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DEVELOPMENT STRATEGIES FOR FRAGILE LANDS

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WORKSHOP ON

SUSTAINABLE AGRICULTURE: CONSIDERATIONS FOR IICA's WORK

San Jose, June 22-23, 1989

IICA

INSTITUTO INTERAMERICANO DE COOPERACION PARA LA AGRICULTURA — OEA —

3. June 22 **Small Group Sessions**

ET York, Joshua Dickinson
Harlan Davis, Cassio Luiselli,
Carlos Pomareda, Eduardo Trigo, Fausto Jordán,
Rodolfo Quirós y Harry Mussman

(hours to be arranged)

4. June 23 **Program***

08:30-08:45	Opening Remarks	Martín Piñeiro
08:45-09:00	The Challenge for IICA	Harlan Davis
09:00-10:00	Sustainable Agriculture: Key Issues and the CGIAR View.	ET York
10:00-10:30	Environment and Natural Resource Management in Central America: A Strategy for A.I.D. Assistance	Jeffery Allen, ROCAP
10:30-12:00	Public Policy for Sustainable Agriculture	Carlos Pomareda IICA
12:30-14:00	Lunch	
14:00-15:00	CATIE's Work and Prospects on Sustainable Agriculture	Rodrigo Tarté
15:00-16:00	The Multidisciplinary Approach: The Potential and Alternatives for IICA	Joshua Dickinson
16:00-17:30	Round Table and Outline of Further Action . The Proposal for an Inter-American Discussion Group . Delphi Questionnaire . Pilot Study in Central America . Other Actions	Harlan Davis
17:30-18:00	Closing Session	

* Coffee to be served at the room

TROPICAL RESEARCH and DEVELOPMENT, Inc.

JOSHUA C. DICKINSON III

Expertise:

LAND USE POLICY AND PLANNING, MARICULTURE, COASTAL RESOURCES MANAGEMENT, ENVIRONMENTAL ASSESSMENTS, RIVER BASIN AND REGIONAL DEVELOPMENT, WATERSHED MANAGEMENT

Education:

Post Doctoral Fellowship, Ecology, Institute of Ecology, University of Georgia, 1973
Ph.D. Geography, University of Florida, Gainesville, 1967
M.A. Geography, University of Florida, Gainesville, 1965
Field Course, Ecology, Organization for Tropical Studies, 1965
B.S. Engineering, United States Naval Academy, 1959

International Experience:

Organizations: U.S.A.I.D., F.A.O., I.D.B., I.U.C.N., O.A.S., U.N.E.P.

Countries: ASIA: Nepal, Thailand. CENTRAL AMERICA: El Salvador, Guatemala, Honduras, Mexico, Panama. CARIBBEAN: Puerto Rico, St. Kitts, Trinidad. SOUTH AMERICA: Brazil, Colombia, Ecuador, Peru, Venezuela.

Languages: English (F.S.I. 4/4)
Spanish (F.S.I. 4/4)
Portuguese (F.S.I. 3/3)

Personal:
Born: February, 12, 1937
Nationality: USA

PROFESSIONAL HISTORY

River Basin and Regional Development

1988: GUATEMALA: **Field Supervisor.** Environmental Impact Study on the Chixoy Dam (Inter-American Development Bank).

1988: BRAZIL: Field Supervisor. Environmental Impact Study on the Sobradinho Dam (Inter-American Development Bank).

1988 NEPAL: U.S.A.I.D. Final evaluation of the Resource Conservation and Utilization project.

1987-present ECUADOR: Feasibility studies for management of the watershed of the Daule-Peripa hydroelectric and irrigation project (BID).

1987-present ST. KITTS/WEST INDIES: U.S.A.I.D. Planning and institution building for tourism development on the Southeast Peninsula (D.E.S.F.I.L.).

1986-present: U.S.A.I.D.. Development of Strategies for Fragile Lands in Latin America and the Caribbean (D.E.S.F.I.L.).

1987 HONDURAS: U.S.A.I.D.. Preliminary design of the Land Use Productivity Enhancement (LUPE) project for small farm development and resource conservation.

1986 GUATEMALA: Designed feasibility study for integrated management of natural resources of the Chixoy Dam watershed (Inter-American Development Bank).

1986 HONDURAS: End-of-project evaluation of the Natural Resources Management Project (U.S.A.I.D.).

1985-1986 PANAMA: Evaluation and selection of projects for consideration in the integrated development of the Darien region (BID).

1985: Demonstration of the use of airborne video imagery for monitoring land use change in the Palcazu Valley of Peru (U.S.A.I.D.).

1985 HONDURAS: Water supply for Tegucigalpa; coordination of institutional priorities and public support for watershed management (Honduran Ecological Association, IUCN).

1984-1985: Evaluation and applications design for ONERN/Peru Geographic Information System project extension (U.S.A.I.D.).

1983-1985 PERU: **Advisor.** Central Selva Resource Management Project. Responsibilities included agricultural, forestry, fisheries and upper watershed protection aspects of integrated development (U.S.A.I.D.).

1983 PANAMA: End-of-project evaluation of conservation and agroforestry aspects of Panama Canal Watershed Management Project (U.S.A.I.D.).

1983 ECUADOR: U.S.A.I.D.. Integrated assessment of agricultural and soil conservation considerations for water resource development in the Jubones watershed (O.A.S.).

1982: Preparation of a water resource development plan for the Surinam River Basin (O.A.S.).

1981 PERU: Project design for integrated agricultural development in the Upper Huallaga and Palcazu Valleys of Eastern Peru (U.S.A.I.D.).

1978-1980 VENEZUELA: Analysis of options for water management and agricultural development; Guanare-Masparro watershed (O.A.S.).

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1975 PANAMA: Evaluation of agricultural development alternatives along the Pan-American Highway route in the Darien of Panama (O.A.S.).

1970 GUATEMALA: Ecological and cultural studies of artisanal fisheries in Lake Izabal (Center for Tropical Agriculture, University of Florida).

1969 PANAMA, COLOMBIA: Agricultural ecological studies along sea-level canal routes (Center for Tropical Agriculture, University of Florida).

Mariculture

1988 HONDURAS: AID. Comprehensive assessment of the development potential for a shrimp mariculture and capture fisheries.

1988 EL SALVADOR: U.S.A.I.D.. Feasibility assessment and program design for development of private sector and cooperative shrimp mariculture.

1987 HONDURAS: U.S.A.I.D.. Mapping of site suitable for shrimp farming and for maintenance of mangrove resources in the Gulf of Fonseca.

1986: Feasibility assessments of shrimp and conch mariculture projects in the Eastern Caribbean (HIAMP) (U.S.A.I.D.).

1985 ECUADOR: Research project on the location and management of shrimp ponds in mangrove areas (U.S.A.I.D. Science Advisor).

1985 HONDURAS: Location and feasibility studies for cooperative shrimp farming enterprises in the Gulf of Fonseca (U.S.A.I.D.).

Policy and Planning

1988 HONDURAS: U.S.A.I.D.. Assistance to the Secretariat of Planning in establishing a natural resource assessment and planning capability.

1984-1985: Document preparation - Natural Resources and the Human Environment for Food and Agriculture in Latin America and the Caribbean (F.A.O.).

1983-1984: Assessment and recommendations on U.S.A.I.D.'s global program of Country Environmental Profiles (U.S.A.I.D.).

1983 VENEZUELA, TRINIDAD: Development of guidelines for mangrove management (U.N.E.P./Sierra Club).

1982 PERU: Conceptual models for development planning of the Central Selva (O.A.S.).

1981 HONDURAS: **Team Leader and Editor.** Honduras Country

Environmental Profile (U.S.A.I.D.).

Forestry

1985-1987 PUERTO RICO: Reforestation and maintenance of 100 acres of Vieques Island with five tropical tree species (US Navy).

1981-1982 ECUADOR: Project design for technical support of the Ecuadoran forest sector, including management, plantations, and protection activities (U.S.A.I.D.).

Industry and Mining

1983: Preparation of an environmental policy paper on phosphate mining and reclamation in Florida (AGRICO Mining Company).

1981-1983: A Policy Delphi to assess future directions for research on phosphate mining and reclamation (Fla. Inst. of Phos. Research).

Urban

1984: Evaluation of development potential and conservation strategies for a 1000 acre tract in Martin County, Florida (Hobe Sound Association).

1984: A methodology for assessment of environmental constraints and opportunities in managing urban development (UN HABITAT).

1981-1984: Ecological and socio-economic evaluation of proposed urban development projects in Stuart, Florida (Martin County Commission).

1982: Water and wastewater management implications of continuing population growth in Mexico City and the Valley of Mexico (UN HABITAT).

1982: Ecological constraints on urban development in arid lands; Nairobi workshop contributor (UN HABITAT).

Environmental Impact Assessments

1984: Assessment of socio-economic and environmental impact of proposed horse racing and boarding facility (Durden, Wicks and Associates).

Selected Reports and Publications:

Dickinson, J.C. 1986. Settlement in the humid tropical life zones of Latin America. Conference of Latin Americanist Geographers. Year Book (12).

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Dickinson, J.C. 1986. Report on natural resources for food and agriculture in Latin America and the Caribbean. F.A.O. Environment and Energy Paper.

Dickinson, J.C. 1984. Environmental profiles in development strategies. Natural Resources Technical Bulletin. No. 5.

Dickinson, J.C. 1982. Development planning at the interface of mountain and plain: A Venezuelan case study. Mountain Research and Development 2(3).

Dickinson, J.C. 1982. Honduras Country Environmental Profile. Agency for International Development. Washington, D.C.

Dickinson, J.C. 1981. Una perspectiva ecologica sobre el desarrollo. Interciencia 6(1):30-37.

Dickinson, J.C. 1974. Fisheries of Lake Izabal, Guatemala. The Geographical Review 84(3):365-409.

Dickinson, J.C. 1972. Alternatives to monoculture in the humid tropics of Latin America. The Professional Geographer. XXLV(3):217-222.

Dickinson, J.C., R.J. Gray and D.M. Smith. 1972. The 'Quality of Life' in Gainesville, Florida: An application of territorial social indicators. Southeastern Geographer XII(2):121-132.

Dickinson, J.C. 1969. The Eucalypt in the Sierra of southern Peru. Annals of the Association of American Geographers 59(2):294-307.

Professional Affiliations:

American Association for the Advancement of Science
Association of American Geographers
Ecological Society of America
Conference of Latin Americanist Geographers (President, 1986-88).1

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TROPICAL RESEARCH and DEVELOPMENT, Inc.

E.T. YORK

Date of Birth:.....
Place of Birth:.....
Family:.....Married, 2 children
Religious Preference:.Protestant

Education

B.S. Auburn University, 1942
M.S. Auburn University, 1946
Ph.D. Cornell University, 1949
Attended George Washington University, College of Law, 1957-59 (Part-time)

Employment

1943-45 Officer, U. S. Army

1949-56 North Carolina State University

Associate Professor, Professor and Chairman--Department of Agronomy

1956-59 American Potash Institute, Washington, D. C.

Eastern Director with responsibility for Market Development work in Eastern U. S. and in many foreign countries

1959-61 Auburn University, Cooperative Extension Service

Director of Cooperative Extension Service

1961-63 Federal Extension Service, U. S. Department of Agriculture

Administrator of USDA Extension program

1963-Present University of Florida

1963-March, 1973: Provost for Agriculture (title changed in 1971 to "Vice President for Agricultural Affairs")--chief administrator of University's agricultural teaching, research and extension programs.

March, 1973-August, 1973: Executive Vice President

September, 1973-July, 1974: Interim President

1974-1980: On leave, State University System

1980-1988: Professor (one year) and Professor Emeritus

1988--: Distinguished Service Professor

1974-Present: State University System of Florida

August, 1974-1975:	Chancellor Designate
1975-1980:	Chancellor
1980-Present:	Chancellor Emeritus

Professional Activities, Appointments, and Assignments

I. Domestic (U.S.)

Member, President's Commission on Vocational Education (appointed by President Kennedy)
Member, Advisory Board, National Agricultural Extension Center for Advanced Study
Member, Board of Directors, Federal Crop Insurance Corp., U.S.D.A.
Chairman, Alabama Rural Areas Development Committee
Chairman, Council on Education in the Agricultural Sciences, Southern Regional Education Board
Member, Board of Directors and Executive Committee, National 4-H Service Committee
President, National Educational Foundation of Alpha Gamma Rho
Member, Board of Trustees and Executive Committee, National 4-H Foundation
President, Association of Southern Agricultural Workers
Member, American Council on Education, Commission on Federal Regulations
Chairman, Division of Agriculture, National Association of State Universities and Land-Grant Colleges
Member, Board of Directors, Southern Interstate Nuclear Board
Member, National Agricultural Research Policy Advisory Committee (Advisory to U. S. Department of Agriculture and National Association of State Universities and Land-Grant Colleges)
Represented the National Association of State Universities and Land-Grant Colleges on a Joint University-U.S. Government Committee appointed to study and make recommendations concerning the future role and scope of the Cooperative Extension Service
Committee representing the U.S. Department of Agriculture and National Association of State Universities and Land-Grant Colleges, commissioned to study U. S. programs of agricultural research and to make recommendations for their future organization
Member, Water Resources Committee of the National Association of State Universities and Land-Grant Colleges
Member of the Florida Governor's Commission on Migrant Affairs
Appointed by President Nixon to the Board of Directors and Planning Committee of the National Center for Voluntary Action
Member, Food Advisory Committee of the Office of Technology Assessment, U. S. Congress, 1974-1977

Commissioner, Member of the Steering and Executive Committees, and National Treasurer, Education Commission of the States
Member, Advisory Committee to Southern Association of Colleges and Schools
Member, Executive Committee, Southern Regional Education Board
Member and Chairman of Florida Research and Development Commission
Member, Committee of the National Academy of Sciences to develop recommendations concerning the allocation of federal funds for research to state universities
While Vice President for Agriculture at University of Florida--
-Established the Institute for Food and Agricultural Sciences (IFAS)
-Initiated the DARE (Developing Agricultural Resources Effectively) program for long-range planning
-Established the Center for Tropical Agriculture
-Initiated the SHARE (Special Help for Agricultural Research and Education) program to raise private funds
Member of Quadrennial Evaluation Committee of Alabama Higher Education Commission, 1982
*Member, Board of Directors and Executive Committee of the Foundation for Agronomic Research, 1980--
Author of more than 100 papers in technical journals, books and popular publications
Invited to speak or lecture at some 40 universities in other states and countries
Member, Council of Presidents, Senate and Executive Committee, National Association of State Universities and Land-Grant Colleges
Member, Florida Commission on Vocational Education, 1985-86
Member, Joint Council on Food and Agricultural Sciences (U.S. Department of Agriculture & NASULGC), 1986

Note: (*) indicates a present or ongoing activity or appointment

II. International

Member, National Food for Peace Council
Member, National Freedom from Hunger Committee
Served at the request of the State Department as the U. S. representative on a Tripartite (U. S., United Kingdom, and Canada) Economic Development Mission in British Honduras (Belize)
At the request of the Government of Nicaragua and the Agency for International Development, carried out a study of agricultural programs in Nicaragua leading to recommendations for reorganization of government agencies concerned with agriculture
Appointed by President's Science Advisory Committee to serve on a special task force to develop recommendations for U. S. Government programs to deal with the World Food Problem
Member, Special Committee of the National Association of State Universities and Land-Grant Colleges, appointed to study the nation's international development programs and to make recommendations concerning how American universities might most effectively contribute to such efforts (Hannah Committee)
Appointed as one of two U. S. Delegates to the World Conference on Agricultural Education and Training, held in Copenhagen, Denmark in 1970

Chairman, National Academy of Science's team dealing with food and nutrition research and training in the U. S. and abroad as a part of the NAS World Food and Nutrition Study, 1975-1977

Member, International Committee of National Association of State Universities and Land-Grant Colleges

While serving as Provost and later as Vice President for Agricultural Affairs at the University of Florida, participated in developmental programs in agricultural research and education carried on by the University in a number of countries.

