the producers have over their markets

   3. The availability of farm credit
      a. Availability of credit at a reasonable rate
      b. Conditions attached to credit that may lead to unsustainable practices

   4. Economic buffering systems available to farmers
      a. The availability of land and options for putting land in rotation
      b. The availability and diversification of labor on the farm

Appendix E. Global Indicators

A. Environmental Indicators (Biophysical/Natural Capital)
- Forests/Vegetation Cover
- Desertification
- Soil quality
- Water quality and quantity
- Energy flows
- Climate change
- Atmospheric quality
- Biodiversity
- Recycling

B. Markets and livelihood systems
- Production practices
- Trade flows and fluxes
- Employment
- Consumption
- Food security

C. Population
- Human/Social interactions
- Population distribution
- Migration
- Population growth
- Equity issues (Gender, Cultural Groups)
- Human carrying capacity
- War and violence

D. Intangibles
- Values/Attitudes
- Land stewardship ethics
- Corporate investments in the environment
- Creation and implementation of environmental legislation
- Interdependency
- Collaboration

Participatory and Interdisciplinary Indicators of Sustainability: Where Do We Go From Here?

Barbara C. Bellows

INTRODUCTION

Sustainability is an often repeated objective within research and development proposals. The papers presented and the discussions conducted during the SANREM CRSP Conference and Workshop represent only a small contribution to the ongoing debate now being devoted to defining and characterizing sustainability. Now, more than over ten years after "sustainability" became a "buzz word," researchers and development workers continue to seek to define the parameters of this elusive term while the "end-users" their programs are designed to serve are forced to develop innovative processes to sustain their tenuous existence within an increasing fragile environment.

The SANREM CRSP Indicators of Sustainability Conference and Workshop had three major objectives:

(1) to expose participants to a range of perspectives of sustainability,

(2) to share information regarding methods and processes for identifying and using indicators of sustainability, and

(3) to initiate development of a field-based workbook for the identification and assessment of indicators of sustainability.

To accomplish these objectives, this Conference and Workshop brought together university and international agricultural research center researchers, governmental and non-governmental development workers, policymakers, and community members to share the breadth of participation. Conference presenters described sustainability from the agricultural, natural resource, social, economic and policy perspectives. They provided examples of sustainable and unsustainable systems from the farm plot and research plot; from farming communities and urban communities; and from the agricultural production system and the protected wilderness areas. Their papers examined site-specific characteristics of sustainability within defined cultures and environmental zones as well as global crises affecting sustainability worldwide. Sustainability was described as a condition, a process, an objective, and "something overarching to strive for." It was described in quantitative terms and as a set of qualitative values.

Conference participants recommended methods for the assessment of sustainability ranging from community-based dialogues to global ecosystem models, from discussions about perceived changes in resource conditions and community values to analytical assessments of soil erosion and biological integrity of stream ecosystems, and from analyzing stressors affecting local unsustainability and global crises to collaborative visioning for a sustainable future. Several speakers discussed perspectives of sustainability and methodologies for indicator assessments in relation to specific disciplines. Other speakers provided methodological frameworks designed to ensure integration of all disciplines and perspectives into any discussion of sustainability. Speakers and poster presenters discussed both processes for developing indicator programs as well as the indicators that are the products of these efforts. Many workshop participants stressed that indicators assessments must be conducted as an integral component of program development. They also stressed that indicators are means to the goal of enhancing sustainability: indicators should not be considered as an independent objective. Product would follow process: as program activities strengthened interdisciplinary and intersectoral associations, the range and type of indicators being addressed would become increasingly comprehensive and interrelated.

For interdisciplinary and intersectoral programs, such as the SANREM CRSP, a range of stakeholders will be involved in the definition of sustainability and its associated indicators. Each sector will introduce a different set of tools and criteria into the assessment of sustainability. Each sector will also have their own values to uphold as well as their own constraints to involvement. Sharing, discussing, and negotiating around these divergent perspectives may be an indicator of progress toward sustainability. One workgroup session recommended that the identification of indicators of sustainability should be perceived as an "invitation to dialogue." This summary attempts to delineate the parameters of this dialogue as developed by the conference speakers and poster presenters. These parameters form the preliminary outline for the development of the SANREM CRSP Indicators of Sustainability Workbook.

DEFINING SUSTAINABILITY

Definitions of sustainability provided by members of the workshop discussion groups ranged from "the ability to continue, recover, and endure" to the "balance among environmental quality, economic viability, and social equity." Conference speakers described several components of environmental quality including soil quality, water quality and quantity, diversity of microbes, flora, and fauna, crop diversity, recycling of resources, reduced use of pesticides and other external inputs, and ecosystem integrity and resiliency. Components of economic viability presented included whole farm profitability, market stabilization, capacity of farmers to adapt to changing market conditions, rural-urban economic linkages, balances between costs and benefits, aggregate economic activity, macroeconomic management, and poverty reduction. Important components of social equity discussed included family dynamics, horizontal social capital, "empowerment with responsibility," and equitable access to resources. Additionally, speakers and participants stressed that the institutionalization of policies that promote sustainability serves analytically as a strong indicator and practically as an requisite enabler of progress toward sustainability.

Sustainability was defined in terms of very practical and immediately measurable issues: viability of the family farm, groundwater pollution, money staying within the community, and awareness of hygiene. It was also defined in terms of theoretical concepts and visions of a sustainable future: ecological system integrity, food security, and social capital.

Ultimately, sustainability describes a universal web of interactions, interdependencies, and balances. Practically, each resource user, community, or organization has the capacity to address only specific components of this web. Remaining cognizant of the relationship of the specific components being addressed to the remainder of the web is the first challenge. Recognizing how changes in the larger web affect component processes is the second challenge. Identifying changes within the specified components that will enhance both the sustainability of the components and that of the larger web is the objective of all "sustainability" projects.

In the development of indicators of sustainability programs, the capabilities, uniquenesses, as well as the limitations of each program must be acknowledged. Difficult decisions must be made regarding priority spacial, temporal, disciplinary, and sectoral perspectives. Difficult decisions must also be made regarding priority beneficiaries of project activities. These decisions will affect processes for identifying and assessing indicators, priority criteria for indicator assessments, and the range of indicators used within a project.

The diversity of definitions for sustainability raises several questions for programs seeking to develop indicators. During the program initiation stage, an intersectoral program designated to identify and assess indicators of sustainability will need to define the unique niche of the programs and identify mechanisms for inter-acting among niches and across systems levels. Questions that may need to asked in defining this niche include:

· What is the primary system level of assessment and program activities?

· Who are the sectors and stakeholders involved in the program? Who will be primarily involved in assessment activities? Who will be the primary users of indicators? Who will be the primary beneficiaries of program activities?

· How will perspectives and criteria for sustainability be evaluated and prioritized? Who defines where the "balance among environmental quality, economic viability, and social equity" exists?

· What are the priority temporal perspectives of the program? How will short-term and long-term goals be addressed?

INDICATOR FUNCTIONS AND CRITERIA

Indicators of sustainability are descriptors of some component or process related to the degradation, maintenance, or enhancement of sustainability. Vosti noted how indicators may represent aggregations of information or be a mechanism for simplifying information. Madden described indicators as tools to motivate, conceptualize, interpret, synthesize, and take action. Functionally, indicators may be expressions of values and perceptions, direct or indirect correlates with the factor of interest, or analytical measurements. Indicators may be quantitative or qualitative, experiential or theoretical. Qualitative indicators may be anecdotal or based on analyses with high levels of significance.

Indicators can serve different functions and describe different processes or elements depending on the user's disciplinary and system-level perspective. Several of the conference speakers used indicators to describe environmental, social, or economic change processes. Change processes described formed a continuum in a causal sequence: stressors, states or conditions, impacts, and responses. Other conference presenters described how indicators could be used as research tools; to define goals and objectives, to predict outcomes, and to monitor and evaluate impacts. Development-oriented participants used indicators as motivational tools; to stimulate dialogue, to inspire visioning, and to empower.

The program perspective and the priority functions of indicators within a program affect the processes used for indicator identification and who is involved in these processes. Speakers from the sociological, anthropological, and development perspectives gave priority to community-based and experiential information and indicators that reflect cultural values (e.g. Flora et al., Rhoades and Sandoval, Kline, Ouadba et al.). From this perspective, involvement of relevant community sectors in the identification and assessment of indicators is essential.

Researchers and farmers concerned with integrating scientific and indigenous information (e.g. Altieri et al., Deutsch et al., Boody and Johnson, and Hitt) described how farmer-researcher collaborations could be used to enhance community involvement in technical analyses. They also discussed how sustainable technologies may be developed based on the comparison or integration of "western" and indigenous analysis systems.

Program managers and research coordinators outlined systematic and iterative methods for generating a comprehensive examination of the issues affecting sustainability (e.g. Muller, Dumanski, and Norton). These frameworks are designed to involve a broad-base of stakeholders in indicator development and to ensure a multidisciplinary discussion of the factors affecting sustainability.

Policy analysts delineated the importance of incorporating information across sectors and systems levels into the formation of policies that enable rather than discourage sustainable practices (e.g. Tschir-ley, Wilcock and English, Benbrook, and Escobar). They also acknowledged that availability of reliable information in usable form and differences in assessment processes and objectives across sectors and countries were constraints to achieving this cross-system integration.

Participants in the workgroup sessions maintained that requisite criteria for indicators will, and should, differ depending on the system level at which the analysis is being conducted and the sectors involved in the analyses. Indicator criteria will also vary based on whether primary or secondary information is being collected, whether area remoteness poses logistical constraints to analysis, or whether a high level of detail and statistical significance is required. Development workers and researchers working at the community level stressed that indicators developed and used at the household and community level must be not only sensitive to but also reflect the local cultural values. Descriptive and qualitative indicators, they argued, provide perceptual, attitudinal, and motivational information that cannot be captured in a quantitative form. Researchers and policymakers interested in monitoring changes across sites and over time, however, required indicators that were based on quantitative measurements associated with reference values.

The system level at which the project operates affects whether priority is placed on site-specific or universal indicators or whether emphasis is given to short-term or long-term perspectives of sustainability. Programs operating at the farming system or watershed levels require indicators that are site-specific: indicators that reflect the unique characteristics and interactions of the area. Programs operating at the national or international levels require indicators that reflect commonalities across sites or that can generate predictions based on tendencies for interactions to occur. Indicators for grass-roots, participatory programs must reflect a balance between short-term needs and long-term objectives. Indicators for research programs must reflect long-term goals while simultaneously being amenable to periodic evaluations. Tschirley warned that short-term objectives and evaluations must be conducted within the framework of long-term goals in order to avoid short-term benefits gained at the expense of incremental degradation. The development of policies having long-term implications requires indicators that can predict and monitor long-term trends.

For intersectoral and interdisciplinary programs, such as the SANREM CRSP, the development of protocols for indicator identification and assessment will require negotiation among all collaborators and stakeholders. Dialogues should address differences regarding sustainability perspectives, system-level focus, indicator criteria, stakeholder involvement, and temporal perspectives. Negotiations should be based on commonalities among programs, capabilities within each program, and a consensus regarding program objectives. The following questions may be used to guide these dialogues.

- What sectors will be involved in the program? What system levels does each sector represent and/or address?

- What are the mandates and missions of each sector? How do each of these mandates and missions complement or conflict with the mandates and missions of the other collaborative sectors?

- What are the capabilities of each sector? What are their limitations or constraints?

- How will priority indicator criteria be chosen? Will sectors use different indicator criteria? If so, how will indicators be shared and integrated intersectorally?

- How will short-term analyses be linked to long-term objectives? How will linkage mechanisms motivate participation while avoiding the pitfall of incrementalism?

INDICATORS OF SUSTAINABILITY IDENTIFICATION AND ASSESSMENT

Several conference speakers and poster presenters described case studies of tested methodologies for identifying and assessing indicators of sustainability. Other presenters discussed proposed approaches for obtaining or integrating indicator information. As many presenters demonstrated, the identification and assessment of indicators can rely to a significant extent on accepted participatory or analytical research methods. Participatory methods that may be used in this process include: Participatory Rural Appraisals (PRA), community meetings, citizen monitoring teams, participatory resource mapping and evaluation, participatory discussions of social values, and community involvement in program decision making. Recommended technical assessments mentioned by participants included assessments of soil erosion, soil quality, climate change, yields, water quality, biodiversity, profitability, and quality of life. Analysis methods included participatory monitoring, on-farm experiments, researcher managed experiments, surveys, analyses of secondary information, remote sensing, modeling, and scenario building.

Workshop discussion group members recommended identifying analysis methods and frameworks for indicators that provide for flexible integration of theories and approaches from a range of disciples. They also recommended the development of innovative techniques for combining process-based, qualitative, and quantitative information. Conference and poster presenters provided several case study examples illustrating how experiential and technical information could be combined. Boody and Johnson, Deutsch et al., and Muller described processes for combining community-based resource monitoring with scientist-directed technical assessments of environmental quality. Madden and Altieri et al. described how NGO-led community groups have combined indigenous and technical information to enhance the sustainability of agricultural systems. Jodha described how people's concerns, frustrations, and hopes could be used to identify degradation processes at both the micro and macro levels. Lightfoot, in his poster presentation, described a processes for integrating participatory monitoring and evaluation information with computer-based analyses. Poster presenters Boerboom and Flitcroft outlined plans for incorporating indigenous knowledge and perceptions from stakeholders into GIS and modeling programs.

Several innovative and iterative processes for integrating indicator assessments across disciplines, sectors, and system levels were also presented. Muller provided a framework for monitoring whether programs are comprehensively addressing all ecological, social, and economic aspects. Conference speakers and poster presenters described iterative methods for proposing, evaluating, and validating potential indicators (e.g. Dumanski, Wilcock and English, Munster and Hellkamp, Siambi et al.). Guidelines for linking macro and micro information across system levels were also provided (e.g. Escobar, Wilcock and English, Tschirley, Benbrook).

Although numerous innovative approaches to indicator of sustainability identification and assessment were proposed, conference and workshop participants cautioned that constraints may frustrate the development of integrated and holistic indicator programs. Carpenter outlined measurement and statistical problems associated with conducting quantitative biophysical analyses under field conditions. Hitt discussed how time constraints, other priorities, lack of commitment by researchers, and poor farmer-researcher communication may discourage farmers from participating in research efforts. Madden warned of "holistic paralysis:" doing nothing while trying to ensure that everything is addressed. Workshop participants noted that academic requirements or journal standards may hinder researchers from forming committed participatory relationships. Similarly, the short-term perspectives of funded programs may be inconsistent with the needs and perspectives of people living in the project site. The development of collaborative programs may be hindered or delayed if there presently are few programmatic mechanisms for communicating and interacting among sectors and disciplines or if disincentives to cross-sector interactions exist.

Processes and methods used for indicator of sustainability identification and assessments will depend on the capabilities and the level of interest of the sectors involved. Workshop members emphasized that collaboration does not mean everyone doing the same thing all of the time. Instead, they argued that project stakeholders should acknowledge and capitalize on the different capabilities of the different sectors involved. For identifying indicators, community members can contribute their knowledge of the area while researchers can contribute comparative information and knowledge of potential external impacts on the area. At the local level, community-based descriptive and qualitative indicators can provide perceptual, attitudinal, and motivational information that cannot be captured in a quantitative form. Assessment of indicators by community members can be facilitated by identifying indigenous methods or analytical tools that are low cost and easy to understand. Researchers can use accepted analytical procedures to verify, correlate with, or supplement the information provided by the community members. These researcher-led analyses should adhere to criteria for technical indicators: replicable, technically acceptable, based on quantitative measurements, and associated with reference values.