Traveled in more than 70 countries

Member, Board for International Food and Agricultural Development -- 1980-86, Vice-chairman of Board, 1981-83, Chairman of Board, 1983-86 (Appointed by President Carter, reappointed by President Reagan)

Chairman, Presidential Mission on Agricultural Development in Central America and the Caribbean, 1980 (Appointed by President Carter)

Member, Board of Trustees of Escuela Agricola Panamericana, Tegucigalpa, Honduras, 1980-1988

*Charter Member, Board of Directors, Action for World Development, Washington, D. C., 1981--

Special Consultant to AID Administrator, Peter McPherson, in reviewing programs of Agency for International Development and developing recommendations for change, 1981

Chairman of a special Rockefeller Foundation Task Force commissioned to review the programs of the International Agricultural Development Service, 1981

Chairman of a team commissioned by U. S. AID and the Government of Egypt to review the Extension programs in Egypt, including their relationship with the Colleges of Agriculture and the agricultural research program, 1981

Chairman of a Presidential Mission on Agricultural Development in Egypt, (Appointed by President Reagan) 1982

Chairman of a Presidential Mission on Agricultural Development in Liberia, (Appointed by President Reagan) 1982

Member of the Board of Trustees of Caribbean/Central American Action, 1980-83

Member of the Technical Advisory Committee (TAC) of the Consultative Group for International Agricultural Research (CGIAR) 1983-1988

Leader of Mission to study and make recommendations for improving programs in agricultural education in Indonesia (for Asian Development Bank) 1983

Leader of team commissioned by U. S. AID and the Government of Egypt to study and make recommendations for improving agricultural research programs in Egypt, 1983

Member of Health, Hunger and Humanity Committee of Rotary International Foundation, 1983-86

Member of team involved in developing plans for a strategic food reserve program for the Middle Eastern countries comprising the Gulf Cooperation Council, 1984

Leader of Mission to India to explore opportunities for collaboration in agriculture between U. S. and Indian universities, 1984

Member, Board of Directors of Honduran Foundation for Agricultural Research, 1984-86

*Member, Executive Advisory Council, The Florida Association of Voluntary Agencies for Caribbean Action (FAVA/CA), 1983--

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Member, The Indo-U.S. Subcommission on Agriculture, 1985-86
Chairman, World Agriculture Development Committee, Rotary International, 1986
*Advisor to Government of Pakistan in efforts to strengthen national agricultural research programs, 1985--
*Senior Associate, Winrock International, 1986--
*Member of Board of Directors of International Fund for Agricultural Research, 1987-
Chairman of Team to evaluate programs of USAID, Office of Food and Agriculture, Bureau of Science and Technology, 1988
Consultant to the Office of Technology Assessment, U.S. Congress, to evaluate the Title XII program (of the Foreign Assistance Act) 1988
Note: (*) indicates a present or ongoing activity or appointment

Business Activities

Member, Board of Directors, Peoples Bank of Gainesville
*Member, Board of Directors, Barnett Bank of Alachua County
*Member of Board of Directors, Caret Corporation
Member of Board of Directors of The Independent Professional
*Member of Board of Directors of Tralisa Corporation
Science Advisory Committee, Estech Chemical Corporation, 1981-84
Member, Board of Directors and Vice President, Gainesville Area Chamber of Commerce, 1984
Member, Board of Directors, Florida Farm Bureau Equities, Inc., 1983-84
Consultant to Control Data Corporation, 1983-87
*Member, Board of Directors of AvMed Corporation
Note: (*) indicates a present or ongoing activity or appointment

Civic and Church Related Activities

General Chairman, National Security Seminar
Member at Large, National Council of Boy Scouts of America
Member, Board of Directors and Planning Committee of National Center for Voluntary Action (Appointed by President Nixon) 1970
Chairman, University of Florida Division of United Way
Chairman, Alachua County United Way Board of Directors
Founding President, Alachua County Center for Voluntary Action, 1970
Member, Board of Directors, Alachua County Chapter, American Red Cross
President and Member, Board of Directors, Gainesville Rotary Club
Member, Education Commission, Florida Baptist Convention
Chairman, Board of Deacons, Sunday School Superintendent, and Chairman of Pastor Search Committee, First Baptist Church, Gainesville
Governor, District 697, Rotary International, 1981-82
Member, Board of Directors, Alachua County YMCA, 1980-83; President, 1983
Member, Board of Directors, American Cancer Society, Gainesville
Member, Board of Directors, Alachua General Hospital, Gainesville, 1981-84
Chairman, "Blue Ribbon" Citizens Committee on Crime, 1982
Member, Board of Directors, Santa Fe Health Care Systems, 1985-86
*Co-Chairman, Board of Governors, Heritage Club of Gainesville, 1984-86; Member of Board, 1986--

Established "Service Above Self Award," Gainesville Rotary Club, 1984--
*President, District 697 Foundation of Rotary, 1983--
Member, Health, Hunger and Humanity Subcommittee of The Rotary Foundation of Rotary International, 1983-86
*Member, Gainesville Police Advisory Commission, 1985--
*Member, Board of Directors and Secretary-Treasurer of the Florida Health Plan, Inc., 1986--
*Member of Board of Directors and Vice Chairman of SantaFe HealthCare Holding Corp., Inc., 1988--
*Member, Trinity Methodist Church, Gainesville, 1985-- ;Member of Board of Administration, 1986--
*Member, Board of Directors of the Samaritan Center, 1988--

Note: (*) indicates a present or ongoing activity or appointment.

Honors or Special Recognition

As student, elected to membership in Alpha Zeta, Scabbard and Blade, Omicron Delta Kappa, Gamma Sigma Delta, Phi Kappa Phi, and Sigma XI, honorary scholarship, scientific and leadership fraternities
Received B. B. Comer Medal for "Excellence in Natural Science" (awarded to graduating senior at Auburn University having highest academic record in natural sciences)
Named "Distinguished Military Graduate," Auburn University
Received award for "Most Outstanding Graduate" in Officer Candidate Class, Fort Sill, Oklahoma, 1943
Elected by students at North Carolina State to honorary membership in Golden Chain and Blue Key
Received dedication of student yearbook and annual student Livestock Day program, North Carolina State University
Designated by students as "Outstanding Teacher," North Carolina State University
Received "Outstanding Performance" rating for service as Administrator of the Federal Extension Service, U. S. Department of Agriculture
Elected a Fellow in the American Association for the Advancement of Science (1959)
Elected a Fellow in the American Society of Agronomy (1960) the Soil Science Society of America (1960) and Crop Science Society (1980)
Received the Honorary State Farmer Awards by the Alabama and Florida Future Farmers of America
Received award as "Individual Making the Greatest Contribution to Florida Agriculture in 1964"
Received "Certificate of Recognition at Large" from Grand Council of Epsilon Sigma Phi--one of three such awards presented nationally at the National Association of State Universities and Land-Grant College's meetings (1965)
Received the Freedoms Foundation George Washington Honor Medal Award (including cash stipend) for public address, "Freedom in Perspective," (one of six from throughout the nation to receive this award) (1966)
Received Freedoms Foundation Honor Certificate for public address, "Conservation of Human Resources" for "outstanding achievement in

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bringing about a better understanding of the American way of life" (1967)

Received the Distinguished Service Award of the Florida Veterinary Medical Association (1966)

Received the National 4-H Alumni Award (one of eight people from throughout the nation) (1967)

Received the Federal Land Banks' 50th Anniversary Medal "for Outstanding Contributions to American Agriculture" (1967)

Received the National "Partner in 4-H" Award (1970)

Received the National Limestone Institute's 1968 Distinguished Service Award for "Outstanding Contributions to the Nation's Agriculture" (one award made annually)

Received Progressive Farmer Magazine's award as "Man of the Year in Service to Florida Agriculture" (1967)

Received Outstanding Alumnus Award, Alpha Gamma Rho Fraternity (1966)

Elected by University of Florida students as honorary member in Florida Blue Key (1968)

Elected an Honorary Alumnus of the University of Florida by U.F. Alumni Association (1970)

Listed in Who's Who in America, Who's Who in South and Southwest, Who's Who in American Education, American Men of Science, Leaders in American Science, the Blue Book (Leaders of the English speaking world), Who's Who in the World, Who's Who in Society and Notable Americans

Received Florida Blue Key Distinguished Faculty Award (1972)

Received Florida Nurserymen and Grower's Association Outstanding Service Award (1972)

Received Gamma Sigma Delta Honor Society of Agriculture's Special Merit Award for "exemplifying the objectives of the Honor Society of Agriculture during his decade of service and leadership to the people of Florida" (1973)

Received Outstanding Service Award from the Florida Agricultural Advisory Council (1973)

Received award for "outstanding service" from the University of Florida Student Agricultural Council (1973)

Recognized by the Florida Forestry Association for "dedicated leadership, ingenuity, and foresight" and for "uncommon courage, insight, and deep understanding of Florida's agricultural community" (1973)

Elected to honorary membership, Florida Veterinary Medical Association for "outstanding and tireless effort in behalf of veterinary medicine" (1973)

Received Gamma Sigma Delta Honor Society of Agriculture's International Award for "distinguished service" (1973)

Special Award of the Florida Association of County Agricultural Agents "for aggressive leadership and faithful service to the Florida Cooperative Extension Service" (1973)

Florida Academy of Sciences Honors Medal--"Outstanding Scientist of Florida" (1974)

Selected as Florida Patriot by Florida Bicentennial Commission (1976)

Received Distinguished Service Citation of the Florida Association of Colleges and Universities (1980)

Inducted into Alpha Gamma Rho National Hall of Fame (August, 1982)

Awarded Honorary Doctor of Science Degree, Auburn University (1982)

Recipient of 1983 Gainesville Sun's Community Service Award "for his

unselfish and devoted contributions towards making Gainesville a better place to live."

Selected to present the Seaman A. Knapp Memorial Address at the Annual Meeting of the National Association of State Universities and Land-Grant Colleges, 1984.

Awarded Honorary Doctor of Science Degree, University of Florida (1984)

Received the President's Voluntary Action Award Citation "established to recognize, inspire and encourage exemplary and voluntary achievements in communities throughout the U.S.," 1986 (Awarded by President Reagan).

Received the Distinguished Service Award from the Florida Commission on Vocational Education "for dedication, leadership and meritorious service in improving Florida's Vocational Education System," 1986.

Received "Distinguished Service to Agriculture Award" for "outstanding contributions to national and international agriculture" from the American Society of Farm Managers and Rural Appraisers, 1986.

Received a special citation from the U.S. Agency for International Development "in recognition of distinguished leadership and dedicated service in the cause of Title XII, 'famine prevention and freedom from hunger' as a member of the Board for International Food and Agricultural Development, March, 1980 to July, 1986 and as Chairman as of July, 1983 by appointments by Presidents Carter and Reagan respectively." (1986)

Received special citation from the National Association of State Universities and Land-Grant Colleges for "outstanding and dedicated service as Chairman of the Board for International Food and Agricultural Develoment," recognizing "his tireless commitment to strive for a better life for the people of developing nations" and for "his inspired leadership in mobilizing the resources of our universities in the ongoing struggle against poverty and hunger throughout the world." (1986)

Received College of Veterinary Medicine medallion "in appreciation from a grateful College" -- in recognition of contributions to the establishment and development of the University of Florida's College of Veterinary Medicine.

Received the E.T. York, Jr. Distinguished Service Award from the Gainesville Rotary Club and Volunteer Center as Alachua County's 1987 Volunteer of the Year.

Received the National County Agricultural Agents 1988 "Service to American/World Agriculture" Award (two other people have received this award -- a former U.S. Secretary of Agriculture and the current U.S. Secretary of Agriculture).

Received the Gainesville Rotary Club's 1988 President's Award with following citation: "In grateful recognition of E.T. York, Jr., Eminent Rotarian, Statesman, Scientist, Educator, World Traveler, Goodwill Ambassador, Builder of Bridges of Friendship, Messenger of Healing."

The following awards or programs established in his name:

E.T. York Award for Student Government's Outstanding Cabinet Member Established by the University of Florida Student Government (1974)

E.T. York, Volunteer of the Year Award, established by the Gainesville Rotary Club to recognize the most outstanding volunteer in

community annually (1974)

E.T. York Distinguished Lecturer program established by Auburn University (1981)

E.T. York Distinguished Service Award established by the University of Florida to recognize "outstanding contributions to agriculture and the people of Florida," First recipient (1973)

E.T. York Service Award--given annually by the Florida Board of Regents "for Outstanding Service to Higher Education in Florida in Honor of E.T. York," First recipient (1980)

E.T. York Award of Merit given annually by the University of Florida to most outstanding Junior enrolled in the College of Agriculture

E.T. York Distinguished Lecturer program established by University of Florida, 1984

Biographical Summary--E. T. York, Jr.

A native of DeKalb County, Alabama, Dr. E. T. York went to the University of Florida in 1963 where he served as Vice President for Agricultural Affairs, Executive Vice President and Interim President. In 1975, he became Chancellor of the University System of Florida where he served for five years. In July, 1980 he became Chancellor Emeritus of the State University System. He is now Distinguished Service Professor at the University of Florida where he continues to pursue his long-term interests in world hunger and malnutrition.

Dr. York holds B.S. and M.S. degrees from Auburn University and the Ph.D. degree from Cornell. He held teaching, research and administrative assignments at North Carolina State University and was Director of the Cooperative Extension Service at Auburn University and Administrator of the Federal Extension Service, U.S.D.A. before coming to Florida.

Dr. York has been given major assignments at the national level by Presidents Kennedy, Johnson, Nixon, Ford, Carter and Reagan, including two terms on the Board for International Food and Agricultural Development to which he was appointed by Presidents Carter and Reagan. He served 3 years as the Board's Chairman. He has served, at the request of the President, as Chairman of three Presidential Missions on Agricultural Development--to Central America and the Caribbean (1980), to Egypt (1982, and to Liberia (1982).

He has traveled in more than 70 foreign countries and has served as a consultant for the U. S. State Department, the Agency for International Development, the White House, the United Nations, foreign governments, and many universities in the fields of education, agriculture and economic development. He serves on the boards of numerous business, educational and civic organizations at local, state, and national levels.

York has served (for six years) on the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research. This worldwide body provides the technical and programmatic guidance to the thirteen international agricultural research centers which are contributing significantly to increasing food production in developing countries.

He has also served on the Health, Hunger and Humanity Committee of Rotary International.

Dr. York has received numerous awards of state, national and international prominence and is listed in Who's Who in America, Who's Who in the World and other biographical sources. He received The President's Volunteer Action Award Citation from President Reagan in recognition of his volunteer activities at local, national and

international levels. He also recently received the award of the National Association of County Agricultural Agents for "Contributions to American/World Agriculture."

In civic activities, Dr. York has served as president of the Gainesville Rotary Club, governor of District 697 of Rotary International, president of the Alachua County United Way, and was founding president of the Alachua County Voluntary Action Center. He served as chairman of the Alachua County Citizens Committee on Crime in 1982, as president of the Gainesville YMCA in 1983, and as vice president of the Gainesville Area Chamber of Commerce in 1984. He has also held leadership responsibilities in other civic and church groups. In addition, he is an officer in family corporations involved in real estate development.

December, 1988

ELEMENTS OF A SUSTAINABLE AGRICULTURE STRATEGY

FOR THE

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE

Prepared by:

E.T. York
and
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ELEMENTS OF A SUSTAINABLE AGRICULTURE STRATEGY

FOR THE

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE

Background

The Development Strategies for Fragile Lands (DESFIL) project of USAID was asked by IICA to provide guidance in the establishment of an institutional program in Sustainable Agriculture. Financing of this initiative was provided jointly by ROCAP and IICA. To date activities have included:

* A review of background materials on IICA programs.

* Presentation of a workshop on sustainable agriculture with particular reference to the CGIAR experience with the maximum of interaction with IICA senior staff.

* Interviews with the Director General and other senior staff to explore their individual interests and questions related to sustainable agriculture and IICA.

* Preparation of a background materials to guide IICA in the formulation of a sustainable agriculture strategy.

This background effort is intended as a point of departure for IICA in defining more specific initiatives addressing the economic, social and biophysical aspects of sustainable agriculture.

Workshop Synopsis

A Definition - It was concluded that the definition of sustainable development presented in the Brundtland report (World Commission on Environment and Development, 1987) serves as an excellent conceptual framework for the development of a sustainable agriculture stance for IICA.

> ....To meet the needs of the present
> without compromising the ability of
> future generations to meet their own needs....

There are many other definitions of sustainable agriculture in the literature. A number of definitions, principally by economists, appear in the appendix at the end of this paper to illustrate the diversity and occasional divergence of views (Pezzey, 1989).

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Institutional Focus - IICA serves 31 countries in the hemisphere through activities of the headquarters in Costa Rica, regional offices and offices in each of the member countries. The institutional focus is upon increasing agricultural productivity with a strong emphasis on policy. The principal clients are ministries of agriculture in each of the member countries. IICA's strength lies in its close ties with the member countries that provide budgetary support to the institution through their contributions. While the countries are concerned with immediate needs of the agricultural sector, the staff noted that IICA should be concerned as much with the needs of future generations and providing leadership in this area of sustainable agriculture.

Agricultural Reactivation - IICA is currently considering a "Plan of Joint Action for Agricultural Reactivation in Latin America and the Caribbean." The need for such a plan grows out of the recognition of the importance of agriculture in the Region and the obvious potential to make the agricultural sector more productive and economically viable. As this plan is formulated, special consideration will be given to efforts which can not only achieve short-term agricultural development goals but which can also insure that the Region will more nearly realize its significant potential for sustained, long-term agricultural development. To do this, IICA will give major attention to policies and programs which will help insure that agriculture in the Region is maintained in a sustainable, productive state -- consistent with the needs and goals of the countries within the Region.

Future Directions - IICA has determined that it will <u>not</u> establish a separate program in sustainable agriculture, rather the strategy will be to integrate its concepts as appropriate in five existing programs. Also decided <u>a priori</u> was that IICA would concern itself with sustainable agriculture strictly in the context of agricultural productivity, and not take on the broader concerns for natural areas, biodiversity or watershed management. It was noted that a clear relationship exists between achieving more sustainable agriculture and reduced stress on natural areas and renewable natural resources. A logical sequence in developing its sustainable agriculture focus appears to be:

* Modification of IICA's Medium Term Plan to include Sustainable Agriculture

* Screen existing projects for Sustainable Agriculture compatibility

* Incorporate Sustainable Agriculture concepts in the design of new projects

* Explore policy implications of Sustainable Agriculture

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* Promote Sustainable Agriculture with ministries of agriculture

A RATIONALE FOR SUSTAINABLE AGRICULTURE

The Global Context

> The next few decades present a greater challenge to the world's food systems than they may ever face again. The effort needed to increase production in pace with unprecedented increase in demand, while retaining the essential ecological integrity of food systems, is colossal, both in its magnitude and complexity. Given the obstacles to be overcome, most of them man-made, it can fail more easily than it can succeed.

This statement by a special panel of the World Commission on Environment and Development (WCED) presents a sobering appraisal of the challenge facing global food systems -- despite the significant advances made in food production in recent decades. For example, from 1950 to 1984, global cereal production increased approximately 2.6 fold -- from 624 million tons to 1,645 million tons. Even though there was a rapid rate of population growth during that period, per capita cereal production still went up some 40 percent.

Despite this unprecedented improvement in food production, there is growing concern that this rapid rate of progress cannot be sustained. Since 1984, per capita production of cereals worldwide has declined each year. During the past four to five years, food production has been essentially static in a number of countries such as India, Mexico, Indonesia and China -- countries which enjoyed phenomenal increases in cereal production as a result of "green revolution" technologies. Global grain reserves in 1989 are estimated to be at the lowest level since immediately after World War II.