Additionally, different sectors may be involved at different system levels or at different times in the indicator assessment process. Just as indicator assessments need to address short-term needs within the context of long-term goals, indicator programs need to be grounded in the practical within the vision of the possible. Process-oriented questions that may help guide the development of a pragmatic yet visionary assessment program include:

- Will all sectors operate at the same system level or at the same time in project development? Could sectoral responsibilities be staggered across system levels and implementation times?

- Are responsibilities for assessments consistent with the involvement capabilities of the stakeholders.

- How will the priority indicator criteria chosen affect how research and development programs are conducted?

- How will the program interact with collaborating agencies and outside programs to ensure a holistic analysis of sustainability?

- How will indicators be assessed and used across system levels? How can community members monitor and use macro-level indicators? How can policymakers and analysts obtain and use micro-level indicators?

- How, when, and in what form will indicator information be shared among sectors or across system levels?

- How will the process used for intersectoral and cross-system integration affect who benefits and who loses from the process? How will who benefits change over time?

· How can the documentation of problems as well as successes encountered in indicator assessments help the program identify and address new indicators?

Intersectoral dialogues should assist programs to identify a comprehensive complement of indicators. In addition, interactions among sectors and disciplines should catalyze the formation of innovative assessment processes based on combinations of disciplinary methodologies and statistics or sectoral criteria. Workgroup members noted that addressing sustainability holistically may necessitate rethinking fundamental disciplinary principles and theories. This may necessitate taking academic risks. It also may involve taking Vosti's advice and being willing to develop indicators before a new supporting theory is developed. Questions that can guide the formation of a comprehensive set of integrative indicators include the following:

· How can indicators or indicator assessment processes be formulated to simultaneously address the mandates, visions, and requirements of each of the sectors involved?

· How can ecological, social, and economic principles be used to develop indicators that are both site-specific and have universal application?

· How will qualitative and value-based information be integrated with quantitative analyses?

· How can anecdotal information from community groups or development programs be incorporated into the development of indicators acceptable to researchers and policymakers?

· How will/can indigenous information be integrated with scientific information?

· How can methodologies, statistics, and analysis tools be shared or combined among disciplines?

· How can indicators be developed or transformed to enhance communication and collaboration among sectors?

WHERE DO WE GO FROM HERE: THE SANREM CRSP INDICATORS OF SUSTAINABILITY WORKBOOK

The component niche of sustainability being addressed by the SANREM CRSP is defined by the four pillars of the program; intersectoral, interdisciplinary, participatory, and landscape-based. Through the integration of these pillars into program development, the SANREM CRSP seeks to provide a forum where scientific, indigenous, analytical, and experiential perspectives can be combined to understand and enhance agricultural and natural resource sustainability. The SANREM CRSP also endeavors to develop frameworks for integrating and aggregating information across farm, household, community, landscape, and global system levels in a manner that maintains sensitivity to local conditions and issues of social equity.

The Indicator of Sustainability Workbook will assist researchers, development workers, and community members to integrate indicator of sustainability information and processes into program development, implementation, and evaluation activities. The workbook processes will encourage collaborators to be innovative while simultaneously recognizing the wealth of information available from existing sources: indigenous knowledge, published reports, grey literature, and methodology handbooks. It will also provide guidelines for networking and sharing information so that "reinventing the wheel" is minimized. It will encouraging the sharing of information being developed by the profusion of programs within research institutions, universities, development organizations, and policy institutes currently addressing this topic.

The workbook will initially be developed in a format appropriate for researchers and development workers. Questions provided in this summary will be used to assist collaborators in identifying indicator criteria, developing collaborative interactions, and ensuring a holistic perspective of sustainability. Indicator implementation will be facilitated by the provision of bibliographies and descriptions of participatory research methods, analytical methodologies, and development processes. Workbook implementation will be based on environmental, social, and economic principles and not on methodological recipes. Successes in workbook implementation will be acknowledged and problems encountered in workbook implementation will seen as opportunities for furthering collaborations and understanding new paradigms. Documentation of successes and problems will permit revision of the workbook. It will also guide the development of two additional formats of the workbook.

Based on participatory, field testing of the workbook and the collaborative identification of site-specific conditions, perceptions, and values, a community-based format of the workbook will be developed. This format will be written in the language(s) of the community members and contain examples from their own experience. Indicators for assessment will include those identified by community members during the initial testing of the workbook. Assessment methods will be consistent with the interests and capabilities of the relevant community sectors.

A final format of the workbook will be developed for policymakers. This format will provide guidelines for incorporating community and watershed based information into regional, national, and international policy analyses.

Through collaborative development and iterative, participatory testing, the workbooks will help guide and monitor the impact of both project activities and exogenous forces on agricultural and natural resource sustainability.

POSTER

ABSTRACTS

COMMUNITY-BASED INDICATORS FOR WATER QUALITY

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As part of a work plan pertaining to water resource management and education at the SANREM, Philippines site, community members were trained to use portable water test kits and other equipment to measure physical, chemical and biological characteristics at several stream sites and a reservoir. Preliminary findings have detected both natural and human-induced water quality gradients for several parameters related to position in the landscape and land use. Continued citizen monitoring will help other community members become more aware and interested in their natural resources, provide valuable baseline data for SANREM researchers and lead to the development of simple micro-indicators for sustainable management of water, soil and biodiversity.

KEY INDICATORS OF AGRICULTURAL SUSTAINABILITY AS IDENTIFIED IN THE CONTEXT OF BURKINA FASO, WEST AFRICAN SITE

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Increased population pressure on land, soil constraints, drought, deforestation and improper management practices have resulted in rapid soil degradation and unsustainable food production at the SANREM site of Donsin in Burkina Faso. This led to chronic crop failure and insecurity. Yet, the social and economic development of Donsin as well as that of the country remains almost entirely dependent on agricultural production. Numerous tentative solutions have failed as a result of instable or improper development programs. With high illiteracy and unadopted education programs, knowledge transfer has been rendered particularly difficult, compounding sustainability constraints.

In recent years, improved approaches to development problems have been initiated by government agencies, international organizations and NGO's. SANREM fits in this scheme as a strong partner and innovator. These new development strategies require good definition and survey of sustainability indicators with time. This poster presents key indicators of sustainability as identified in the context of Burkina Faso. These indicators can be classified according to their social, biophysical, economical, infrastructural, institutional and political components.

EARTH AND SUSTAINABLE MANAGEMENT OF HUMID TROPICS OF LATIN AMERICA

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The Humid Tropics is perceived as the last frontier for expanding high cash input agricultural practices to fulfill the increasing demands for food and fibers worldwide. This has led to the destruction of natural ecosystems and presently poses a serious threat to our own survival. The school of agriculture for the humid tropical region (EARTH) plays a leadership role in educating young people from Latin America in sustainable management of this fragile environment. This 4-year teaching institution uses the philosophy of learning-by-doing through a well structured upside down curriculum centered towards agriculture, food and natural resource management. The courses such as work experience, entrepreneurial projects and research projects challenge the student to explore sustainable production alternatives and to share them with the community through the internship and continuing education programs. These students are our real assets and once graduated they will seek out viable and sustainable management alternatives for this fragile region.

THE LANDSCAPE AND LIFESCAPE OF THE MANUPALI WATERSHED

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· DILG/Lantapan
Romeo Banaynal
·NECI
Gladys Buenavista
· SANREM CRSP/Philippines
Teddy Pajaro
· Mayor Municipality of Lantapan
Mariliza Ticsay-Ruscoe
· UPLB/IESAM

An informational poster displaying the landscape and lifescape of the Manupali Watershed.

A FRAMEWORK FOR THE IDENTIFICATION, ASSESSMENT AND USE OF INDICATORS OF SUSTAINABILITY

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The identification, assessment and use of indicators of sustainability are affected by the perspectives and objectives of the organization conducting the assessment, the primary and secondary system (hierarchy) levels of assessment and proposed use of the indicator information. An interactive and iterative identification and assessment of indicators depends on the integration of community-based/experiential information with technical/analytical assessments. To link participatory and technical assessments across hierarchy levels, indicators assessments may be based on a combination of analysis processes including experiential information, retrospective data, technical biophysical and socioeconomic assessments and policy-based information. The assessment of indicators will lead to the development of alternative systems that meet the present and future objectives of society (applied research/development) and processes to motivate change and awareness of sustainability processes, resource use practices and policies. Indicator assessments will be iterative based on the impact of pressures on systems processes and functions and how the responses elicited from these pressures affect natural resource sustainability and sustainable human systems.

SUSTAINABILITY INDICATORS AND ISSUES: THE CASE OF BARANGGAY HALOG IN LAMUT, IFUGAO, PHILIPPINES

Rogelio C. Serrano
· PCARRD

Amidst the ongoing recession of forest lands in the Philippines, the indigenous forestry and agroforestry system of the Ifugaos in Northern Philippines stands out as a model case. The system involves a combination of *muyung* (second growth dipterocarp forest underplanted with coffee), *uma* (traditional swidden) and *payoh* (rice terraces). The *muyung* subsystem is key to providing sustainability to the *payoh* and *uma* subsystems. It serves as source of water and nutrients for the *payoh* while providing protective buffer affect and seeds for the *uma* under fallow.

The existence to date of this upland farming system under productive state attests to its sustainability. Indicators of its sustainability include conservation of biodiversity (flora and fauna), conserved status of soil and water, adequate swidden fallow system (7-8 years) and continuity of streams of economic benefits. The inherently high ecological consciousness of the Ifugao folks and the affinity of the production system to their local culture are contributory to the persistence of their practice through the years.

Of late, however, the current influence of the cash economy system from the adjoining lowland tends to serve as temptation to the community to cut their standing timber at a faster rate in order to convert it into cash.

BENEFIT SUSTAINABILITY CONTINUUM: INTEGRATED ANIMAL AGRICULTURE

Jennifer Shumaker and Jerry Aaker
· Heifer Project International

This poster presents the dynamics of the development process over time, in terms of three categories of change: direct benefits, continuation of benefits, and expansion of benefits. It can be used both for presenting the concept of indicators for these three categories as well as a participatory training tool with project groups.

A basic framework for HPI's program are 12 "cornerstones of just and sustainable development." These are used to screen, monitor and evaluate livestock projects aimed at bringing about holistic transformation in people's lives.

Using these cornerstones and their corresponding indicators, the poster demonstrates how to evaluate and visualize change and benefits to people. As a training tools, these can help project participants and technicians identify their most important indicators, where they are in an ongoing and dynamic process and the tendency (or not) toward sustainable change.

RESTORE: A RESEARCH TOOL FOR NATURAL RESOURCE MANAGEMENT MONITORING AND EVALUATION

Clive Lightfoot
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RESTORE is a farmer participatory research tool for natural resource management monitoring and evaluation. The tool comprises a set of participatory research procedures and computer based analysis for four sustainability indicators: bioresource recycling, species diversity, natural resource capacity and economic efficiency.

The following procedures provide a "learning experience" for both researchers and farmers in natural resources management:

(1) Indigenous categories of natural resource types on the farm are identified and mapped. How these resources are used and who has access to them are determined. The flows of biological resources within the farm are then modelled.

(2) These outputs provide a vehicle for farmer-researcher brainstorming on experiments to rehabilitate water resources, increase the number of utilized species and recycling of by-products and wastes.

(3) Participatory monitoring and evaluation tells us which way the farm is changing in terms of the four sustainability indicators. Results are "taken back" to the farmers using the sustainability kit and bar graphs which enhance the farmer-researcher brainstorming. This process sets in motion further changes and thus the continuing transformation of the farming system.

RESTORE captures the participatory research data to enable comparisons of sustainability indicators both across farms and in time series. Our limited experiences with RESTORE in Malawi, Ghana and the Philippines suggests that impacts at the farm level can be impressive - net incomes rose by more than 50% except in Malawi where drought and devolution held increases down to a still impressive 15%. Moreover, all four sustainability indicators improved. However, there was much dynamism involved in their behavior over time. We anticipate that RESTORE will provide benefits to farmers, extensionists and researchers. Farmers could improve their knowledge and skill in natural resource management. Research and extension workers could learn more about natural resources and sustainability as well as becoming more responsive to farmers technical needs. They could also improve their capacity to monitor and evaluate the impact of their interventions.

INTEGRATED VILLAGE DEVELOPMENT PLAN FOR PROGRAM SUSTAINABILITY

Anibal Oprandi
· PLAN International/Surabaya, Indonesia

The Integrated Village Development Plan is a systematic approach which utilizes specially designed evaluation methods and techniques to enable communities to assume responsibilities for their own development. Linkage of community groups has been implemented in several parts of the world. PLAN's own experience was based on efforts in the Philippines, with modifications over the last 10 years. Today our challenge is to empower communities to make changes themselves which make the model more appropriate and effective to their own needs.

LINKING A GIS, WATER QUALITY MODEL AND AN EXPERT SYSTEM TO INTEGRATE SCIENTIFIC AND INDIGENOUS KNOWLEDGE IN THE PHILIPPINES

Luc Boerboom and Ian Flitcroft
· University of Georgia

Problems that the stakeholders in the Philippines SANREM site have identified are related to water shortage, transport of sediments, nutrients and pesticides. Intensive land use and deforestation are thought to threaten quality of potable water, power supply from a reservoir, agricultural production, and water availability for irrigation.

This poster illustrates that Geographic Information Systems have been used so far to monitor spatial databases of indicators of the resource base, such as land use or income distribution. However, in order to monitor and predict dynamic erosion processes, simulation modeling is required. Here, GIS would be used to display input and output.

Sustainable land use systems can not be designed by looking at scientific knowledge only. Stakeholders that are part of the cause-effect relationship with regard to erosion, are the ones that manage a watershed. They have to manoeuver within the options they have, making decisions based on their knowledge about their environment, and using their set of indicators for sustainable land use. The boundary conditions set by different indigenous knowledge bases, need to be taken into account when land use alternatives, to minimize erosion related problems, are simulated.

To achieve this, the GIS and modeling group is using the Soil and Water Assessment Tool (SWAT), which is linked to a GIS, in cooperation with its developers at the Blackland research station in Temple, Texas. The group will prepare GIS overlays of SWAT's simulations for the catchment and the perceptions of different interest groups concerning water erosion.

In order to account for the rules that are employed in both scientific (SWAT) and indigenous knowledge bases, we propose to develop an expert system that optimizes between knowledge bases. Both sciences and social sciences have experience in developing expert systems. It would make expertise of scientists and different stakeholders explicit and comparable. Furthermore, it would go beyond analysis, searching for alternative land uses.