The phenomenal Green Revolution in cereal production was achieved by relatively few of the world's farmers using technologies and grain varieties capable of efficiently utilizing purchased agricultural chemicals on the best land, often with irrigation. This technology, created by internationally funded centers, is not readily adapted to less favored lands nor to the majority of the rural population that has no land or insufficient land to produce a surplus under any available technology. Africa, and to a great extent Latin America, have been little influenced by the Green Revolution. Latin America has joined Africa during the 1980s as the second major region to experience a decline in food production per capita. Since 1981, Latin America's output of food per person has fallen some 10 percent, expanding still further the Region's food deficit.

This decline in per capita food production in Latin America as well as globally means, simply, that population is increasing more rapidly than food production. The arable land base of the earth is ultimately finite. In looking into the future, agriculture must provide the basis to feed some 90 million more people each year, worldwide. The enormity of this problem is highlighted by the fact that about 90 percent of the increase in population is occurring in the developing world where food deficits are already critical in some areas. On closer examination the problem is far more complex than simply a race between population growth and food production, particularly in Latin America. Among the factors contributing to lagging per capita food production are:

* Land tenure patterns under which the majority of the rural population is concentrated on a small fraction of the arable land.

* Land use patterns under which the majority of the best arable land is not used for food production, but rather is used for export crops or extensive grazing.

* Lack of access by the majority of the rural population to extension services, credit, material inputs, or basic education, health and family planning services.

* An array of policies affecting commodity prices, land use intensification, land titling and rural infrastructure investments that discriminate against small food producers.

These same factors contributing to lagging food production often contribute to natural resource degradation as well. For example, the growing population without access to productive land and services are clearing fragile lands incapable of sustaining traditional agriculture. Poor farmers deprived of appropriate agricultural extension services contribute to widespread erosion. The rate of loss of biologically diverse natural areas is compounded by the expansion of subsidized cattle ranching and land titling policies which require the clearing of lands unsuitable for agriculture.

Intensification of traditional agricultural systems to meet growing needs has often had undesirable environmental or ecological consequences. Increased demand for fuelwood as well as increased need for agricultural areas to cultivate have resulted in major problems of deforestation and related soil degradation. Growing food needs have forced farmers to clear and cultivate hillsides and other fragile lands, resulting in a severe erosion and loss of productivity. In many areas, water reserves are being seriously depleted. The forage needs of livestock in many developing countries now exceeds the carrying capacity of grasslands -- in some areas by as much as 50 - 100 percent. This results in the deterioration

of rangelands, often leading to desertification. Air, soil and water are being contaminated by the waste products of industry, urban development and some agricultural practices. The global warming trend, the long-term effects of which are still uncertain, could have enormous effects upon food production capabilities in many parts of the world.

These are some of the circumstances which have led to increasing concern over the ability of global agricultural systems to produce sustainable levels of food.

Sustainable Agricultural Development

The report of the World Commission on Environment and Development, known as the Brundtland Report, has focused major attention on this problem -- encouraging the achievement of sustainable development (WCED, 1987). Applied to agriculture, this might be characterized as "development that meets the (agricultural) needs of the present without compromising the ability of future generations to meet their needs (for agricultural products)." This is a dynamic concept which recognizes that, globally, agriculture must do far more than maintain current levels of production. Indeed, productivity must increase to accommodate steadily growing demands from an expanding world population. Efforts to meet this demand without compromising the capability of future generations to meet their needs must include vigorous programs to control population growth as well as adoption of sustainable agriculture practices.

Sustainable agriculture is not synonymous with low input agriculture. Poor farmers are obligate users of few inputs. Among the approaches to reducing the spread and acceleration of resource deterioration and increasing poverty is to increase the access to, and use of, off farm inputs such as fertilizers. International agricultural research centers are now exploring how to increase the efficiency of use of limited resources available to small farmers on less favored sites.

Intra and inter-generational equity are both integral concerns in sustainable agriculture. The two concerns are intimately linked. When a large proportion of today's rural population in developing countries lack access to land and services, not only is food production suppressed, but those eking out an existence cause dramatic resource degradation. This in turn threatens the resource base of future generations.

Constraints to Achieving Sustainable Agriculture Objectives

There are many problems or constraints which limit the achievement of sustainability objectives. First and perhaps foremost is population growth. Unless this is controlled, the task will be very difficult, if not impossible. A second major issue is the amount of land available to expand cultivated areas. While this would

appear to be sufficient for the foreseeable future, a variety of circumstances make it very difficult to develop and use much of this land effectively. Many experts believe, therefore, that new areas brought into cultivation will do little more than compensate for the loss of agricultural land diverted to other use and otherwise lost through various processes of degradation such as erosion, salinization, desertification and other factors. The growing global demand for agricultural production must, therefore, be met primarily by intensification of production on land already under cultivation.

There are many physical, biological, economic, social, and political problems which constrain or limit the achievement of sustainability goals. These problems include soil erosion, water pollution, agricultural pests and diseases, pesticide resistance and toxic effects, loss of protective watersheds, crop pests and animal diseases, desertification, government policies unfavorable to agriculture, weak research, extension and educational institutions, inadequate laws and regulations protecting natural resources, political instability, and many others. These circumstances are treated in detail in several current publications relating to the subject (e.g., the report of the World Commission on Environment and Development, the report on Sustainable Agriculture by the Technical Advisory Committee of the Consultative Group on International Agricultural Research (FAO, 1988), and others).

IICA's Sustainable Agriculture Strategies

As IICA develops activities in its five Program areas and in its Plan of Joint Action for Agricultural Revitalization in Latin America and the Caribbean, consideration will be given to incorporating sustainable agricultural concepts and objectives into such a plan. Specifically, as actions are taken to revitalize and accelerate the development of agriculture in the Region, consideration will be given how this can be done in a sustainable manner -- i.e., how short-term agricultural development objectives can be achieved without jeopardizing or compromising the ability of the Region to meet future long-term goals and needs. Special emphasis will be placed on maintaining or enhancing the quality of the environment and conserving the natural resource base on which agriculture depends. Decreasing agricultural productivity, deterioration of fragile lands, and deforestation are closely related to the lack of access to productive resources including land, credit, technology and education by the poor majority.

This suggests a flexible approach. The implementation of sustainable agriculture programs for poor hillside farmers, underutilized/over-grazed lands, and high input export agriculturists would require far different strategies. Priorities and approaches need to be established to meet the tremendously broad range of needs both among and within the countries served by IICA.

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To carry out such commitment will not require a separate program within IICA, dealing specifically with sustainable agriculture. All five of the current program areas in IICA deal with problems or issues having significant sustainability implications. Each of the five major programs has the potential capability to address many of the sustainability-related problems or constraints and, by so doing, contribute to the achievement of sustainability goals. This means that sustainability concerns will be reflected in and made an integral part of the process of planning, executing and evaluating many of the efforts related to agricultural development in the Region.

For example, as the Plan of Joint Action for Agricultural Revitalization is implemented, efforts will be made to incorporate a sustainability perspective into the various facets of the Plan. As a part of the Plan, consideration will be given to the activation of specific projects that will address important sustainability issues. IICA's Medium Term Plan will also be modified to reflect the commitment to sustainability.

IICA will give major emphasis to sustainability considerations in the planning and execution of projects and programs under its immediate jurisdiction. Moreover, IICA will also provide assistance to its member states as they address sustainability-related issues. Because of its close ties with the governments in the Region, IICA is in a unique position to give leadership and assistance to the member states as they deal with this matter.

The report of the World Commission on Environment and Development suggests a wide range of strategies for achieving sustainable agricultural development. Following are examples of suggested strategies to deal with specific issues:

* Government Intervention. "In general, patterns of government intervention suffer three basic defects. First, the criteria that underlie the planning of these interventions lack an ecological orientation and are often dominated by short-term considerations. These criteria should discourage environmentally unsound farm practices and encourage farmers to maintain and improve their soils, forests, and waters.

  "The second defect is that agricultural policy tends to operate within a national framework with uniform prices and subsidies, standardized criteria for the provision of support services, indiscriminate financing of infrastructure investments, and so forth. Policies that vary from region to region are needed to reflect different regional needs, encouraging farmers to adopt practices which are ecologically sustainable in their own areas.

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"The third defect in government intervention lies in incentive structures. In industrialized countries, overprotection of farmers and overproduction represents the accumulated results of tax reliefs, direct subsidies, and price controls. Such policies are now filled with contradictions that encourage the degradation of the agricultural resource base and, in the long run, do more harm than good to the agricultural industry. Some governments now recognize this and are making efforts to change the focus of subsidies from production growth to conservation.

"On the other hand in most developing countries, the incentive structure is weak. Market interventions are often ineffective for lack of an organizational structure for procurement and distribution. Farmers are exposed to a high degree of uncertainty, and price support systems have often favored the urban dweller or are limited to a few commercial crops, leading to distortions of cropping patterns that add to destructive pressures on the resource base. In some cases, price controls reduce the incentives to produce. What is required in many cases is nothing less than a radical attempt to turn the "terms of trade" in favor of farmers through pricing policies and government expenditure reallocations.

"Strengthening food security from global point of view requires reducing incentives that force overproduction and noncompetitive production in the developed market economies and enhancing those that encourage food production in developing countries. At the same time, these incentive structures must be redesigned to promote farming practices that conserve and enhance the agricultural resource base."

* Trade. "Countries must recognize that all parties lose through protectionist barriers which reduce trade in food products where some nations may have genuine advantage. Nations must begin by redesigning their trade, tax, and incentive systems using criteria that include ecological and economic sustainability and international comparative advantage."

* The Resource Base. "Agricultural production can only be sustained on a long-term basis if the land, water, and forests on which it is based are not degraded. Public intervention will be often necessary to provide a framework for this. But more specific policies that protect the resource base are needed to maintain and even enhance agricultural productivity and the livelihood of all rural dwellers."

* Land Use. "The initial task in enhancing the resource base will be to delineate broad land use categories....

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Classifying land according to best use will determine variations in infrastructure provisions, support services, promotional measures, regulatory restrictions, fiscal subsidies and other incentives and disincentives."

* Water Management. "Improvements in water management are essential to raise agricultural productivity and to reduce land degradation and water pollution. Critical issues concern the design of irrigation projects and the efficiency of water use.

"Where water is scarce, irrigation projects should maximize productivity per unit of water; where water is plentiful, it must maximize productivity per unit of land. But local conditions will dictate how much water can be used without damaging the soil. Salinization, alkaliniza tion, and waterlogging can be avoided by more careful approaches to drainage, maintenance, cropping patterns, the regulation of water quantities, and more rational water charges.

"In some areas, excessive use of ground water is rapidly lowering the water table. Where ground water use exceeds the recharge capacity of local aquifers, regulatory or fiscal controls will become essential."

* Chemical Use. "Many countries can and should increase yields by greater use of chemical fertilizers and pesticides, par- ticularly in the developing world. But countries canal sc improve yields by helping farmers use organic nutrients more efficiently. Hence, governments must encourage the use of more organic plant nutrients to complement chemicals. Pest control must also be based increasingly on the use of natural methods. These strategies require changes in public poli- cies....Developing countries must possess the basic legisla- tive and institutional instruments to manage the use of agric- ultural chemicals within their countries."

* Forestry and Agriculture. "Forests protect watersheds, reduce erosion, offer habitats for wild species and play key roles in climatic systems. They are also economic resources providing timber, fuelwood and other products. The crucial task is to balance the need to exploit forests against the need to preserve them.

* Human Resources.
"The technological transformation of traditional agriculture will be difficult without a matching effort to develop human resources. This means educational reforms to produce researchers more attuned to the needs of rural people in agriculture. Illiteracy is still widespread among the rural poor. But efforts to

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promote literacy should focus attention on functional literacy covering the efficient use of land, water and forests.

"Despite women's critical role in agriculture, their access to education and their representation in research, extension and other support services is woefully inadequate. Women should be given the same educational opportunities as men. There should be more female extension workers and women should participate in field visits. Women should also be given more power to make decisions regarding agricultural and forestry programs."

* Land Reform. "In many countries where land is very unequally distributed, land reform is a basic requirement. Without it, institutional and policy changes meant to protect the resource base can actually promote inequalities by shutting the poor off from resources and by favoring those with large farms who are better able to obtain the limited credit and services available. By leaving hundreds of millions without options, such changes can have the opposite of their intended effect, insuring the continued violation of ecological imperatives.

"Given the institutional and ecological variations, a universal approach to land reform is impossible. Each country must work out its own program of land reform to assist the land poor and to provide a basis for coordinated resource conservation. The redistribution of land is particularly important where large estates and vast numbers of the land poor coexist. Crucial components include the reform of tenancy arrangements, security of tenure, and the clear recording of land rights. In agrarian reform, the productivity of the land and, in forest areas, the protection of forests should be a major concern."

The above excerpts from the report of the World Commission on Environment and Development provide examples of possible strategies which IICA might consider in dealing with sustainability-related issues. IICA will consider these and other ideas in formulating specific strategies for programs to address sustainability matters.

The Importance of Agricultural Sustainability

It has been suggested that "sustainability is important because the future is important." Certainly, efforts to achieve sustainability in agriculture directly reflect a concern for the future. Such a concern emphasizes IICA's unique role and mission. Many developing country governments are more concerned with immediate, short-term problems or issues and often have difficulty in developing policies and strategies for the longer term future. Yet it is vitally important that there are those who are concerned about the future

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and who will encourage policies and programs that help assure that there is a future for our planet and the people on it. There is great need for an organization like IICA to concern itself with longer-term issues, helping member governments to give appropriate attention to such issues.

The challenge facing IICA and its member countries is to find ways of removing the impediments to sustainable agricultural production, whether the causes are technical, economic, social, institutional, political, or some combination of all. Accepting this challenge offers IICA an opportunity to make unprecedented contributions not only to the Region but also to global community through efforts to find solutions to serious problems that threaten the future welfare of humanity.

Sustainable agriculture implies the integrated consideration of social, technical and economic factors by experienced professionals. That agriculture is a sector in a broader context of sustainable development considering also urban-industrial and natural areas.

The consideration of land capability is critical in the formulation of policies and projects in sustainable agriculture. Resource deterioration can often be traced to over and under-utilization of the land. The sustainability of land titling, colonization, concessions, subsidies, and management schemes are all vitally influenced by land capability.

Grupo Interamericano

Eduardo Trigo, head of the Technology Generation and Transfer Program of IICA, proposed that IICA sponsor an Inter-American Discussion Group on Environment and Sustainable Agriculture. This group would have a permanent technical secretariat and dedicate itself to meetings and studies on broad issues related to sustainable agriculture in the hemisphere.

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APPENDIX 1 DEFINITIONS OF SUSTAINABILITY IN THE LITERATURE

This Appendix is not exhaustive, but it gives a good idea of the variety of definitions of sustainability concepts that have appeared in the last decade, and of the people who use such concepts. (Bold type is added where appropriate to emphasise which concepts are being defined.)

Allen (1980) - summarising IUCN (1980)

1. "**Sustainable utilization** is a simple idea: we should utilize species and ecosystems at levels and in ways that allow them to go on renewing themselves for all practical purposes indefinitely." (p18)

2. "The importance of ensuring that utilization of an ecosystem or species is sustainable varies with a society's dependence on the resource in question. For a subsistence society, **sustainable utilization** of most, if not all its living resources is essential. ... The greater the diversity and flexibility of the economy, the less the need to utilize certain resources sustainably, but by the same token the less the excuse not to." (p18)

3. "...it is essential...to ensure that...people protect those parts of the biosphere that need protecting and modify the rest only in ways that it can sustain." (p20)

4. "**sustainable development** - development that is likely to achieve lasting satisfaction of human needs and improvement of the quality of human life" (p23)

Barbier (1987) - academic economist

1. "...the concept of **sustainable economic development** as applied to the Third World....is therefore directly concerned with increasing the material standard of living of the poor at the 'grassroots' level, which can be quantitatively measured in terms of increased food, real income, educational services, health-care, sanitation and water supply, emergency stocks of food and cash, etc., and only indirectly concerned with economic growth at the aggregate, commonly national, level. In general terms, the primary objective is reducing the absolute poverty of the world's poor through providing lasting and secure livelihoods that minimize resource depletion, environmental degradation, cultural disruption and social instability." (p103)

Brown et al (1987) - environmental scientists

1. "In the narrowest sense, **global sustainability** means the indefinite survival of the human species across all the regions of the world. A broader sense of the meaning specifies that virtually all humans, once born, live to adulthood and that their lives have quality beyond mere biological survival. Finally the broadest sense of global sustainability includes the persistence of all components of the biosphere, even those with no apparent benefit to humanity." (p717)

Burness and Cummings (1986) - academic economists

1. "Professor Daly's notion of "**sustainability**" [in Daly 1986] is extraordinarily vague and ill-defined. ...in a pedagogical sense **sustainability** requires that all processes operate only at their steady state, renewable level, which might then suggest a return to a regulated caveman culture." (p323)

Clark (1986) - environmental scientist and policy analyst, IIASA

1. "A major challenge of the coming decades is to learn how long-term, large-scale interactions between environment and development can be better managed to increase the prospects for ecologically **sustainable improvements** in human well-being." (p5)

Coomer (1979)

1. "[The] **sustainable society** is one that lives within the self-perpetuating limits of its environment. That society...is not a 'no-growth' society. ... It is, rather a society that regonizes the limits of growth...[and] looks for alternative ways of growing." (p1)

Daly - academic economist

1. "The market does not distinguish an **ecologically sustainable scale** of matter-energy throughput from an unsustainable scale, just as it does not distinguish between ethically just and unjust distributions of income. Sustainability, like justice, is a value not achievable by purely individualistic market processes." (1986, p320).