SOIL QUALITY RESEARCH AT THE NATIONAL SOIL TILTH LABORATORY

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Introduction

The importance of developing sustainable land management practices is being recognized by more people as their awareness of the health and environmental implications of conventional crop production strategies increases. One product of this increased awareness is the concept of soil quality, which may provide a basis for evaluating the long-term effects of various soil and crop management practices. Several definitions for soil quality have been proposed, but in general it can be defined as the capability of a soil to produce safe and nutritious crops in a sustained manner over the long term and to enhance human and animal health, without impairing the natural resource base or harming the environment (Parr, et al., 1992). Developing the protocol to measure and evaluate soil quality is a prerequisite for determining sustainable management practices. A first step in this process is defining soil quality attributes (indicators) which, depending on the land use, are measurable soil properties that influence the capacity of a soil to perform a specified function (Acton and Padbury, 1993).

Rationale

Assessments of soil quality may be useful for optimizing land use plans and choice of crop management strategies. However, it is imperative that quantitative assessments be valid, reliable, sensitive, repeatable and accessible. Ideally, several indicators could be identified and used in developing a framework for overall evaluation of soil quality.

Objective

A multi-faceted approach has been adopted at this laboratory to develop a procedure that can be tailored to site specific situations and used to quantify soil quality impacts. Evaluations of several biological, chemical and physical indicators of soil quality from long-term experiments and Conservation Reserve Program (CRP) lands have been done and more experiments are in progress.

Materials and Methods

The initial studies have focused on soil aggregate characteristics, penetration resistance, bulk density, volumetric water content, earthworm populations, respiration, microbial biomass, ergosterol concentrations and chemical parameters as primary physical, chemical and biological indicators of soil quality. These measurements are interpreted or scaled according to the typical values published in the literature. The scaled or normalized values are then combined in a matrix designed to evaluate how well a soil performs certain functions. Our initial studies have focused on four soil functions: (1) accommodating water entry (infiltration) (2) water retention and availability to crops (water holding capacity) (3) resistance to degradation (crusting and aggregate breakdown) (4) ability to support plant growth (productivity). Potential soil quality indicators which help quantify these functions are identified, assigned a priority or weight that reflects its relative importance and scored. Individual scores are used to compare an overall soil quality rating based on several physical and chemical indicators.

Results

CRP Sites. Ten sites were identified in northeast and southeast Iowa. Sites consisted of paired soils of the same type under both CRP and row-crop arrangement. Preliminary results indicated that nitrous oxide evolution, soil ergosterol content and electrical conductivity were not useful indicators of soil quality at all sites. Total N, Total C, microbial biomass, wet aggregate stability, nitrate and hyphal length appeared to be useful indicators of soil quality and should be included in the minimum data set.

Crop Residue Effects. An evaluation was conducted on a long-term no-till site established on loess-derived Rozetta and Palsgrove soils. Several proposed soil quality indicators were evaluated to determine effects of removing, doubling or maintaining crop residues for 10 years in a no-till, continuous corn production study. Soil aggregates from double residue treatments were more stable in water than those from normal and removal treatments. The double and normal residue treatments had higher levels of microbial activity as measured by CO2 evolution. Ergosterol concentrations, where crop residues were removed, were 8 to 10 times lower suggesting that this biochemical measurement of fungal biomass may be a sensitive soil quality indicator. Earthworm populations, where crop residues had been removed for 10 years, were significantly lower than in either normal or double residue treatments.

Tillage Effects. The same framework for evaluating soil quality was used to evaluate data collected from a long-term tillage study. Plots managed with no-till practices for 12 years before samples were collected had surface soil aggregates that were more stable in water and higher total carbon, microbial activity, ergosterol concentrations and earthworm populations that either chisel- or moldboard-plow treatments. The soil quality index indicated that long-term no-till management had improved soil quality. The index values support the conclusion that no-till practices on Rozetta and Palsgrove silt loam soils can improve soil quality. Furthermore, the systems engineering methodology used to develop a soil quality index may prove useful for developing a more comprehensive sustainability index.

Spatial Variability Effects. The spacial variability of several potential soil quality indicators was evaluated at the field-scale for two sites in central Iowa. Distributions and spatial trends for 28 different soil parameters were evaluated. Twelve parameters at site one (including organic C, total N, pH and macroaggregation) and four parameters at site two (including organic C and total N) were very spatially dependent. Six parameters at site one and nine at site two were moderately spatially dependent. By understanding the spatial variability of these parameters, we will be able to improve our ability to extrapolate information taken from one field or location to others with similar landscape characteristics.

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ASSESSING BIOPHYSICAL CONSTRAINTS TO SUSTAINABLE AGRICULTURE IN AFRICA

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Africa is a vast continent with a tremendous resource endowment and good potentials for sustained agricultural productivity. If the agricultural performance is measured in terms of per capita food production, there is an alarming decline in the last few years. There are many reasons for this including political and socioeconomic instability. The consequence is a decline in the quality of the land resources base in many countries. Many assessments have been made of the land resources of Africa. The current study, presented in this poster, uses recent information and a larger database than previous studies. The objective of this study is:

- an assessment of the land resource base for sustainable food production at several levels of management inputs using biophysical conditions as indicators of sustainability.

Methodology

The digitized maps were prepared using digital data derived from the database developed by the World Soil Resources group of the Soil Conservation Service. The source of the base map is the U.N. Food and Agriculture Organization's Soil Map of Africa, (UNEP/GRID 1992) at 1:5 million. PC Arc/Info was the GIS platform used for all vector maps. The initial phase was to convert the FAO soils map to the Soil Taxonomy classification. During this process, soil climate, derived from over 2000 African weather stations were converted using the Newhall Model and merged as attributes to the database. Georeferenced pedon descriptions from the SCS international soils database and country data were used to evaluate classification reliability. Assessment and classification of soil quality and sustainability are thus inferred to soil polygons having similar relationships of physical, water relations, chemical and potential fertility attributes.

The biophysical component of the concept of Soil Sustainability are those soil related processes that affect the long-term sustainability of managed agricultural systems. Interpretations of the soil biophysical characteristics are inferred from the range of properties employed to classify the soil at the Great Group level of Soil Taxonomy. Some of the processes that are evaluated and spatially shown as indices of Soil Quality are the influences of erosion, nutrient depletion, salinization, and acidification. This leads to a general measure of Soil Quality which is an evaluation of the enduring quality of the soil for the following functions:

- Facilitate plant growth,
- Regulate infiltration and distribution of surface water,
- Buffering of long-term effects of agricultural chemicals or organic wastes.

Sustainability potential is rated for three levels of input scenarios.

Low Inputs: Assuming only hand labor, no fertilizer and pesticides, no soil conservation measures and assuming productivity losses due to soil degradation.

Medium Inputs: Assuming use of improved hand tools and draught implements, some fertilizer and pesticide application, some basic soil conservation practices thus moderating losses from soil degradation.

High Inputs: Assuming full agricultural mechanization, full use of optimum genetic stock, use of necessary farm chemicals and soil conservation practices.

Discussion

Conversion of FAO soils data to, the more soil climate dependent, Soil Taxonomy provide for improved visualization and assessment of the potentials of biophysical constraints to Soil Taxonomy. Soil interpretation reliability is enhanced with the additional level of environmental classifications which are correlated to other verified soil climates distributed globally. Soil sustainability for regions lacking sufficient soils/ climate information can thus be inferred with a greater degree of reliability based on similar environmental conditions in regions having more of a diversity of data.

At the map scales shown, the climate domains show similarity in distribution that correspond to latitudes north and south of the equator. The distribution of the ecologically fragile semi-arid regions bordering the northern and southern deserts are prominently visualized. These regions are where the biophysical constraints are especially severe due to a combination of drought susceptibility and increasing human pressures on the land resulting in the spread of desertification. The potential for agricultural sustainability is marginal without heavy inputs and management which is beyond the capability of many developing countries. Social unrest is a related threat in these stressed ecosystems as evidenced by political instability, communal/tribal conflict and by the impairment of regional food production and distribution infrastructure.