2. "By 'growth' I mean quantitative increase in the scale of the physical dimensions of the economy; ... By '**development**' I mean the qualitative improvement in the structure, design and composition of physical stocks and flows, that result from greater knowledge, both of technique and of purpose." (1987, p323)

Georgescu-Roegen (1988) - academic economist

1. "...'**growth**' is if you get just an increasing number of the same type of mail coaches. And if you pass from traveling in mail coaches to traveling by railway, that is '**development**'." (pS294)

Goodland and Ledec (1987) - institutional environmental scientists

1. "**Sustainable development** is here defined as a pattern of social and structural economic transformations (i.e. 'development') which optimizes the economic and societal benefits available in the present, without jeopardizing the likely potential for similar benefits in the future. A primary goal of sustainable development is to achieve a reasonable (however defined) and equitably distributed level of economic well-being that can be perpetuated continually for many human generations." (p36)

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2. "...**sustainable development** implies using renewable natural resources in a manner which does not eliminate or degrade them, or otherwise diminish their usefulness for future generations.....Sustainable development further implies using non-renewable (exhaustible) mineral resources in a manner which does not unnecessarily preclude easy access to them by future generations..... Sustainable development also implies depleting non-renewable energy resources at a slow enough rate so as to ensure the high probability of an orderly societal transition to renewable energy sources....." (p37)

Howe (1979) - academic economist

1. "GUIDELINES FOR A RESPONSIBLE NATURAL RESOURCES POLICY

(6) ...activities should be considered that would be aimed at maintaining over time a constant effective natural resource base. This concept was proposed by Page (1977) and implies not an unchanging resource base but a set of resource reserves, technologies, and policy controls that maintain or expand the production possibilities of future generations." (p337)

Markandya and Pearce (1988) - academic economists

1. "The basic idea [of **sustainable development**] is simple in the context of natural resources (excluding exhaustibles) and environments: the use made of these inputs to the development process should be sustainable through time. ....If we now apply the idea to resources, **sustainability** ought to mean that a given stock of resources - trees, soil quality, water and so on - should not decline." (pp9-10).

2. "...**sustainability** might be redefined in terms of a requirement that the use of resources today should not reduce real incomes in the future...". (p11)

Morey (1985) - academic economist

1. "...much of the desertification literature also suggests that desertification is nonoptimal from both the producer's and society's perspective. **Sustainable use** is generally put forward as the **optimal** strategy." [Morey then shows how sustainable land use may or may not be optimal] (p551)

O'Riordan (1988) - academic environmental scientist

1. "It may only be a matter of time before the metaphor of **sustainability** becomes so abused as to be meaningless, certainly as a device to straddle the ideological conflicts that pervade contemporary environmentalism." (p29)

2. "**Sustainability** is a much broader phenomenon [than **sustainable development**], embracing ethical norms pertaining to the survival of living matter, to the rights of future generations and to institutions responsible for ensuring that such rights are fully taken into account in policies and actions." (p30)

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Pearce - academic economist

1. "The **sustainability** criterion requires that the conditions necessary for equal access to the resource base be met for each generation." (1987, p13).

2. "In simple terms [**sustainable development**] argues for (a) development subject to a set of constraints which set resource harvest rates at levels no higher than managed or natural regeneration rates; and (b) use of the environment as a 'waste sink' on the basis that waste disposal rates should not exceed rates of (natural or managed) assimilation by the counterpart ecosystems. ... ... There are self-evident problems in advocating sustainable rates for exhaustible resources, so that 'sustainabilists' tend to think in terms of a resource set encompassing substitution between renewables and exhaustibles. Equally self-evident is the implicit assumption that sustainability is a 'good thing' - that is optimising within sustainable use rates is a desirable objective. On these terms, sustainability could imply use of environmental services over very long time periods and, in theory, indefinitely." (1988a, p58)

3. "The key concept [regarding natural resource degradation in developing countries] is '**sustainability**'. Changes in resource management practice toward sustainable resource use could at least contribute to the preservation of the renewable resource base, and hence to the direct well-being of the population and to the future of the macroeconomy." (1988b, p102)

Pearce, Barbier and Markandya (1988) - academic economists

1. "We take **development** to be a vector of desirable social objectives, and elements might include:
- increases in real income per capita
- improvements in health and nutritional status
- educational achievement
- access to resources
- a 'fairer' distribution of income
- increases in basic freedoms.

...**Sustainable development** is then a situation in which the development vector increases monotonically over time." (p4)

2. "We summarise the necessary conditions [for **sustainable development**] as 'constancy of the natural capital stock'. More strictly, the requirement as for non-negative changes in the stock of natural resources such as soil and soil quality, ground and surface water and their quality, land biomass, water biomass, and the waste assimilation capacity of receiving environments." (p6)

Pirages (1977) - from conference funded by the Institute for World Order

1. [**Sustainable growth**] means economic growth that can be supported by physical and social environments in the foreseeable future. An ideal sustainable society would be one in which all energy would be derived from current solar income and all non-renewable resources would be recycled." (pp10-11)

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Porritt (1984) - Director, U.K. Friends of the Earth

1. "All **economic growth** in the future must be **sustainable**: that is to say, it must operate within and not beyond the finite limits of the planet." (p120)

Repetto (1985a) - economist, World Resources Institute. Also in Repetto (1986a), pp16-17

1. "The core of the idea of **sustainability**, then, is the concept that current decisions should not impair the prospects for maintaining or improving future living standards. ... This implies that our economic systems should be managed so that we live off the dividend of our resources, maintaining and improving the asset base. This principle also has much in common with the ideal concept of income that accountants seek to determine: the greatest amount that can be consumed in the current period without reducing prospects for consumption in the future." (p10)

2. "This does not mean that **sustainable development** demands the preservation of the current stock of natural resources or any particular mix of human, physical and natural assets. As development proceeds, the composition of the underlying asset base changes." (p10)

3. "There is broad agreement that pursuing **policies** that imperil the welfare of future generations, who are unrepresented in any political or economic forum, is **unfair**." (p11)

Redclift (1987) - academic economist

1. "...to what extent is **economic growth** an adequate measure of development?" (p15)

Solow (1986) - Nobel Prize academic economist

1. "...a society that invests in reproducible **capital** the competitive rents on its current extraction of exhaustible resources, will enjoy a **consumption** stream constant in time. ...this result can be interpreted as saying that an appropriately defined stock of capital - including the initial endowment of resources - is being maintained intact, and that consumption can be interpreted as the interest on that patrimony." (p141).

Talbot (1984) - former Director-General, IUCN

1. "OBJECTIVES OF THE WORLD CONSERVATION STRATEGY

Conservation has three basic objectives:
(1) To maintain essential ecological processes and life support systems.
(2) To preserve genetic diversity.
(3) To ensure that the **utilization of living resources**, and the ecosystems in which they are found, is **sustainable**." (p4)

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Tietenberg (1984) - academic economist

1. "The **sustainability criterion** suggests that, at a minimum, future generations should be left no worse off than current generations." (p33)

2. "Rather than eliminating the [positive] discount rate, the present-value criterion should be complemented by other criteria, such as **sustainability**. ....For example, we might choose to maximise present value subject to the constraint that future generations are not made worse off". (p432)

Tolba (1987) - Executive Director, U.N. Environmental Programme.

1. "[Sustainable development] has become an article of faith, a shibboleth: often used but little explained. Does it amount to a strategy? Does it apply only to renewable resources? What does the term actually mean? In broad terms the concept of sustainable development encompasses:

(1) help for the very poor because they are left with no option other than to destroy their environment;
(2) the idea of self-reliant development, within natural resource constraints;
(3) the idea of cost-effective development using different economic criteria to the traditional approach; that is to say development should not degrade environmental quality, nor should it reduce productivity in the long run;
(4) the great issues of health control, appropriate technologies, food self-reliance, clean water and shelter for all;
(5) the notion that people-centred initiatives are needed; human beings, in other words, are the resources in the concept." (p98)

Tonn (1988)

1. "Two principles of 500-year planning:
Principle 1: Future generations should not inherit, from present generations, unacceptable risks of death owing to environmental or other preventable catastrophes.
Principle 2: Future, as well as present, generations may inherit constraints on their primary freedoms as sacrifices for enjoying the conditions of Principle 1." (6th page of article)

Turner - academic economist

1. "The World Conservation Strategy...gave considerable prominence to the sustainability concept, although its precise meaning and practical applications were not presented in a detailed and operational form." (1987, p576)

2. "The precise meaning of terms such as '**sustainable resource usage**', '**sustainable growth**' and '**sustainable development**' has so far proved elusive." (1988, p5).

3. "In principle, such an optimal [**sustainable growth**] policy would seek to

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maintain an 'acceptable' rate of growth in per-capita real incomes without depleting the national capital asset stock or the natural environmental asset stock." (1988, p12)

4. "It makes no sense to talk about the **sustainable use of a non-renewable** resource (even with substantial recycling effort and reuse rates). Any positive rate of exploitation will eventually lead to exhaustion of the finite stock." (1988, p13)

5. "...in this [sustainable development] mode...conservation becomes the sole basis for defining a criterion with which to judge the desirability of alternative allocations of natural resources." (1988, p21).

WCED (1987) [Brundtland Report]

1. "We came to see that a new development path was required, one that sustained human progress not just in a few places for a few years, but for the entire planet into the distant future. Thus '**sustainable development**' becomes a goal not just for the 'developing' nations, but for industrial ones as well." (p4)

2. "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs." (p43)

3. "Even the narrow notion of **physical sustainability** implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation." (p43)

4. "Living standards that go beyond the basic minimum are sustainable only if consumption standards everywhere have regard for long-term sustainability. Yet many of us live beyond the world's ecological means, for instance in our patterns of energy use. Perceived needs are socially and culturally determined, and **sustainable development** requires the promotion of values that encourage consumption standards that are within the bounds of the ecological possible and to which all can reasonably aspire." (p44)

5. "Economic growth and development obviously involve changes in the physical ecosystem. Every ecosystem everywhere cannot be preserved intact." (p45)

6. "The loss [i.e. extinction] of plant and animal species can greatly limit the options of future generations; so **sustainable development** requires the conservation of plant and animal species." (p46)

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World Bank

1. "...satisfy the multiple criteria of **sustainable growth**, poverty alleviation, and sound environmental management." (1987, p10)

2. "To a large degree, environmental management should be seen as a means of attaining the wider objectives of **sustained economic growth** and poverty alleviation." (1987, p18)

3. "...elevating concern about environmental matters...and developing the capacity to implement sound practices for environmental management...are [both] needed to reconcile, and, where appropriate, make tradeoffs among the objectives of growth, poverty alleviation, and sound environmental management." (1987, p28)

ASSERTIONS OF ECONOMY-ENVIRONMENT INTERACTIONS

Allen (1980) - summarising IUCN (1980)

3. "development.... **depends** upon conservation, and that **conservation depends** equally upon development." (p9)

4. "conservation of the biosphere is a prerequisite for human survival and well-being; ...**interdependence** is an inescapable fact of life." (p16)

Bartelmus (1986)

1. "...the overall goals of environment and development are not in conflict but are indeed the same, namely the improvement of the human quality of life or welfare for present and future generations." (pp13-14)

Clark (1986) - environmental scientist and policy analyst, IIASA

2. "Throughout most of history, the interactions between human development and the environment have been relatively **simple** and local **affairs**. But the complexity and scale of these interactions **are** increasing. ... What were once straightforward questions of ecological preservation versus economic growth now reflect **complex linkages** - witness the **feedbacks** among energy and crop production, deforestation and climatic change that are evident in studies of the atmospheric 'greenhouse' effect." (p5)

Tolba (1987) - Executive Director, UNEP

2. "...economic development and environmental quality **are interdependent** and, in the long term, mutually reinforcing. **The rational management of the** world's threatened natural resource base **forestalls a loss** in environmental quality and enhances sustainable economic growth." (p150)

WCED (1987)

7. "...it is impossible to separate economic development issues from environment issues; many forms of development erode the environmental resources upon which they must be based, and environmental degradation can undermine economic development. Poverty is a major cause and effect of global environmental problems." (p3)

World Bank

4. "Promoting growth, alleviating poverty, and protecting the environment are mutually supportive objectives in the long run. ... In the short run, however, the objectives are not always compatible..." (1987, p5)

5. "Poverty - of people and of countries - is thus a major cause of environmental degradation. That makes it essential, if environmental degradation is not to become completely unmanageable, to devise policies oriented toward economic growth, with special emphasis on improving the incomes of the poor. ... Nevertheless economic growth may also destroy the environment and further jeopardize the already tenuous lives of the poor. ... Thus, although growth is imperative for alleviating poverty, it may also adversely affect the poor and the environment if inadequate attention is paid to the poor and their needs." (1987, pp6-7)

6. "...economic growth, the alleviation of poverty, and sound environmental management are in many cases mutually consistent objectives." (1988, p1)

Report on natural resources for food and agriculture in Latin America and the Caribbean

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FOOD
AND
AGRICULTURE
ORGANIZATION
OF THE
UNITED NATIONS

1. CLIMATE, SOIL AND LAND USE

1.1 ECOLOGICAL LIFE ZONES

The Holdridge Life Zone System provides an ecological context for discussion of climate, soils and land capability (Holdridge, 1967). This departure from conventional European and North American approaches which focus on soil characteristics is necessitated by the complexity of the environment which supports agriculture and forestry in the humid tropics. The more densely populated areas of Central and Andean South America may have as many as twenty distinct agro-ecological zones within a 50-km radius. The System is widely used in Latin America for rural development planning and Life Zone maps have been published for most of the countries of Central and Tropical South America, as well as for several Caribbean islands. (Espinal, 1963; Holdridge, 1962; Onern, 1976; Tosi, 1971) (Fig. 1).

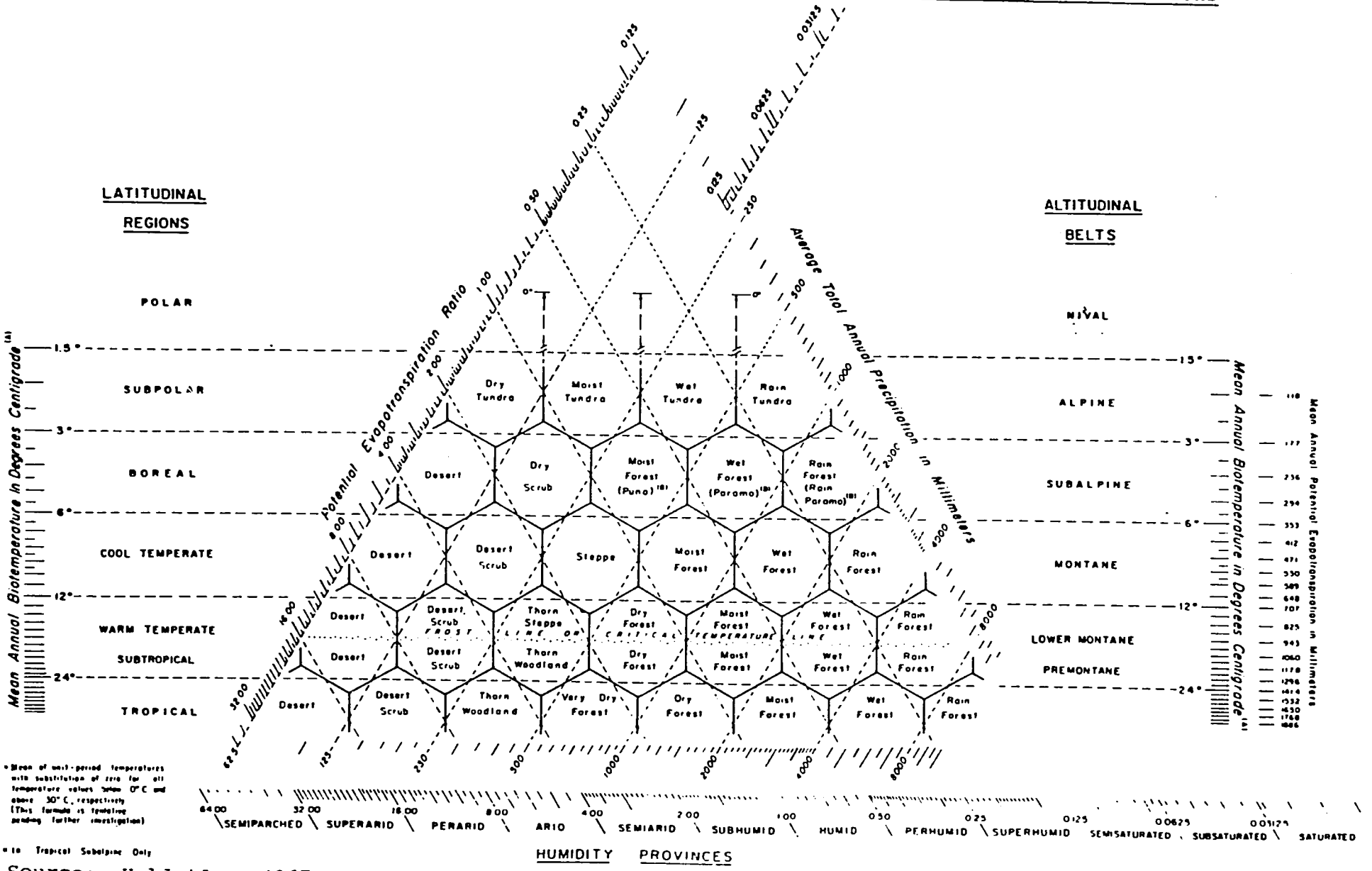
Ecosystems are described on a world-wide scale based on three climatic parameters: mean annual temperature, precipitation, and potential evapotranspiration (PET). The Life Zones defined by these parameters are prefixed by latitudinal and altitudinal indicators to identify them. For example, the tropical premontane dry forest has a mean annual temperature range from 16 to 24°C, precipitation between 500 and 1 000 mm, and a ratio between evapotranspiration and precipitation ranging from 1.0 to 2.0.