AN EVALUATION OF SUSTAINABLE LAND MANAGEMENT IN THE CIMANUK WATERSHED, JAVA, INDONESIA

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The island of Java, Indonesia has one of the highest human population densities in the world with a 1990 population of nearly 108 million. Where population is high, agricultural land is often highly stressed. To meet demands for food and fuel, people are often forced to use marginal lands. These lands are often highly susceptible to degradation caused by intensive land uses. Utilization of sustainable land management practices is vital in attempting to maintain the future viability of current agricultural lands. The identification of the spatial distribution of constraints to sustainability becomes important in order to focus implementation of sustainable technologies to areas having the greatest need.

The Cimanuk watershed is located in West Java, comprises approximately 41,000 ha and has a tropical climate. The original soil survey was completed in 1976 by the Food and Agriculture Organization and the Soil Research Institute of Bogor, Indonesia.

The objectives of this study are to evaluate the spatial distribution of constraints to sustainable agriculture for the Cimanuk watershed area. Soil conditions are matched to crop performance in order to recommend areas for specific crops, and an assessment of land use for the area is performed to aid in land use policy decisions.

Materials and Methods

The soil map of the watershed at 1:100,000 scale was digitized using Geographic Resource Analysis Support System (GRASS) geographic information system (GIS). The digitized map has 622 polygons made up of 158 different map units. Attribute data for each map unit was entered into a data base management system to facilitate data base queries. The following data was available for each map unit: USDA Soil Taxonomy classification to the subgroup level, slope, depth, texture, coarse fragments, drainage, base saturation, cation exchange capacity, available P, exchangeable K, and pH.

Results and Discussion

Maps identifying soil classification, slope, soil depth, texture, drainage, pH, and available phosphorus were produced. Based on some of these soil properties, a map showing the biophysical constraints to sustainable agriculture was also developed. Four biophysical constraint classes were defined: unsustainable, many, moderate, and few. A map unit was classified as unsustainable if: the slope was steep or very steep, or the depth was shallow, or the coarse fragment was skeletal, or the pH was very acid or very alkaline.

Maps were then developed showing potentials for growing particular crops. The two most important soil properties that influence each crop were identified and were used to create three crop potential classes: high, medium, and low.

Maps were produced identifying potentials for traditional crops and include: padi rice, upland rice, coconut, bananas, and papaya. Maps identifying potentials for non-traditional crops were also developed and include: cocoa, rosella, jute, oil-palm, and rubber. One reason for identifying these non-traditional crops is that they could possibly provide added economic stability to the area while maintaining the sustainablilty of the land.

Validation of the methods used in making these interpretations was not performed. Future study of this area to gather more data is necessary for a more comprehensive assessment. Crop selection and land use options are largely determined by the prevailing socioeconomic conditions occurring at a locality. Therefore, demographic data is crucial in forming a valid assessment of land use options and crop potentials.

Table 1. Biophysical constraints to sustainable agriculture

Constraint Class	Area (Ha)	Percent
Unsustainable	131,960	32.1
Many	179,830	43.7
Moderate	91,584	22.3
Few	7,500	1.8
Water	520	0.1
TOTAL	**411,123**	**100.0**

ASSESSMENT OF SOIL QUALITY INDICATORS IN ALBANIA

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The recent traumatic change from a centrally controlled to a free market economy in Albania has impacts on all aspects of the agricultural systems. A major result is creation of a large force of landowners who have limited experience in making farm management decisions and with the absence of a functional extension service, are handicapped in practicing sustainable land management. If the situation prevails for any length of time, degradation of the resource base is guaranteed. Consequently, assessment and monitoring of the resource base is a prerequisite to understanding the system and with the implementation of sustainable land management, major catastrophes could be averted.

The poster is a preliminary assessment of the land resource conditions. The Soil Map of Albania, at scale 1:200,000 published in 1958, is used as the base information for the 1994 Soil Map. A major task was to translate the Albanian system of soil classification, which has been adopted from the Russian system, to Soil Taxonomy. This is partially accomplished by traversing major landscapes in the country, making spot observations at randomly selected points and describing and sampling about 17 major soils of the country. The Soil Map is generated using a GIS (PC ARC/INFO) and the poster presents additional information on soils and landscapes.

As might be seen also in the pie chart, Alfisols occupy vast areas all over the country, followed by Inceptisols, Mollisols, Entisols, Vertisols and Histosols. Albanian landscape is very broken, but mostly dominated by mountains and bared rocks. That is why we have included in the map a special subdivision named Rock Land, which is a mixture of rock and soil.

In addition, the poster presents maps showing soil climate, texture, soil depth, wheat performance and potential land use. In a preliminary evaluation we can say that Albania has sufficient soil resources to provide food and timber for its people in harmony with the environment.

These maps will be the basis for major national development planning initiatives and challenges that the country faces in its new steps to the free market economy. Soil properties and climatic and landscape conditions are used to evaluate and signal the high risk degradational areas. Indicators are also developed to assist this process. They consist mostly in defining the best land use for different areas regarding their slope, climate and soil quality. In the centrally controlled economy, decisions were taken by the government for everything and the farmers did not have any choice in changing those decisions. That caused damage on natural resources, primarily forests and pastures, which mistakenly were used for arable crops resulting in severe erosion.

Now Albania faces other problems which may have other kinds of repercussions. This relates to an almost complete abandonment of the farmers by the government. We think that this is also dangerous and needs to be moderated. Farming systems must be organized and coordinated so that the prices of farm products are stabilized and food security ensured.

The study also signals the fact that privatization in the absence of simultaneous application of sustainable land management practices is not the best formula for equity development. Indicators become very valuable to evaluate trends in conditions so that corrective measures are taken before the situation become irreparable.

THE EMAP-AGRICULTURAL LANDS PROGRAM: ASSESSING THE ECOLOGICAL CONDITION OF FARM LAND IN THE UNITED STATES

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Background and Objectives

In 1988 the United States Environmental Protection Agency, needing data to show whether environmental policy is working, launched the Environmental Monitoring and Assessment Program (EMAP). Many agencies now participate in the program, including several within the U.S. Department of Agriculture: the Agricultural Research Service, the Soil Conservation Service, and the Forest Service. Within EMAP there are seven resource groups: Forests, Rangelands, Agricultural Lands, Surface Waters, Estuaries, the Great Lakes and Landscape Ecology. Parallel to the objectives of EMAP as a whole, the Agricultural Lands Resource Group (ARG) seeks to:

(1) estimate the status and trends in selected indicators of the condition of U.S. agricultural lands on a regional basis with known statistical confidence,

(2) estimate the geographic coverage and extent of U.S. agricultural lands with known statistical confidence,

(3) seek associations between selected indicators of natural and anthropogenic stresses and indicators of the condition of agricultural lands, and

(4) provide annual statistical summaries and periodic assessments.

Conceptual Framework

A great deal of effort was put into deciding on a definition of an agroecosystem and into developing a conceptual model to describe agroecosystems. Once written, the definition and conceptual model were primarily used as presentation tools. They point out that we consider agricultural lands to be ecosystems and that such systems include not only fields, orchards and pastures, but also the surrounding windbreaks, drainage networks, etc., although the boundary of the system is unavoidably vague. One helpful concept is the recognition that the agroecosystem fits into a landscape which in turn belongs to the rest of the world. Various materials and information are exchanged among those levels. In addition, agroecosystems belong to economic units (farms) and are affected by socioeconomic forces such as government policy. It is the mission of EMAP-Agricultural Lands to collect data from agroecosystems and landscapes and to provide that information to policy makers, scientists and other users.