Within a Life Zone, associations are found reflecting atypical or azonal edaphic, hydric or atmospheric conditions. Geologic and geomorphic processes, for example, have resulted in extensive areas of sterile, excessively-drained soils in the granite and sandstone Guiana Shield of Venezuela and Brazil. Recent alluvium or the fertile terra roxa soils derived in situ on basalt are examples of azonal fertile edaphic associations. The extensive treeless areas of the Venezuelan llanos reflect a hydric association of the Tropical Dry Forest Life Zone due to frequent flooding and a high water table. Probably the most common atmospheric association in Latin America is the cloud or mist associations where moisture is higher than measured in rain gauges. Associations may exist in combination and are reflected in distinctive vegetation characteristics and land-use options. Topography and slope reflect geologic, climatic and geomorphic processes and are associated with edaphic associations.

A major division is made between Dry and Humid Life Zones. The "Unity Line" occurs where annual potential evapotranspiration (PET) is equal to precipitation: PET/P = 1. In all Humid Life Zones, precipitation is greater than potential evapotranspiration. Dry Life Zones are distinguished by precipitation being less than potential evapotranspiration. See ratios of potential evapotranspiration to precipitation in Fig. 1.

Cold, a limiting factor affecting huge areas across the northern hemisphere, affects only small areas of the tropical Andes (above 4 000 metres) and extreme southern Chile and Argentina.

Fig. 1. Diagram for the classification of World Life Zones or plant formations



(A) * Mean of unit-period temperatures with substitution of zero for all temperature values below 0°C and above 30°C, respectively (This formula is tentative pending further investigation)

(B) * In Tropical Subalpine Only

Source: Holdridge, 1967.

The most reliable indicator in predicting the productivity of agriculture and concentration of population in Latin America and the Caribbean since pre-Colombian times is the PET/P = 1 Unity Line. When Latin American capital cities are plotted on a Life Zone diagram, 19 fall in the Life Zones flanking the Unity Line. The exceptions are Lima (Peru) and Santiago (Chile). Lima is a major seaport surrounded by irrigated land (the original Spanish and Inca capitals were on the Unity Line in the Andes). Santiago lies to the dry side of the Line in a valley with good water resources. For many years, the Spaniards were constrained from settlement nearer the Unity Line to the south by the belligerence of the Araucarian Indians.

According to the Economic Commission for Latin America (ECLA), 90% of the Latin American population live in areas with rainfall of from 500 to 2 000 millimeters. When corrected for elevation, this corresponds over wide areas to the better soils and topography of the five Life Zones flanking the Unity Line, with preference given to the drier side of the Line in lower, warmer areas. The other 10% of the population is divided between arid (or irrigated) and excessively wet areas (ECLA, 1979).

Zonal or azonal fertile soils, where precipitation and potential evapotranspiration are approximately equal, have neither excessive leaching nor accumulation of salts. During the dry fallow season, a net upward movement of nutrients occurs through evaporation and capillary movement. Weeds and pest populations tend to die back. This is analogous to the temperate winter fallow period.

1.2 DRY CLIMATES

Areas where moisture is insufficient to support most types of agriculture (PET twice precipitation), cover a relatively small area in Latin America and the Caribbean, principally along the Pacific coast of South America and in northern Mexico (Table 1.1). Irrigation is used successfully to produce crops in areas where exotic streams cross dry lands, although only 7% of the cultivated land in the region is under irrigation (FAO, 1984a).

The problem of dry climates is more severe in areas where evapotranspiration exceeds rainfall by a factor of 1.5 to 2.5, because land-use practices from more humid Life Zones are extended into these areas by the poorest farmers. Precipitation is not only marginal for crops, but tends to be less reliable and more "aggressive", often occurring as violent thunderstorms with resultant high runoff and erosion. When dry areas habitually subjected to overgrazing and fuelwood cutting are exposed to sporadic violent storms, they become rapidly degraded. Because of low biological productivity, recovery is slow even with careful management practices.

Advances in agriculture in dry areas have been achieved mainly by overcoming the physical stress of lack of sufficient water to grow crops. Some of the most productive irrigated agriculture is found in the driest areas of the hemisphere. Topography restricts irrigation to areas of level valley and coastal alluvium where abundant surface water from More Humid Life Zones can be tapped. Irrigated agriculture in the dry tropics allows the use of intensive agronomic and hydraulic engineering practices from the mid-latitudes with a minimum of adaptation.

Irrigated agriculture can be highly productive and profitable. In Mexico for example, 80% of the increase in agricultural production during the 1960s took place on less than 4% of the production units, mostly in the irrigated north (Dourojeanni, 1982, p. 69). The cost of irrigation is

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high and the technical competence of the users must also be high. Small farmers, lacking both capital and technical expertise, often fail. Poor water management can result in salinization of soils.

Table 1.1 Arid and semi-arid lands in the region

Region/country	Arid area	% of region/country	Semi-arid area	% of region/country
	(sq km)		(sq km)	
NORTH AMERICA				
Mexico	493 136	25	295 882	15
Total	493 136	25	295 882	15
ANDEAN				
Bolivia	164 786	15	109 857	10
Ecuador	-	-	14 178	5
Peru	257 042	20	-	-
Venezuela	-	-	45 602	5
Total	421 828	9	169 637	4
ATLANTIC				
Brazil	85 118	1	507 920	6
Parguay	-	-	20 337	5
Total	85 118	1	528 257	6
SOUTHERN TIER (a)				
Argentina	833 066	30	833 066	30
Chile	302 779	40	37 848	5
Total	1 135 845	32	870 914	24
SOUTH AMERICA	1 642 791	9	1 568 808	9
LATIN AMERICA/ CARIBBEAN	2 135 927	11	1 864 690	9

(a) Excluding Antarctic territories.

Source: Paylore & Greenwell, 1979.

Although pest problems are less severe in the dry tropics than in the wet, lack of effective pest management practices can lead to heavy use of pesticides with adverse effects on humans, downstream ecosystems and the economic viability of the operation itself (Barducci, 1972, pp. 423-438).

Dry lands have a productive potential far greater than what is being exploited in the region today. The rediscovery of water conservation practices common in pre-Colombian America and the Middle East, as well as the application of technologies such as drip irrigation and genetic engineering to achieve drought resistence, offer possibilities for increasing agricultural production.

1.3 VERY HUMID TROPICS

Very Humid Life Zones (evapotranspiration less than half precipitation) have had low population densities since pre-historic times. They encompass extensive lands in the Amazon basin including the steeply sloping "Ceja de Montana" along the eastern front of the Andes where rainfall ranges from 3 000 to 6 000 millimeters per year. Other very humid zones include a small area in the Gulf of Campeche in Mexico and a narrow band running from Belize along the Caribbean coast to eastern Panama crossing to the Pacific side and extending down to northern Ecuador. The highest population densities in these humid areas are along major floodplain rivers where atypically fertile alluvial soils are found, fish are abundant and there is access to markets for forest products.

During the last three decades roads have penetrated these areas and extensive spontaneous settlement has occurred (Nelson, 1973). However, poor soils and lack of appropriate technologies have limited socio-economic development. In the very humid tropics markedly different conditions prevail than are found in the drier, higher tropics, drastically affecting the viability of the Iberian and mid-latitude crops and cropping systems.

The difference in nutrient dynamics between the humid mid-latitudes and the wet tropics is poorly understood. A mid-latitude forest ecosystem has 25% of its nutrients tied up in living biomass, the remaining 75% being available in the soil. The reverse is true in the wet tropics where most of the nutrients are in the living vegetation. An efficient root system rapidly recycles nutrients in dead organic matter back into the above-ground living component. With no winter, nutrient cycling is rapid and almost continuous. When a mid-latitude forest is cleared 75% of the nutrients remain in the soil for crop production once a year. In contrast, when tropical forests are cleared and burned, a flush of nutrients representing most of the stock, is available in the ash and then rapidly washed or leached away.

In addition to erosion and mass movement when soils are cleared and exposed to heavy rainfall, extensive areas with low cation exchange capacities are subject to chemical erosion due to leaching. Fertilizers are rapidly leached from the root zone, removed in runoff or rendered chemically unavailable to crops (FAO/UNEP/Unesco, 1979, pp. 16-17). Soils with incomplete plant cover are subject to rapid oxidation of organic matter with resultant physical degradation, loss of nutrients and erosion (FAO/UNEP/Unesco, 1979, p.19). Cattle grazing also results in the degradation of soils due to compaction and increased organic matter oxidation resulting from annual burning and exposure to direct solar radiation.

The primary challenge in the very humid tropics is to overcome biological competition between crop plants on the one hand, and weeds, pests and diseases, on the other. Primitive agriculturists have taditionally used two strategies to produce food. One is shifting cultivation, using fire to release nutrients and destroy weeds and pests, which permits several harvests before production declines. The other is the intensively managed dooryard garden which imitates the structure and diversity of successional forests (Ewel et al, 1982).

Conventional crop and pasture monocultures are difficult to sustain at high levels of productivity in the Very Humid Life Zones. Capital and energy-intensive palm oil and banana plantations have penetrated the more humid tropics. However, these systems are costly and complex to serve as models for basic food production.

Knowledge is lacking about alternative values and uses of the very humid tropical environment. The forest products industry uses only a small fraction of the tree species. Screening of organisms for medicinal and other uses is promising but slow. Indigenous cultures that have evolved sound management practices are largely ignored and research to develop farming systems has only begun (Wilson, 1984). Because the very humid tropics are not attractive for settlement, infrastructure in the form of roads and facilities for health care, education, research, extension and marketing services is lacking.

1.4 SOILS OF THE REGION

The physical and chemical characteristics of the soils of Latin America and the Caribbean described and mapped in Volumes III and IV of the Soil Map of the World (FAO/Unesco, 1971-75) provide a widely accepted information base at a scale of 1:5 000 000. The South American volume observes that an outstanding feature of South American soils is their low natural fertility. Approximately 50% of the continent consists of various kinds of Ferralsols, Orthic Arenosols and Ferralic Arenosols, all low in cation exchange capacity and in exchangeable bases.

Another limitation which severely affects the agricultural use of the soils is deficiency of water. Broadly speaking, 20% of South America has semi-arid or arid climates, making agriculture without irrigation hazardous or impossible. The soils are mainly Yermasols, Zerosols, Regosols, Lithosols, salt-affected soils like Solonchaks and Solonetz, Ferric Luvisols and Chromic Luvisols.

There are also extensive areas with poor drainage, which make up about 10% of the continent. Here soils are mostly Gleysols, Plinthic Acrisols, Vertisols and Planosols.

The large area of steeplands in the Andes makes up 10% of the continent. Apart from Lithosols, which are dominant, Dystric Cambisols, Andosols and Arthic Acrisols are important, their occurrence being clearly related to altitude and parent material. These are acid soils, but relatively large areas of eutrophic soils can also be found in the inter-Andean valleys and on some foothills. These include Kastanozems, Phaeozems, Chromic Luvisols and Eutric Cambisols.

Regions which consist mainly of soils not having these limitations are rare in South America and extend over less than 10% of the total area. Important soils in these regions are Phaeozems, Kastanozems, Ferric Luvisols, the Rhodic Ferralsols with medium to high base status, Eutric Nitosols and Chromic Luvisols.

However, although the area of productive soil is limited, much of it is still uncultivated or cultivated by traditional methods. Substantial increases in agricultural production are therefore possible.

In most of the countries of the region, governments have soil maps at scales appropriate to their needs. In Peru, for example, the National Resources Office (ONERN), has large-scale soil maps for all major irrigation projects. Smaller scale maps (1:50 000 to 1:100 000) are available for rainfed agricultural projects in the Andes and in the eastern lowlands.

The Guanare-Masparro Project in Venezuela found that a geomorphological study had certain advantages over a soil survey. The original study employed traditional soil survey techniques with extensive field work and air photograph interpretation to produce a soil association

map at an original scale of 1:100 000. The geomorphologist using the same air photographs was able to deduce the basic soil characteristics from a map of depositional landforms interpreted from vegetative patterns. This combined geomorphic, vegetation, and soils map was obtained at a fraction of the cost of traditional soils mapping. The advantage of the geomorphic map is that it reveals actual patterns, shapes, and orientations of land-forms and associated soils, details which are lost in a map grouping soil associations. This map has been an invaluable aid in the assessment of least-cost routings for drains and roads, location of population centres, and land-use planning (Dickinson, 1982).

1.5 LAND RESOURCE AVAILABILITY

No issue in development is subject to wider variations in inter-pretation than land resources availability. "Land" in this broad context refers to (a) arable land with soil, slope and moisture conditions suitable for crop and animal production; (b) forest land capable of sustained production of fuelwood and forest products; and (c) protective land providing multiple services of water, erosion control, waste treatment and recreation.

Cultivated land forms 65.5% of the potential in Mexico; 74.1% in Central America; 63.9% in South America and 91.2% in the Caribbean islands (Annex Table 5). The discrepancy between land potentially available and land actually used has two dimensions - accessibility and suitability. A third dimension is the feasibility of increasing production through more intensive use of either presently occupied lands or new lands.

1.5.1 Land accessibility

There is a considerble differance between the availability of arable land and its accessibility for productive use by small and medium-scale farmers. FAO indicates that this problem is more acute in Latin America than elsewhere in the developing world (FAO, 1984a). In the region as a whole, 8% of land holdings cover 80% of the area. Much of the land used for subsistence and basic food crop production is not suitable for agriculture because f its shallow, rocky soil and potential for erosion. In many countries, a high percentage of basic food crops comes from steep lands (Table 1.2). The best agricultural land is generally under-utilized, being in large holdings for extensive cattle production.

Table 1.2 Contribution of steep slopes to agricultural output in Tropical America in the mid-1970s

Country	Steep land as % of arable land	Contribution to total agricultural production	
		including coffee	excluding coffee
Andes	%	%	%
Ecuador	25	42	33
Colombia	25	38	26
Peru	25	22	19
Central America			
Guatemala	30	45	26
El Salvador	40	75	18
Honduras	15	38	19
Caribbean			
Haiti	70	50	30
Dominican Rep.	15	43	31

Source: Adapted from Posner & McPherson, 1982.

Smallholdings comprise four fifths of the farm units in Latin America, although most of the land is in large farms. Despite their lack of access to productive resources (land, credit, technical and marketing assistance) small farms produce two fifths of the domestically consumed products and one third of the export products (Lopez, 1982). In Honduras for example, farms of less than 5 hectares comprise 65% of the total farms, though occupying only 9% of the land.

At the other end of the spectrum, farms larger than 50 hectares comprise 4% of all farms and occupy 56% of the land. (JRB, 1982). Improvement in small farm productivity in Latin America cannot directly alleviate the serious socio-economic problem of the 70% of the rural population living at subsistence level: half with inadequate land resources and half with no land at all (FAO, 1979).

The land-use planner is faced with a series of dilemmas. Low natural fertility is exacerbated by the susceptibility of humid tropical soils to chemical erosion (leaching) when cleared and used for annual crops and pasture. The costs of establishing and maintaining agriculture on these fragile lands is higher than on better soils, while the potential yields are lower.

On steep lands in Jamaica it was found that crop yields were substantially higher during the first two years under shifting cultivation than on land where conservation measures had been applied (Table 1.3). Under such conditions poor farmers find terracing and other conservation measures economically unattractive. If small farmers are to have access to better land with the potential for increasing agricultural production with less soil degradation, the political difficulties associated with major land reform must be faced.

Table 1.3 Production of yellow yams from runoff plots in Jamaica (tonnes/hectares/year)

Treatment	Year 1	2	3	4	Average
Traditional method					
Total production	56.3	53.1	3[illegible].1	26.4	40.0
Saleable production	31.6	37.8	22.0	16.8	26.9
Bench terraces					
Total production	35.3	44.2	32.6	37.8	38.5
Saleable production	18.5	30.4	21.0	23.2	23.2
Hillside ditches and contour mounds					
Total production	37.5	44.5	39.8	37.3	40.0
Saleable production	20.5	29.6	26.2	23.2	24.9
Hillside ditches and hills					
Total production	43.2	47.2	37.1	35.3	40.1
Saleable production	24.9	33.3	25.2	23.5	26.7

Source: Sheng & Michaelson, 1973.

1.5.2 Land Suitability

Tabulated data allow useful comparisons to be made if the analyst has an intimate knowledge of the ecological differences among regions, socio-economic factors, and the assumptions made in defining land use potential. Arable land in one country or among countries may vary widely in productive potential, controlling factors not being apparent in aggregate statistics (Annex Table 5). What can best be produced as determined by moisture and temperature regime can be inferred from the Life Zone. Generally, zonal soils of the lowland humid tropics are less fertile than soils at higher elevations and latitudes.

Grasslands in the llanos of Venezuela or Colombia with a carrying capacity of one cow per 3 hectares differ from Uruguay or Argentina where temperate Pampas may support 3 cows per hectare. Large areas of unimproved pastures in humid and wet forest areas of Honduras, Peru or Brazil may be as productive as the pampas during the first year after establishment and fall to a level closer to that of the llanos when nutrient leaching and weed invasion become pronounced.

Much discussed is the productive potential of extensive areas of Tropical Moist and Wet Forest Life Zones. These areas have remained sparsely populated through pre-Columbian and colonial up to modern times. This indicates that caution should be used in determining whether improving and intensifying agriculture where people are concentrated should be emphasized or whether colonization of tropical forests would be more beneficial.

One view is that production in the more humid lowland tropics can be improved substantially by the application of capital-intensive soil management technology to annual crop production (FAO 1981a; Higgins et al 1982; Sanchez, 1982). Those versed in Life Zone ecology urge sustained management of forests for wood products and tree crop production in the more humid tropics with intensification of food crop production in those Life Zones where population is concentrated (Tropical Science Centre, 1982; Tosi, 1975; NRC, 1982).