Early writings of the ARG emphasized sustainability as the central principle around which indicators were to be designed. It was recognized that there are different levels of sustainability from the field to the landscape to the region to the world. Parallel to this spatial hierarchy there are ecological, economic, and social aspects to sustainability. The conscious decision was made to focus on ecological sustainability, consistent with the mission of EMAP as a whole. However, there is a growing recognition that socioeconomic matters cannot be ignored when doing assessments. Decisions about the difficult issues of carrying capacity, human health, or the appropriateness of growing certain crops were deliberately avoided.

There has been a slow shift in the way the ARG describes its work. Now we talk more about monitoring and assessing ecological condition rather than sustainability. In part this is because of the difficulty of making statements about the future, and the fact that the concept of sustainability is so nebulous. We constantly struggle with how to define condition or sustainability in a highly managed ecosystem.

Values and Assessment Questions

The EMAP program recognizes three values in relation to the environment: consumptive uses (such as logging, fishing or agricultural production), nonconsumptive uses (such as recreation and regulation of water flow) and biological integrity. Productivity: quality of air, water and soil and biodiversity are aspects of particular concern in the Agricultural Lands Program. We are now developing an assessment framework, in which we describe why these three aspects are important and what system properties are therefore important. From that we will generate assessment questions, whose answers will come from specific indicators.

Indicator Development

Indicator development has taken place essentially independently from the conceptual work, although the two are slowly being united. The currently active indicator categories are soil quality, crop productivity, land use and landscape structure, and insect diversity. We did some very simple water quality work (nitrate and pesticides in wells and ponds in one state), but are no longer working in that area. A biomonitor of ozone, using differentially sensitive clones of white clover (*Trifolium repens* L.) is being tested by researchers in several parts of the United States. More is said about the other indicators below.

Statistical and Logistical Aspects

One of the hallmarks of the EMAP program is its careful attention to statistical design and the importance of presenting measures of statistical confidence when reporting results. The Agricultural Lands program is using a stratified random sampling method. This is the Area Frame used by the National Agricultural Statistics Service, and it is efficient for sampling from cropland. Specific sites are not revisited in future years, which weakens the statistical ability to detect trends but allows a reduction in the burden on farmers whose fields are selected.

The NASS is also providing the field workers for much of the data collection for EMAP-Agricultural Lands. These "enumerators" are accustomed to conducting various surveys of farm operators, and a post-season questionnaire is an important source of data on crop type, yield, fertilizer and pesticide applications, and other management practices. In addition, enumerators are learning to collect soil samples and take field data on windbreak condition.

Pilot Field Programs

Field pilots have been conducted in North Carolina (1992, southeastern U.S.) and Nebraska (1993, central U.S.). Sampling was limited to fields with annually harvested herbaceous crops, a category which includes grains, legumes, cotton, tobacco and hay. Pastures, orchards and other agricultural areas will be added to the program later. The report from the North Carolina work is complete and includes indicators of land area under field crops, diversity of crops, nitrogen use efficiency (nitrogen applied per unit of harvested output), agrichemical use and water quality. Several soil characteristics were measured, including clay content, organic matter, pH, cation exchange capacity and the concentrations of phosphorus, lead, and cadmium. Soil biological condition was quantified by maturity indices for free-living and plant parasitic nematodes, as well as a nematode trophic diversity index. For the soil measures, components of variance were also studied, and associations among different soil indicators were investigated. Data were summarized for the state as a whole and for subregions of the state such as the piedmont and the coastal plain. The report on the 1993 Nebraska pilot is now being prepared and will include similar indicators.

Current Efforts

In 1994, the main field project will include a questionnaire and soil sampling across the states of Pennsylvania, Maryland, Delaware, West Virginia and Virginia (eastern U.S.). Again, annually harvested herbaceous crops are the focus. This effort is part of the Mid-Atlantic Integrated Assessment, in which three other EMAP groups will be operating (Forests, Estuaries, and Surface Waters). In addition, a pilot project is being conducted in Nebraska to test an index of the suitability of windbreaks as habitat for birds. Next year, bird counts will be made at those same sites. Finally, more sophisticated soil indicators such as respiration and infiltration are being tested, along with an indicator of ant diversity, on a small number of fields in North Carolina and Pennsylvania. Other microbial indicators of soil quality are being sought as well.

Current conceptual work includes the assessment framework mentioned above, along with a "report card" for soil physical, chemical and biological properties. These properties will be scored by comparison to expected values for a particular class of soil. Work is also underway to adjust for the effects of weather and management on crop productivity by using crop simulation models. If these effects can be factored out, trends in productivity should be easier to detect.

SHOWCASE OF SUSTAINABLE AGRICULTURE INFORMATION AND EDUCATIONAL MATERIALS

Gabriel Heyges
· Sustainable Agriculture Network/
Sustainable Agriculture Research and Education

Information on sustainable agriculture issues and practices is available from a wide variety of sources, including research and educational institutions, private nonprofits, farmer organizations, publishers, consultants, lenders and suppliers. Finding the available information, as well as identifying the gaps in the knowledge base, is an increasing challenge.

The Sustainable Agriculture Network (SAN) was formed to help meet this challenge. SAN is a cooperative effort of universities, government, business and nonprofit organizations dedicated to information exchange. It was developed by a committee from diverse organizations, with support from the USDA's national Sustainable Agriculture Research and Education (SARE program.

The committee's vision is that of a decentralized system that encourages and supports interaction among a diversity of information providers and users, rather than a centralized system with a one-way flow of information. To support this vision, the committee eagerly solicits comments, criticisms and active participation from colleagues as the system takes shape. Current activities include:

Showcase of Educational Materials

SAN sponsors a "Showcase of Educational Materials." Begun by John Ikerd at the University of Missouri, it is a compilation of publications, videos and other materials as a way to identify both the exemplary and the missing in sustainable agriculture knowledge. Materials that synthesize information in forms readily usable to farmers are a particular focus of the Showcase. The results are available as a printed document, as a computerized database or over Internet.

INDICATORS OF SUSTAINABILITY: PRODUCER PERSPECTIVES FROM NORTH CENTRAL REGIONAL SUSTAINABLE AGRICULTURE RESEARCH AND EDUCATION PROJECTS

Lisa Jasa and Steven Waller
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North Central SARE

In 1992 the Administrative Council of the North Central Regional sustainable Agriculture Research and Education program initiated a producer grant program: (1) to learn more about what producers in the regional identified as barriers to their implementing sustainable agriculture; and (2) to more directly involve producers in the regional SARE program.

In the last three years grants of up to $5,000 have been made to 87 projects led by producers who wanted to conduct on-farm research or demostration projects related to sustainable agriculture. Topics have ranged from incorporating reduced chemical weed and insect control strategies into conventional systems to rotational grazing, organic soybean production and development and marketing of specialty crops. Not surprisingly, the projects indicate a high interest in:

Agricultural diversity
Reduced use of purchased inputs
Whole-farm interrelated systems
Environmental quality
Alternative markets and crops

In addition to providing financial support, producers have reported that the grants also have helped open doors to government agencies and university offices, which formerly had dismissed their ideas.

The North Central Region SARE funds three grant programs: Sustainable Agriculture Research and Education (SARE), Agriculture in Concert with the Environment and Implementing Sustainable Agriculture (producer grants). It requires that all SARE grants actively include producers, not just as contributors of research plots, but also in the design, implementation or evaluation of the research. This cooperative arrangement has provided invaluable information from producers' experiences to help researchers better address and fine tune their work. While many of these projects have addressed basic science and crop production issues, increasingly mentoring, communication and leadership programs to increase communication among farmers. These programs are breaking through the barriers of isolation described by early adopters of sustainable agriculture. Projects also are providing training for bankers, extension faculty, government agency representatives and high school teachers and students -- all of whom are essential to creating a support network for current and future generations.

COMMUNITY SUPPORTED AGRICULTURE/REGIONAL MARKETING

Molly Bartlett
· North Central Regiona/SARE

This display had three components:

(1) National statistics on Community Supported Agriculture (CSAs).

(2) Why CSAs - farmer/consumer benefits.
(3) Silver Creek Farm, Hiram, OH, a CSA case study of regional marketing.

Handouts were available.

INDICATORS OF SUSTAINABLE FOOD SECURITY

Charles Benbrook
· Benbrook Consulting Services

The United Nations Development Program (UNDP) is developing a methodology to estimate and track over time indicators of sustainable food security. Progress to date will be reviewed and conference attendees will be invited to participate in a "Round II" international teleconference focusing on the design, estimation and application of macro-level indicators. Information will be available on the UNDP indicators database and methodology, including how to obtain spreadsheets with data on selected countries. Preliminary results will be shared.

USING AGRICULTURAL POLICY ANALYSIS TO HELP SOLVE NATURAL RESOURCE PROBLEMS: THE USAID AGRICULTURAL POLICY ANALYSIS PROJECT

Malaika Riley
· Development Alternatives, Inc.
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This poster presented information on The Green Book, as discussed in the oral presentation by Wilcock and English.

SUSTAINABILITY AS A "WEB" OF DYNAMIC INTERACTIC, INTERCONNECTED PROCESSES

Ralph B. Montee and Bill Collins
· Center for PVO/University Collaboration in Development

Conceiving Sustainability

Sustainability may be conceived as a "web" of dynamic, interactive interconnected processes that move toward a desired state or goal of maintaining or strengthening the web (Figure 1). This is an attempt to visualize, in a dynamic and holistic way, the many interconnections and cross-linkages, indicators and sub-indicators, that characterize sustainability.

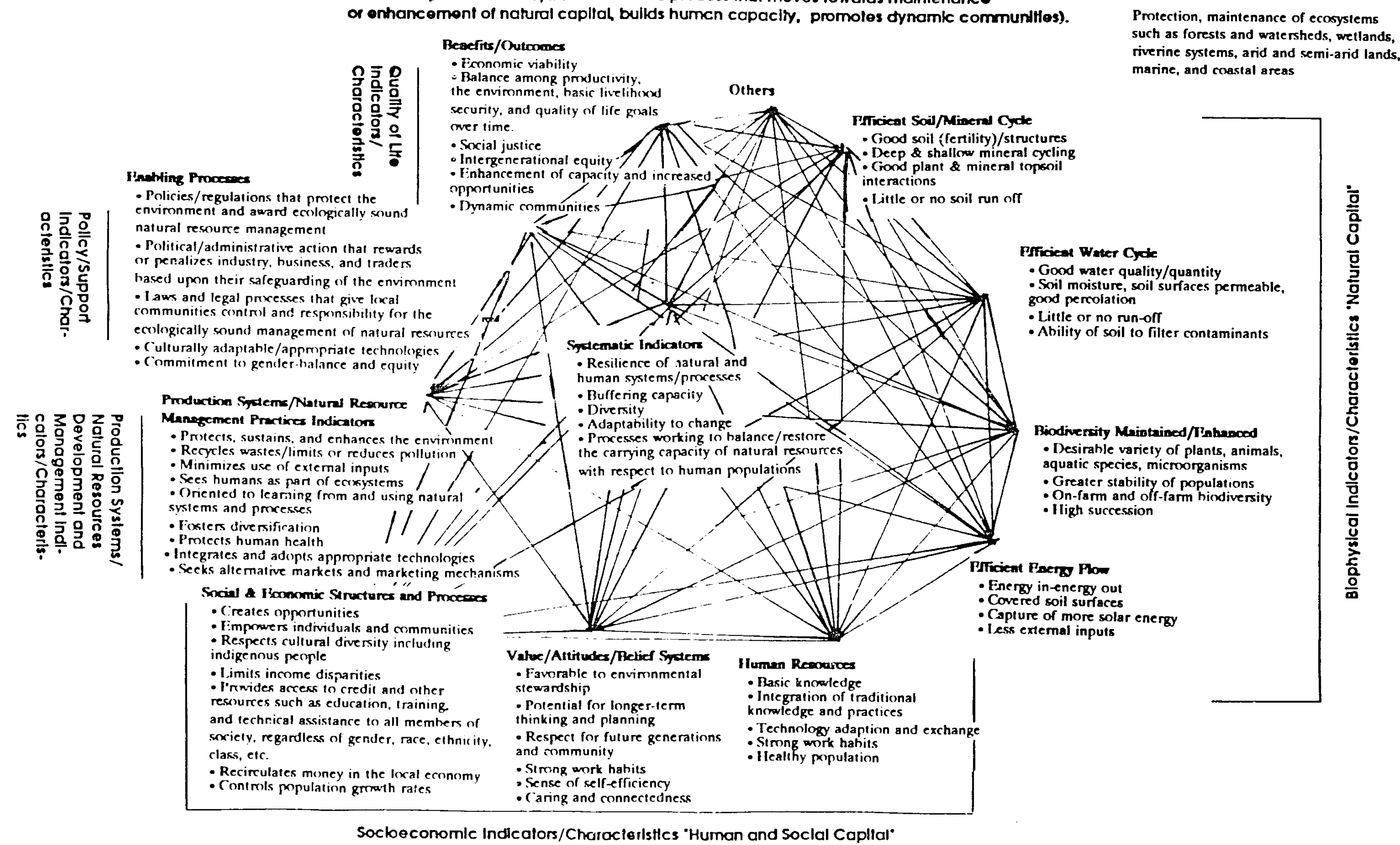
The ability of the web to remain largely intact, to adapt to change, to repair itself is an overall manifestation of its sustainability. It is a function of the resilience and adaptability of a system or a web to be able to provide the stability that keeps it intact. This allows the web to withstand the pressures, shocks, stresses that would alter it so much the result is its destruction. A web may survive even when a number of strands are broken. If too many strands in the web are broken, however, the web is weakened. It begins to degrade. When the processes of degradation go too far, there is a collapse and irreversibility -- conditions like desertification -- where recovery is unlikely or cannot be made because of unacceptable cost and effort given the present state of technology and resources. There is unfortunately, no "spider" that can rebuild or restore the web in this analogy once environmental conditions reach the collapse stage.

Ralph Montee & Bill Collins, July 1994

Center for PVO/University Collaboration in Development

Core Indicators of the Web of Sustainability

(An interactive, interconnected process that moves towards maintenance or enhancement of natural capital, builds human capacity, promotes dynamic communities).



FORCES/THREATS/CRISES ASSAULTING SUSTAINABILITY: High population growth rates | Entrenched/vested interests | Fluctuations and changes in international trade, global markets, and capital flow | External debt | Civil disturbance political breakdown | Diseases and infestations

Why a Web?

We came up with a web for anumber of reasons. First, it is holistic. A web can readily be grasped as whole while it conveys the complexities and interconnectedness that are involved in sustainability. Second, it is dynamic and it allows for change. You can add, subtract, move around, and recombine indicators, without losing sight of the other parts of the web. Third, the image of the web portrays both strength and fragility. It is also goal oriented -- sustainability as a gold to strive for -- the building and maintaining of a strong web. Lastly, despite is many connections and complex visual representation, it is simple.

What Good Is It?

First, it provides a useful overall visual and conceptual framework with which to view sustainability. Second, as measures are developed, key indicators from the web can be selected according to specific sites, system levels, and priorites. Thirdly, on a more practical note of application, the key or priority indicators selected through analysis can be utilized as warning signals, to monitor and evaluate program interventions designed to promote sustainability, and to establish goals and objectives.

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