Much of the best land, technical expertise, chemicals, machinery and credit, especially in the lowland humid tropics, are devoted to the production of non-nutritive, luxury crops and feed crops for export. There is essentially no market for many indigenous products. Few people are left who know the diverse range of plants and animals or how to manage them. In the Andes, quinoa (Chenopodium sp.) has been largely abandoned in favour of bread and pasta made from imported wheat. More nutritive and easier to cultivate pot herbs (yuyos) have been supplanted by European greens (Hurtado, 1977).

Land suitable for agriculture is used for extensive livestock production (with cattle dominant), often for export. More than half a million hectares of abandoned agricultural terraces are extensively grazed in Peru.

1.5.3 Intensification of land use

The wide disparities in estimates of arable land are probably due to the fact that natural fertility and manageability are not taken into account when calculating the arable land base of a country. Table 1.4 shows how flexible the definition can be. In all the countries covered, agriculture has potential for expansion; in Peru by a factor of more than ten. With high levels of input, major increases in production can be achieved, mainly on land under intensive use, obviating the need for expansion of the arable land base.

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Table 1.4 Arable land base and potential in some countries of the region

Country	Area of arable land in use (1)	% of national territory	Total potential (2)	
			Area	% of national territory
	(sq km)		(sq km)	
Bolivia	32 500	3	300 000	27
Colombia	40 500	4	439 730	39
Haiti	5 480	20	6 450	23
Honduras	15 650	14	32 670	29
Ecuador	17 550	6	125 320	46
El Salvador	5 600	27	13 200	62
Peru	32 000	3	335 650	26
Venezuela	20 800	4	406 330	44

Sources: (1) FAO, 1983e; (2) OAS, 1974.

Haiti and El Salvador have the greatest need to intensify production because of their limited land base and population density, while Venezuela and Brazil have a greater economic capacity for intensification. Fertile soils are a major factor in long-term agricultural production when a large proportion of the agricultural population does not have access to sophisticated technology, imported agricultural chemicals or an integrated service infrastructure. For Honduras, Peru and Bolivia, the alternatives are either more conservative use of good soils or continued expansion of agriculture into less fertile lands. In the absence of capital investment in agricultural chemicals, neither alternative has the potential to yield major increases in production or improvement in economic well-being.

Opening up new lands in the humid parts of the region is a costly operation, where only one hectare in fifteen can be expected to be even moderately fertile. The failure of the massive Trans-Amazonian Highway settlement project in Brazil was closely linked to the limited areas of fertile soils and the cost of inputs, services and marketing for farmers scattered along thousands of kilometers of road. Had settlement followed rivers rather than a line on a map, a much higher proportion of good soils would have been encountered at considerably lower cost.

It is estimated that 6% of the Amazon Basin has soils of moderate fertility (Sanchez, 1982). This 32 million hectares is roughly equal to the arable land base of Peru, but is spread over a 484 million hectare area, mostly in alluvial deposits of limited extent. 84% of the (excluding sandy soils) has a high nutrient status per hectare if the minerals contained in the living biomass are included. Table 5 shows the various categories of soil.

The results of more than a decade of controlled experimentation in the upper Amazon Basin in eastern Peru show the productive potential of relatively infertile, but well-structured tropical soils under intensive management (Sanchez, 1982). Yurimaquas lies just on the humid side of the PET/P Unity Line in the Life Zone diagram (Fig. 1) marking the division between dry and humid climates. Average yields were between 2.3 and 3.5 tonnes per hectare for rice, corn, soybeans and peanuts, with a combined yield of 7.8 tonnes per hectare over a year of continuous cropping. Three tonnes of lime were applied every three years, 80-100 kg of nitrogen to corn and rice, and 25 kg of phosphorous, 80-100 kg of potassium and 25 kg of magnesium to each crop. Traces of copper, zinc, boron and molybdenum

were applied to correct deficiency problems. This work demonstrates that mid-latitude crops and soil management technology can be transferred to the humid tropics. The model described closely approximates the "High Level Input" scenario of the Agro-Ecological Zones Project (FAO, 1981a).

Table 1.5 Amazonian soils

Soil groupings	Flat, poorly drained	Well-drained Slope 0-8%	Slope 8-30%	Slope >30%	Total (%)
	----------million ha----------				
Acid, infertile (Oxisols, Ultisols)	43	207	88	23	371(75)
Poorly-drained alluvial (Aquepts, Aquents, Gleysols)	56	13	1		70(14)
Moderately fertile, well-drained (Alfisols, Mollisols, Vertisols, Tropepts, Fluvents)	0	17	13	7	37 (8)
Very infertile, sandy (Spodosols, Podzols, Psamments)	10	5	1		16 (3)

Source: Sanchez, 1982.

Such intensification might be an alternative to the prevalent process of tropical forest decapitalization, resulting in the conversion of land to poor pasture.

"Primitive" dooryard gardens (Denevan, 1984) and modern approaches to agroforestry are designed to imitate the mineral cycling and conservation of the humid tropical ecosystem (FAO, 1984b and NRC, 1982). This moderately productive alternative has the advantage of being adaptable to a wide range of ecological conditions and levels of input. Such systems rely on long-cycle crops. Multiple cropping of annuals requires almost three times the fertilizer, pesticide, fuel and labour inputs required for one grain crop in the mid-latitudes. Total yield is comparable if not higher in the mid-latitudes based on only one crop per year because of the longer day and lower night-time respiration.

Longer-cycle crops, including cassava and plantains, produce more calories per hectare per year than do corn or other grains, even when double cropped, because they capture solar energy continuously over a longer period. The forest products industry uses only a fraction of the species found in the tropical forests. More benefits can be derived from much of the tropical forest *in situ* in the form of medicinal plants, animals, water conservation, genetic research and recreation (Myers, 1983).

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8. INTEGRATED AREA DEVELOPMENT

Integrated area development is widely practised in Latin America and the Caribbean, encouraged and supported by the Organization of American States (OAS), the Inter-American Development Bank (BID) and the US Agency for International Development (USAID).

An "area" here is considered to be a coherent sub-national unit chosen for the purpose of development. It may be defined by physical or biological features (e.g. the treeless plain of the llanos of Venezuela and Colombia, the Amazonian floodplain vegetation and soil known as the varzea, the watershed of a river system); or by historical or modern socio-cultural parameters (e.g the Otavalo region in Ecuador); or it may be a political unit (eg. a municipality or province). An area for integrated development may vary in size from the six million sq km Amazon basin shared by six countries to an urban area of 100 sq km. Most important is that the definition be understood by all participants in the planning process.

Development is the rational managment of the environment (the inter-connected terrestrial and aquatic ecosystems) to provide goods and services on a sustained basis for human well-being. Goods are the natural resources harvested and transformed for use. Services are those dynamic processes in the environment which directly or indirectly benefit society, be they economic, social, cultural or scientific.

Integrated area development is a complex process of balancing sectoral interests with broader, long-term interests. Being multisectoral in scope, a coordinated interdisciplinary effort is required, i.e. a team approach with communication among the sectors involved. As it is assumed that the process will lead to improvement in human conditions through the sustainable use of natural resources, there must be a just distribution of benefits. All projects have targets or beneficiary groups. There may also be groups whose interests are prejudiced by the project. Integrated development should minimize conflict and compensate those negatively affected.

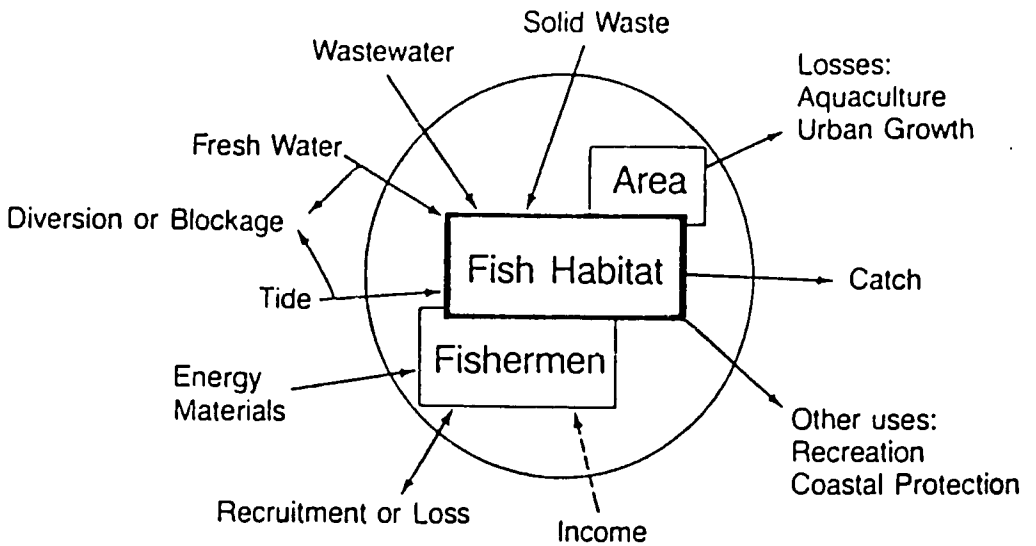
At the planning stage, it is necessary to discern the most significant among the many development activities envisioned. In the case of reservoirs, for example, it is not necessary to make an exhaustive study of erosion for the whole watershed. It is sufficient to identify the areas where sediment actually enters major reservoir tributaries, and what proportion entering the reservoir is excavated from the stream bed. This will show priority areas and determine the proportion of erosion that is uncontrollable. If this proportion is high, the viability of building a dam in the watershed is debatable.

Frequently, planners do not perceive that their activities may adversely affect other sectors. An inter-disciplinary analysis of a country or region is a means of identifying interaction with other sectors. Fig. 3 shows some of the interactions of one sector (fisheries)

with others within a local regional system. The output from one component (e.g. water, forest products or wastes) may become the input, desirable or not, in another component or system.

Fig. 3. An example of intersectoral interaction

Fisheries Sector Interactions.



Source: Dickinson, 1984.

Integrated area development enables a clearer picture to be obtained of how a region or country functions as a system and its potential for development. It allows individuals of diverse disciplines and sectors to appreciate how their knowledge fits into the overall scheme. The identification, quantification and evaluation of interactions permit management options to be defined and potentials assessed (Dickinson, 1984).

8.1 PROJECT FORMULATION

A scheme for the design of development strategies and the formulation of investment projects has been established by OAS, based on twenty years' experience (OAS, 1984). This integrated development approach provides a useful framework for development assistance institutions when designing projects.

Integrated planning is a flexible process, not a formula. Prior to committing resources, it is important that a preliminary (pre-feasibility) mission define the area to be developed, the intended scope of activities, the expenditure envisioned and the agencies to be involved. This is followed by the diagnostic and project formulation phases.

The diagnosis phase is a systems approach to identify relevant data, and organize interdisciplinary team activities. An inventory is made of the basic components of an area - natural ecosystems and their associated soil, water and living elements; managed systems including agriculture, aquaculture and sylviculture; urban-industrial centres; transport infrastructures; legal and institutional aspects. Actual and potential land use is compared to identify the sectoral activities associated with each component. The capacity of supporting institutions to provide education, research, extension, credit, materials and marketing assistance is assessed. Inputs and outputs are identified within the boundaries defined for the area. These include rainfall and river flow, goods and services used in the area and outputs to other areas, such as river outflow, products and contaminants. (Inter-American Development Bank, 1981).

With this basic information, development opportunities and constraints can be identified, alternatives formulated and projects designed within the context of national development strategies and priorities. Environmental scientists have an important role to play with sectoral experts in analysing specific issues and identifying inter-sectoral conflicts within and beyond the area. In this context the environment is not considered a sector but rather the regional system within which all sectoral activities take place.

An evaluation is made of the social, cultural and economic (as distinguished from financial) situation in the area, as affected by existing or proposed sectoral activities. It is important to evaluate the land tenure situation which affects access to land and the effectiveness of institutions in providing goods and services, such as fertilizers, and extension and marketing assistance. Potential target groups for sectoral projects are identified as well as those likely to be adversely affected by the proposed activities. Attention is given to indigeneous people who may lack effective political representation.

As projects are formulated at the pre-feasibility level, it is important that the intersectoral systems perspective evolved during the diagnosis phase be maintained (Annex Table 21).

The feasibility of a proposed project should be evaluated at the following four levels, with emphasis as appropriate:

1. Extra-regional scale. Larger than the planning area and may include urban or international sources of goods and services or markets. Resource availabilty should be assessed at the appropriate level when export of a product is involved, or use of technical assistance, materials, capital investment or water supplies from outside the area.

2. Regional scale. The area may be a province or a region defined by natural features, such as a sea coast or intermontane valley. A comparison is made of several sites with similar soil resources to find the most suitable with respect to: transportation infrastructure, support services and water supply; the site where the proposed activity will pose the least threat to other sectoral activities; and where the natural ecosystems can provide goods and services.

3. Watersheds are closely associated with land forms, soils, vegetation and land capability. Areas can be defined according to river basin or watershed. River basins are sub-divided into convenient watershed units for projects in soil and water conservation, agriculture, forestry and fisheries. The OAS Pilcomayo Project, the Amazon Project, and the Guayas in Ecuador are examples of this approach.

4. Farm systems. Within a watershed are individual management units or farms varying in size according to land capability, population pressure and tenure structure. Only in the last decade has agricultural research and development assistance been oriented to the family farm as a system, reinforced by the recognition of the important role of women in agriculture. Farms are ecological and economic systems operated by families within a specific cultural context. The concept can be extended to family-scale fishery, aquaculture, livestock and forest management activities.

8.2 THE WATERSHED IN INTEGRATED AREA DEVELOPMENT

A watershed is the land area drained by a stream and its tributaries. Precipitation within a watershed returns to the atmosphere through evapotranspiration, is stored for varying periods as groundwater in lakes or reservoirs, or runs off the land to form a river. The runoff from an undisturbed watershed has a characteristic hydroperiod or discharge rate (usually measured in cubic metres per second), reflecting the type and amount of precipitation, soil characteristics, vegetation and topography. Discharge rate is associated with water quality - dissolved minerals, organic matter content and type, and sediment.

Mountain watersheds are of particular concern because of their physical and cultural diversity, fragility, and degradation due to human pressure. Mismanagement can jeopardize agriculture, fisheries, power generation, and navigation downstream. Changes in the hydroperiod due to human activities in one part of a water shed affect downstream activities. For example, road construction through an upper watershed encourages spontaneous settlement; runoff increases as a result of land clearing which is followed by erosion; the rapid increase in tributary stream flow results in more erosion with three major impacts downstream. First, the stream bed is raised by sedimentation, destroying fish habitats and causing increased flooding during high-flow periods. Second, more rapid runoff means less water stored in the soil for slow release with resultant lower dry-season flow affecting fish and all water users downstream. Third, reservoirs for power generation, irrigation or potable water supply are adversely affected by sedimentation, wet-season overfilling and dry-season scarcity.

Impoundments themselves change the hydroperiod, reducing stream flow, affecting downstream freshwater and estuarine fisheries dependent on fluctuating water levels and reduced salinity at certain times of the year. Saltwater intrusion increases and floodplain soils are not renewed.

A study of the Suriname River watershed found that the establishment of a constant flow in the river below the Brokopondo Dam virtually eliminated the freshwater fish that depended on seasonally-flooded forests for feeding. In the OAS Guanare-Masparro study three predictable but unanticipated impacts of flow regularization and flood control are noted:

1. Floodplain basins (esteros), subject to seasonal inundation, serve as areas of wet-season feeding and reproduction for various economically important fish species. Flood control destroys this habitat.

2. Grasses spring up in abundance in the basins as water recedes with the onset of the llanos dry season. Cattle under traditional management depend on this supply of fresh grass and water to carry them through the dry season. This too is lost with flood control and drainage.

3. Several fish species ascend the rivers with the onset of the dry season to find pools of permanent water in Andean piedmont. Their migration is blocked by dam construction (Dickinson, 1982).

While few sectoral projects encompass an entire watershed, most interactions between a project, other sectors and the supporting resource base occur at the watershed level. Integrated area planning at this level can identify potential problems early in project formulation and, if necessary, suggest an alternative location, scale, design or operation to mitigate conflict with other sectors.

The preliminary mission defines the development goals for the area. The first step of the diagnosis phase is to translate regional goals into specific watershed objectives in keeping with the land and water use capacity in the area. In OAS studies of the Darien of Panama, the Dominican Republic, the Santiago-Mira area of Ecuador, and subsequent studies in Peru and elsewhere, Life Zone mapping was combined with geomorphic analysis, and a preliminary soil survey was made to arrive at a Life Zone association classification of land capability. When capability maps are compared with actual land use, conflicts are easily identifiable. It was noted in the Dominican Republic that using maps of differing scales was difficult and time consuming. Today, relatively inexpensive geographic information systems are available which allow digitized resource maps at varying scales to be compared.

At the core of watershed management is the rational use of soil and water resources, which benefits fisheries, irrigated agriculture, energy generation and urban areas, as well as wildlife. Terracing and contour ploughing result in medium term on-farm benefits along with the off-site water conservation benefits. Restriction or prohibition of agriculture or forest use to achieve water management goals represents opportunity costs borne by the agricultural and foresty sectors. Rehabilitation of already degraded areas, particularly dams, is initially a costly undertaking, with a slow accumulation of benefits either on-site or downstream.

The number of watershed management projects in South America has declined in the past decade, due to institutional, fnancial and technical problems. It is difficult to obtain financial assistance because watershed management projects provide long-term rather than immediate economic returns. In addition, they require a coordinated effort among several government ministries and the active participation of local people, both of whom are often left out in the design and implementation stages of watershed management programmes or projects.

In recent years, Venezuela, Columbia and the Dominican Republic have implemented watershed management projects integrating all types of land use (agriculture, forestry, livestock, etc.). The possible impact of upstream activities on downstream users is taken into account, together with social and cultural aspects. In Colombia, the revenue from a tax on the sale of hydroelectric power in urban areas is re-invested in the watershed area of a dam. Half of the revenue is used for rural electrification, and the other half for watershed management activities.

Other watershed management projects in the region concentrate on upland soil and forest conservation activities, but have difficulty in establishing integrated structures because of institutional constraints. Watershed management projects sometimes confuse reforestation with revegetation on degraded, steeply sloping sites. Erosion can be reduced and water infiltration increased by the inexpensive expedient of excluding grazing animals, and using fire to promote revegetation. To engage in expensive reforestation with timber trees can be uneconomical and

assessments generally show that such sites should be left in undisturbed natural forest. When trees inappropriate for soil conservation (e.g. eucalyptus) are planted, the investment makes even less sense.

There are far more watersheds in need of conservation in the region than can be funded by governments and development assistance agencies. Priorities must be established for watersheds where the maximum benefit can be derived from modest investment, those which would benefit from conservation, and those beyond economic recovery. In the first category are watersheds whose upper parts are relatively undisturbed, and whose lower parts have potential for hydro energy, agriculture or fisheries. In the second are watersheds currently over-exploited. In these areas, conservation practices must be built into local farming systems.

Coordination among countries with similar watershed problems is important to avoid duplication and to exchange information, expertise and research. An excellent way to achieve this is through a network approach. FAO has established the Amazon Agrarian Research Network (RDINNA), which focuses on soil management, pasture improvement and forestry. FAO also sponsors a watershed management network for exchange of information and expertise within the region. Through this network the National Electrification Institute of Ecuador (INECEL) was able to call upon expertise from Chile and Colombia to explore strategies for management of the watersheds of hydroelectric projects.

There are two other networks in the region: the Caribbean Network on Upper Watershed Management (for Caribbean countries) and the Regional Cooperation Network in Watershed Management (covering Latin America). Their mandate is to strengthen watershed management activities through workshops, training courses and meetings; to facilitate the exchange of information between countries and to coordinate activities which span several countries, such as the Rio Parana watershed in Argentina, Brazil, Uruguay, Paraguay and Bolivia.

8.3. COASTAL ZONES

The coastal zone represents a special case in watershed management. The coast is the focus of a variety of often conflicting sectoral activities: fisheries, aquaculture, intensive agriculture, wildlife management, recreation and tourism, urban-industrial and port development, and piedmont dams for energy and other uses. The smaller islands of the Caribbean are essentially a closed circle of coastal zone with limited alternatives to disperse conflicting activities.

Coastal marshes, mangroves and coral reefs have in common their productive fisheries and role in coastal stabilization. Marshes and mangroves are open systems dependent for productivity on both upstream runoff and tidal exchange. Coral reefs are dependent on wave action and tidal exchange with the open sea, and even a small amount of nutrients and sediment from the land can be detrimental. As open systems, all three are vulnerable to contamination and to activities such as road building. In Panama, coral mortality is linked with the intensive use of pesticides in the coastal plain. The Baranquilla-Santa Marta coastal highway in Colombia, built without adequate provision for tidal exchange or fresh-water flow to the estuary, was responsible for the loss of mangroves and a decline in fisheries on both side of the highway. Such problems are predictable and can be mitigated through an interdisciplinary area planning approach.

8.4 FARM SYSTEMS

Integrated area development planning applied at the regional and watershed levels finds its ultimate expression at the farm level. In the final analysis, most natural resource management decisions are made by individuals. Deforestation, erosion, overgrazing, burning and over-exploitation of floral and faunal resources are the result of individual activities. While people may be influenced to a limited degree by education, media campaigns, credit facilities and subsidies, a more effective mechanism to reach them must be found. A farm-system approach within an integrated area development framework can provide that mechanism.

A farming system has been defined as a stable arrangement of farming enterprises, operated by a household according to well-defined practices, in response to the physical, biological and socio-economic environment and in accordance with the household's goals, preferences and resources. These factors combine to influence output and production methods. (FAO, 1984e, Shaner, 1982).

The size depends on environmental conditions and population pressure in a particular area, but is usually a small-scale farming operation. In tropical America, a farmer may plant annual row crops; practise horticulture, small or large-scale animal husbandry and sylviculture; hunt, fish and process goods for the market. Such a farmer is not served by crop and cattle programmes designed to meet the needs of large entreprises.

The farm system approach has promise as a means of improving the economic lot of a large segment of the region's society. The organization and management of individual farm units and the structure of government support is important. The farm system approach is a natural outgrowth and complements the integrated area development perspective.

8.5 EXPERIENCE IN THE REGION

Integrated area development experience in Latin America and the Caribbean shows that exhaustive resource inventories and large scale detailed mapping for entire regions are not mandatory for effective planning. In the 1960s, a massive inventory approach in the Dominican Republic delayed the planning process with resultant loss of momentum, as sectoral projects moved ahead under their own economic impetus. There is a tendency for a single sectoral element of a complex, regional programme to become the dominant, if not the only, activity executed.

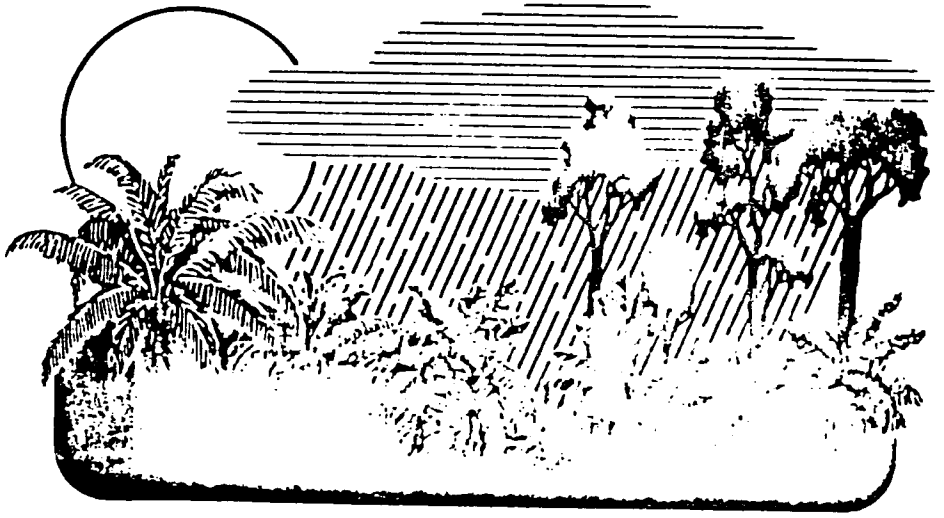
Venezuela, Colombia and Brazil are foremost in the region in autonomous, well-funded regional development corporations. Peru has embarked on a similar process of decentralization. Such entities have more potential to carry out planning recommendations than do national planning institutes, as they combine planning and execution under one administrative structure.

The Palcazu Project in eastern Peru, designed as an integrated area development project following a government decision to build a road through the Palcazu Valley, is translating plans into action. Amuesta Indian lands have been titled, and national parks and forest lands defined, in concept if not yet legally. Experiments in tropical forest succession management, agroforestry and tropical fruits are underway. The main constraint is imposed by the Valley itself with its 6,000 mm per year rainfall, poor soils and difficult topography, which makes it difficult to get technical expertise into the field, where on-farm projects are executed.

Land capability studies, settlement schemes, watershed management plans and social programmes are complex and require much more coordination than do infrastructural elements such as dams. The neglect of these supporting elements stems from a lack of conviction on the part of national agencies and financing institutions of their political and developmental value.

ECOLOGICAL DEVELOPMENT IN THE HUMID TROPICS

Guidelines for Planners



Winrock International

MODULE 5

SETTLEMENT AND LAND DEVELOPMENT

Arthur J. Hanson and Joshua C. Dickenson III

Optimists calculate that little more than one half the world's potentially arable land is currently in agricultural production. Perhaps 75% of these "underused" arable lands are to be found within the humid tropics. Yet the preceding chapters clearly show that we face immense difficulties in creating sustainable resource management strategies, whether through opening new agricultural areas or through intensifying use of existing lands. How then can a planner proceed when faced with the need for continued expansion of food output and a host of other concerns related to land development? People and governments throughout the world place high hopes on the expansion of agricultural area. Can we define a composite model based on comparative experience to establish firm guidelines for successful settlement and land development? Or is land opening to end bleakly in most cases, with the spread of rural poverty to new areas? In total numbers of migrants and in immediate political and economic impact, migration to cities is more significant than migration to the agricultural frontier. But the potential ecological damage and socioeconomic disruption associated with spontaneous and government-sponsored agricultural settlement schemes can hardly be overstated.

A relevant review paper (World Bank, 1978, p. 17) indicated the following major problems of settlement: 1) the agronomic output is unusually risky, relative to that of development projects in established areas where the potential is more fully known; 2) settlement projects are particularly susceptible to political manipulation because they entail highly "visible" allocation of people and land; 3) government assisted settlements demand large inputs of scarce qualified manpower with high opportunity costs; 4) settlements are generally characterized by long gestation periods required to build minimal new infrastructure in the project area; 5) possibilities of earning government revenues in recovery of significant portions of public expenditure are limited, because projects often settle landless families at little more than subsistence levels; and 6) spontaneous or low-cost assisted settlements frequently result in adverse environmental effects.

Settlement and resettlement at their worst, represent rampant frontier development. Often there is an element of compulsion (e.g., displacement from dam/reservoir areas throughout the world) or of redistribution (e.g., land reform in Latin America and Africa). New settlement of humid tropical lands has resulted in only modest increments in economic production, at costs that

sometimes exceed US$10,000/ha. Direct involvement by government is not necessarily an advantage, although there are exceptions, such as the development of rubber and palm oil smallholder lands in Malaysia. In a thorough study of 24 cases in the Latin American tropics, Nelson (1973) concluded that "evidence is on the side of those who would restrain expansion in the hope that higher returns would result from a sequence that places initial emphasis on consolidation, education, the accumulation of knowledge, and the improvement in public administration. The prudent approach to movement into pioneer areas is a gradual one designed to attract spontaneous settlers and...private investment and enterprise." Unfortunately, both governments and international lending institutions tend to overestimate project benefits and underestimate costs in their financial analyses. Ecological and social costs are never fully factored into present-day land-development projects. Indeed, there are some who consider that the "rational model" noted above by Nelson is generally inoperative because follow-through is weak in both spontaneous and government-planned activities.

Planners who draw up the schemes for settlement operate in a complex political and social decision-making arena. Their political masters may hold a variety of goals, not all of which can be acceptable from either a social or ecological perspective (table 3.3.1). They may be trying to bring rationality and scientific inputs to an otherwise disordered land-grab, such as often accompanies opening of new highways or commercial logging. Project implementors are under intense pressure to accomplish an almost impossible task within an unrealistic time frame. Their task is to accommodate new settlers on lands of unknown or marginal productivity, where there may be strong local resentment or even events that amount to local cultural genocide. Whatever model for sustainable development is proposed, it likely will fall short in actual implementation -- leading to a demand for research and adjustments in the model of development. Resettlement becomes a race between factors that favor land abandonment and efforts to create stable settlements with ever-increasing levels of productivity from the resource base. Hence ecological understanding is absolutely essential for the success of any resettlement program.

Table 3.3.1. Goals in humid tropic settlement.

Valid goals	Inappropriate goals
Effective and sustainable use of nation's resources	Generation of the revenues based on decapitalization of forest, soil, and water resources
Exploitation of mineral resources	
Achievement of balanced distribution of population relative to resources	Alternative to comprehensive birth control and health action
Regional development	Standard for resolving land inequities and access to government services
Effective occupancy of national territory	Occupancy as repressive or paternalistic measure against local cultural groups

Ecological information needs extend beyond those pertaining to site productivity. Planners must consider alternative uses within an area, especially tradeoffs between agricultural and forest land use. Reserve and buffer areas will be essential, for example, to provide adequate protection for key genetic resources, to ensure environmental protection of watersheds, and for public health aspects such as drinking water supply and disease vector control. Unfortunately, rigid application of "ecological rules" may be as damaging as their complete neglect. Location of greenbelts, planning for development of hilly areas, and attention to attributes such as mangrove swamps or other wetland areas requires considerable sensitivity to local circumstances so as to avoid senseless, ineffective creations. The classic example is the designation of numerous reserve patches that are too small to be sustainable, and which may form refugia for mammalian and insect pests. On the other hand, an ecological inventory, with follow-up interpretation conducted in time for input to early planning stages may be the most important determinant in the long-term outcome of a land development.

MEASURES OF SUCCESS

In this chapter, particular emphasis is placed on the need to consider human ecology as an essential factor of land development. Farmers are remarkably adaptive to new circumstances, yet many projects fail because the farmers eventually abandon the land. Declining land fertility or failure in the war against pests and disease are common reasons for failure. However, economic and social factors may dominate or interact with ecological effects. Thus, successful land development must:

- create production patterns that are sustainable and resilient in the face of fluctuating environmental conditions

- establish an economic framework that provides for ongoing infrastructure maintenance, market assess, and consideration of ecological-economic interactions (e.g., not destroying key environmental attributes for short-term gain, thus avoiding option foreclosure)

- foster harmonious social relationships within and between cultural groups within the region

- set aside sufficient amounts of the resource base to provide for environmental protection needs and for use by future settlers (including their children)

Unfortunately, political and national development planning pressures may result in success being defined as simply numbers of people moved or area of land opened. Such measures may lead to the worst abuses -- for example, as planning measures are quite literally bulldozed aside (along with the topsoil), as traditional knowledge is lost in the rush to crop monoculture, and as people starve when they are placed in poorly prepared settlements (or are denied access to their customary resources in forests or swamps). Economic costs escalate in these circumstances. Planners must be aware of these possibilities and take active steps to avoid them.

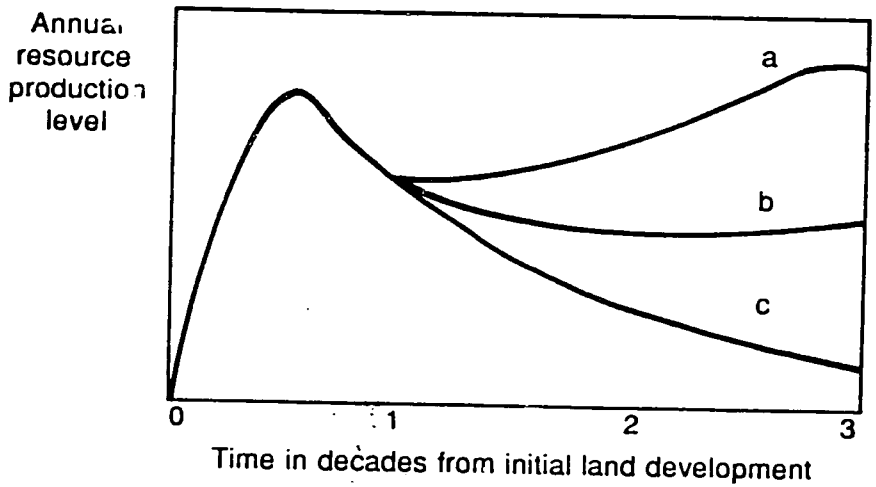
What is the profile of successful land development? The answer will depend very much on the professional to whom this question is directed. Many ecologists concerned about tropical forest destruction would be loath to consider any project successful that destroys significant areas of primary forest, even where there is evidence of medium-term success of agriculture. Those professionals who have witnessed the tragedy of indigenous/tribal

people who lose traditional hunting and gathering grounds, and the subsequent breakdown of their social structure, will be disinclined to measure success on the basis of cassava or palm oil exports. These moral and judgmental concerns should be much more a part of the development equation than they are at present. If they can be satisfactorily answered, then ecological production concepts can be used to profile land development.

Figure 3.1.1 indicates three possible outcomes of agricultural land development in the tropics. Only **outcome "a"** can be considered successful. After an initial (generally misleading) peak in production, there will be a decline in production, as stored soil nutrients are depleted and as pests and diseases become prevalent. From this point the outcome is totally dependent on management and on ecological, economic, social, or other factors that may reduce the effectiveness of management inputs. The scenario is played over at least a 30-year time span, far longer than the period covered in most economic feasibility studies. For some developments, it would be more useful to consider 50-year time scales to determine whether the land development is successful. The initial 4 to 6 years of success are unlikely to be repeated (perhaps extending a decade or more under the best of management circumstances). Secondly, the period of from 5 to 15 years after development begins is frequently a critical juncture from an ecological perspective. Yet often this is the time when land developments are transferred from special development status to less-coordinated arrangements involving many government agencies.

INTENSIFICATION VERSUS EXTENSIFICATION

In most countries, the best lands are already under cultivation. Consequently, new agricultural lands will have one or more significant limitations to sustainable use. There are exceptional circumstances where fertile river basins may become available for settlement and cultivation (e.g., West African lands freed from the scourge of river blindness). The more marginal lands demand adaptive techniques and careful placement of agricultural systems to avoid the worst conditions. Peat bogs in Southeast Asia provide wetlands on which rice may be grown. However, if the peat is deeper than 1.5 m to 2 m, nutrient limitations make sustainable development unlikely. Furthermore, if excessive tillage causes the underlying potential acid sulphate soils to oxidize, the result may be a biological desert that can be rectified



a. Sustainable production with marketable surplus

b. Subsistence production level

c. Eventual land abandonment (after 10-30 years)

Figure 3.1.1. Outcomes of agriculture in land development.

only at enormous cost. On the low-fertility podzolic soils that underly most of the tropical forests in the world, only careful experimentation with a locally appropriate mix of plants and fertilizers can lead to sustainable agroecosystems. For semiarid conditions found in countries such as Pakistan and the Sudan, land development is linked to irrigation, with inherent dangers of salinization and soil waterlogging. In Latin America, migration to humid lowlands has sometimes been encouraged by governments that are unwilling or unable to resolve fundamental land tenure and development-assistance problems.

In all of the examples cited, there is a need to consider whether it would make better sense to invest more in the intensified use of existing lands, and leave the marginal areas to traditional uses that might include low-intensity grazing, shifting agriculture, or forest harvest. There is no general answer to this question. Agricultural intensification brings about its own set of ecological and social problems. However, intensification almost always will be cheaper in terms of the capital investment, and involves areas with much better understood characteristics. Yields from most existing agricultural systems are markedly below potential. In addition to present-day gains of the Green Revolution (which are available to less than 50% of existing agricultural areas in developing countries), yield increases of 2 to 6 times may be conceivable for some sites in coming decades. Increased attention to postharvest technology is another way to lessen the dependence on marginal land settlement for food supply. These potentially high values, rather than current production figures, should be used in any comparison -- because production values from the new lands are unlikely to stabilize in a period less than a decade or two from the time development starts. Thus, in both cases, we must look to future values.

The high cost (in both ecological and economic terms) of any new land development dictates that the starting point in planning should be a detailed analysis of alternatives, including the potential for meeting objectives through intensification of existing agricultural systems. Factors that should be taken into consideration are shown in table 3.1.2. Obviously, if the objective of settlement is primarily political (e.g., distribution to landless poor, or "securing" of territory), development sometimes will proceed, whatever the analysis reveals. Even in these circumstances, there may be value to considering alternatives, because the worth of the

resource base will be more clearly defined so that reserves are set aside and(or) valuable timber is not burned in the process of development. Also, a better balance between intensification and extensification may be established if opportunities for the intensification are explicitly incorporated into development.

Table 3.1.2. Agricultural intensification versus extensification.

	Intensification	Extensification
Economics		
Infrastructure	In-place, modification to to enhance quality of output	High cost, potential time delays
Economic efficiency	High	Low
Labor demand	Increased	Increased but high cost/job created
Resource allocation	Improved practices on existing model	Wasteful (e.g., forest burning)
Human Ecology		
Land ownership	Unchanged	Potential clash with traditional users
Distributive	Existing pattern reinforced	Landless may acquire farmland
Shifting cultiv.	May convert to settled cultiv.	May interfere with existing shifting cultiv. and over long term may create more shifting cultivators
Health	Upgrading through rural development	Face new hazards; limited care
Education	Can build on existing structure	New educational infrastructure

Table 3.1.2. (continued).

Ecology		
Natural ecosystems	Indirect impacts (e.g., pesticides)	Inevitable major destruction
Maintenance of ecol. processes	Nutrient retention; soil buildup (e.g., rice paddy)	Open system, high nutrient loss, rapid soil depletion
Agroecosystem	Complex, sometimes resilient (e.g., home garden)	Simplified, focus on few crops, vulnerable to climate, pest, and diseases
Species diversity	Low to medium	High, drastically dropping

PROJECT "KILLERS"

Given the complexity of most land developments, it is helpful to be able to identify those situations most likely to destabilize the project. Nine situations deserve special attention: Five of these are most likely to become evident over the first 10 to 15 years of the project (although they may remain significant after this period); the other four lead to collapse over longer time spans. The outcome in each of the cases could be land abandonment, even in the face of considerable inducements for families to remain within a settlement area. Each of the nine "killers" is discussed.

Factors in Land Abandonment: First 10 to 15 Years

1. **Decline of soil fertility decline and soil toxification.** Nowadays most planned land developments proceed with some knowledge of soil characteristics and a basic understanding of nutrient limitations. Yet such information is not sufficient to avoid project failure. The landscape is generally far more "patchy" than is perceived on examination of a topographic map. Detailed soil surveys are required to find the "islands" of good soil. Regrettably, even when this information is available, engineers and physical planners may choose to use other criteria as they lay out settlement patterns along

roadsides, or seek to maximize land development in an area with many ecological boundaries. In hilly areas, the consequence may be the placement of families on erosion-prone slopes where soil nutrients will be quickly lost. In coastal-zone deltas, ecological boundaries may be transgressed so that people settle in zones influenced by saltwater intrusion. In this case, nutrients are certainly present, but crops cannot survive. Because the initial soil disturbance makes the limited pool of soil nutrients immediately available, reasonable crops may be obtained, especially over the first 4 to 6 years of cultivation. Then crop production declines. The worse-case scenarios are land development on white sandy soils, deep peats, or other very-low-nutrient soils, and projects where the shallow topsoil (often less than 10 cm depth) is bulldozed when land is cleared. Under such circumstances, there is virtually no hope for sustainable development.

The decline of soil fertility may be slowed through the application of chemical fertilizers. However, such inputs are only part of the essential package for success. Soils in the subtropical and tropical areas exposed to intense sunlight and high temperatures rapidly lose their organic content. Hence they must receive input of "green manure" (decaying vegetation), and benefit greatly from animal wastes. Often chemical fertilizers are restricted to only one of the standard N-P-K macronutrients. Without other chemicals (e.g., lime on acid soils), their application may be worthless. Micronutrient inputs may be essential, and it may take years of research to determine which micronutrient, or combination, is effective on a given site. Unless fully anticipated, soil decline may come on so rapidly that appropriate solutions, delivery mechanisms, and acceptance by farmers cannot be developed before the land is abandoned. Once secondary vegetation takes over the land, ameliorative costs to reestablish agriculture become very high.

2. **Castastrophic environmental events.** Storms, floods, drought, volcanic eruptions and earthquakes, and pest and disease outbreaks are the principal natural hazards that must be taken into account. These may be interactive with other factors; certainly pests and disease have more serious effects on plants growing under stress conditions. Farmer response to periodic environmental events follows two distinctive patterns. Those who have long experience in a given locale will understand the periodicity of hazards and may be extremely skeptical about exposing themselves to risk. Thus it is not unusual for them to grow only one (rather than two) crops per year (e.g., to avoid the possibility of total dry-season crop loss in an occasional bad year). Such behavior may be counter to the project's feasibility analysis, which may indicate a reasonable cost-benefit ratio only if double-cropping is assumed. On the other hand, farmers placed in a new environment may have very little perception of what natural hazards to expect, and thus may expose themselves inadvertently to high risks. Should they plant on a rising flood, or on falling waters? Is costly application of pesticides essential in all circumstances? What type of cultivation is least likely to destroy soil structure and reduce wind erosion losses in drought conditions? Unless the pertinent questions for any particular site within the project area can be adequately answered, disaster may be in the offing. Planners often fail to perceive how risks may differ widely, even within a small geographic area. Rain shadows can occur even on reasonably flat areas. Salt-intrusion zones, differences in flood levels within a delta, and dangers from flash floods in highlands are examples of frequently overlooked hazards.

3. **Human health hazards.** The most obvious risks to human health are related to nutrition, water-borne disease, and to ecological changes that result in the build-up of disease vectors. Malnutrition will result when there is miscalculation of the food subsidy needed in relation to the stream of food production from the new development. Besides leading to land abandonment, this miscalculation may lead to loss of reserve lands as hungry people seek to increase total production by opening more than allotted lands. Also, special medical problems may result from vitamin or mineral deficiencies (lack of vitamin A due to insufficient yellow vegetables; goiter in iodine-deficient diets).

Water-borne diseases flourish in the poor sanitary regime surrounding new settlements. Drinking-water supplies are rarely safe, especially in dry periods. Sewage disposal may be rudimentary. Even if funds are available for improvements, their benefits may be temporary, especially for settlements located on unstable soils, or if insufficient attention is given to maintenance.

Disease vector build up can be the most troublesome problem since it may involve plant or animal community ecology changes that are difficult to monitor or prevent. Some of the worst circumstances are found in areas such as the Niger River Basin in West Africa. Land settlement there depends on a sustained reduction of blackfly populations that cause river blindness, yet it is quite possible that fly populations will rebound after people move back into abandoned villages. Also, perceptions of farmers may be as important as actual disease incidence in determining whether they will stay on the land. In this region, health of inhabitants, and therefore their ability to perform useful farm work, is also affected by malaria, sleeping sickness, and intestinal parasites.

In Asia, farm settlements located close to forests may suffer higher incidences of malaria. If the natural drainage patterns of the mangrove forest are blocked, stagnant pools are created, providing an ideal habitat for the malaria-bearing mosquito Anopholes sundaicus. Although many relationships between ecological change and disease are well documented, such knowledge rarely finds its way to the front line of development activity where field project managers each day make decisions that may have significant positive or negative effects on the potential for disease outbreaks.

4. **Resource conflicts.** Land development may involve complex shifts in ownership, and the privatization of common lands. It may also be a reverse process in which communal ownership overtakes private estate ownership. In either case, there inevitably will be some degree of conflict as one set of laws supercedes, or coexists with, another. Often written law replaces unwritten, but effective, indigenous codes. Although planners often wish to believe it were the case, lands are rarely "empty" or unencumbered by any claimant. Grazing rights, harvest of forest products, and shifting cultivation are episodic -- within a season, or even over periods of years or decades. Developments are endangered if they do not adequately recognize and protect such uses, or provide satisfactory compensation. Traditional systems of resource use also may provide an integrated management base including water, land, forest, and fisheries resources. In contrast, new development may be focused exclusively on agriculture. Where more than one development type is proposed

(e.g., forestry concessions and agriculture), there may be difficulties in ensuring coordination of resource use -- significant land degradation may take place even before settlers arrive.

5. **Project economics.** The cost of implementing a sustainable development plan is inevitably much greater than anticipated, and the economic returns can be significantly less, especially when there are delays in project implementation or a failure in assumptions concerning double-cropping or yield levels. A temptation is to spread inputs over very large areas; however, this drastically reduces their effectiveness. If available funding does not arrive on schedule to purchase inputs, the same effect is likely. Project economics also may be influenced by markets and by alternative opportunities that become available to settlers. In general, the project economic model cannot provide adequate analysis for the mixed farming systems and occupational pluralism characteristic of traditional land development. Therefore, projects that place prime emphasis on upgrading these existing systems receive less attention than do those that seek to introduce simplified agroecosystems.

Longer-term System Collapse

6. **Insidious ecological change.** Once a system has been altered by cutting of original forest, construction of drainage ditches, or other such drastic measures, it may be impossible to reconstruct original conditions within a human lifespan. Hence it is important to recognize each major development for what it is -- an ecological experiment with an uncertain outcome. Three types of long-term ecological change may be drastic enough to seriously threaten project viability. One is a **general decline in ecosystem productivity** so that even massive inputs are unlikely to alter the situation in a 10-to-20-year period. Desertification in many parts of the world is the prime example. However, it is important to recognize that insidious ecological changes can accompany any type of land development, ranging from fishponds in the coastal zone to tea and coffee plantations in the mountains.

A second source of concern is the **emergence of a key limiting factor.** Soil toxification may result from exposure of soils to oxidation or high evapotranspiration rates. An insect pest or plant disease

never before deemed important may become so prevalent and persistent that certain important crops simply cannot be grown. It is sometimes difficult to predict what may become a key limiting factor. Much may depend on the sequence of wet or dry weather in the first years of cultivation, or on the introduction of exotic pests and diseases. An adaptive management strategy is essential to deal with potential limiting factors. Inappropriate management (e.g., insecticide spraying that removes natural predators) may lead to the emergence of a key limiting factor.

The third type of change is **decoupling of ecological processes**, either within the development areas, or with the surrounding support zones (e.g., the water basin). The decoupling may result from a deliberate act such as water transfer from one river to another (leading to changes downstream), or from inadvertent changes such as the land slumping that accompanies ditching of deltaic areas. In these cases, whole ecosystems may be lost as nutrient flows are cut off and as surface or groundwater flow is changed. Estuarine-dependent fish resources may disappear, or swamp forests die. Migratory waterfowl or mammalian herds that form part of the area's resource base are reduced. Elephants and other mammals can become destructive pests as they move into croplands in their search for food.

7. **Loss of resilience.** Developments that crowd large numbers of people onto relatively small plots of marginal farmland will run into serious problems sooner or later when there is overcrowding (as children mature and take over land), when there is economic dependence on one or a few crop types, and when there is no type of integrated management approach to ensure that needs such as water, fuelwood, and building supplies are met. Resilience is a term that is equally applicable to the surrounding ecosystems, which if they have been badly degraded, may be unable to assimilate wastes or to adequately regenerate following natural disasters such as droughts. The term "agricultural involution" was coined to describe how Javanese rice farmers always were able to coax a little more production from their land through extra care, even in times of economic or ecological adversity. The rice field is one of the best examples of a resilient agroecosystem. Another good example is the home garden, found in many forms throughout Asia, Latin America, and Africa, but often ignored as a component in land development. At the other extreme is the smallholder estate developed on red-yellow podzolic soils and growing a few cash crops such as cassava and cocoa. Ecological resilience is conditioned by human actions; it can be enhanced or reduced.

8. **Cumulative impact derived from multiple actions.** Over a period of 20 to 30 years many ideas may be tested in an area, and many types of projects may emerge. The imprint of these actions, good and bad, will remain, sometimes with unexpected consequences. There may be contamination of groundwater with agrochemicals. Land partitioning may result in plots that are too small for application of reasonable management. A threshold may be reached where fish no longer spawn in tidal creeks or polluted streams. Repeated burning of the forest may lead to replacement by other vegetation. Obviously, a major effect of good management will be to ensure that cumulative actions are directed to benefits such as the increase in soil fertility that can accompany the development of rice terrace systems. Indeed, **outcome a** in figure 3.1.1 is predicated on this assumption.

9. **Lack of regional environmental protection.** Failure to provide for adequate reserves, buffer zones, and protection of upland watersheds, shorelines, and lowland water storage (swamps to protect from flood damage) will result in high costs in later stages of project life. Warning signs are, for example, when catastrophic events occur more frequently than the usual 10-to-25-year return period. As more settlers are attracted to a successful land-development area, these costs, expressed in terms of human lives and property damage, may indeed become frightening. There may be a coupling of events in the settlement areas with hinterland environmental destruction (e.g., when settlers search farther afield for wood). In theory, land development functions best as a part of a regional development plan. The difficulty is not only in development of ecological parameters for such a plan, but also in the follow-up enforcement of its provisions.

Other Considerations

Unfortunately, nine potential "killers" can be interactive within a single project, or can occur in sequence. Since they are not always identifiable as major concerns in the early stages of a project, the situations

described receive secondary attention compared to urgent matters such as settlement construction and building of basic agricultural infrastructure (e.g., irrigation systems). When ecological or social changes become a serious problem, mitigative costs turn out to be very expensive and the knowledge base elusive. There is no real substitute for anticipatory planning and field ecological research in land-development settlements. In the remaining part of this chapter, strategies are considered for increasing ecological inputs throughout the life of the project.

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

The most sensible advice for planners is **to establish realistic goals.** Projects may extrapolate from test-plot productivity values and create unrealistic expectations of double-cropping as a means of boosting the benefit-cost ratio. Grandiose schemes seeking to move huge numbers of people, or to open vast areas are more likely to fail simply because of the difficulties of managing inputs. They are more difficult to monitor. Furthermore, aroused expectations lead to a greater gap with reality -- modest success can then be perceived as failure. Worse still, when objectives are not fully met, good practices fall by the wayside in the race against time. The most depressing aspect of land development in such circumstances is to recognize that ecological and economic information available to planners and managers is likely to be ignored. How can the case for adequate ecological safeguards be made during crisis times? Obviously, it is better to avoid creating impossible expectations and thereby avoid dealing with this question -- which appears to have no easy answer.

Linking Information and Decision Processes

There are several potential weak links in the process of converting basic ecological and socioeconomic data into information that will actually influence decision-makers, planners, and implementors of land- settlement schemes. Data must be relevant to clearly defined questions and should be comprehensive and accurate enough to provide usable answers. While these observations may seem obvious, in practice they are overlooked, leading to worthless inventory and monitoring exercises. It is certainly not enough to produce basic data in the expectation that it will be used! There must be an integration of information, often from a combination of technical and traditional sources. Neither the

scientists nor the planners involved may be skilled in this type of analysis. It has been suggested that analysis by small teams makes the most sense. Sometimes the task may be tackled by a single individual skilled in interdisciplinary analysis of resource and environmental problems.

Information management should be considered a key issue in the development planning process. There should be a definite strategy for the gathering and analysis of information, as well as for its dissemination. The timing of inputs to each important decision is perhaps the most essential concern -- before a project is initiated, the important **decision categories** should be mapped out and related to potentially significant ecological (or other) issues. This may be done as a simple matrix, as shown in table 3.1.3 for a swampland rice-development project in Indonesia. Then an attempt should be made to determine **when** decisions will be required. It is then possible to lay out a critical pathway for information gathering and use in decision-making. This "scoping" exercise is particularly useful when budgets and(or) manpower are scarce.

At a strategic level, information management should be seen as a means of screening information to ensure that it is presented in the most meaningful and timely form for the intended recipient. To accomplish these objectives, information managers must have direct linkages with decision-makers and with local councils, etc. In other words, they must fully understand the decision-making process, and track it over the life of the project. Often this vital aspect of project management is overlooked; the provision of information is on an ad hoc basis and not perceived to be of particular strategic significance to project success. The other extreme is the provision of excessive amounts of data, poorly processed as information -- which are justifiably ignored.

Information management should start with the effective use of existing data. This should involve coordination among agencies and the development of compatible information-exchange systems. In the future, micro-computers will be an important medium for this exchange. At present, some of the most essential ecological information is derived from satellite imagery and aerial photography. Even where there are only a few images in a time series, significant local patterns and dynamics of land use can be identified. These images also are important for soil and water analysis. Too often data

analysis of remote-sensing images stops at a rudimentary level. Individuals trained to identify ecological zones will spot important gradients that will be extremely helpful in setting out reserve areas and in ensuring that both village and agricultural infrastructure are well placed. Aerial photography also will illuminate existing patterns of land ownership and can delineate common areas used for grazing, etc. Besides remote sensing, there are many sources of secondary information that should be tapped as part of the "armchair" examination of resource potential and limitations. One of the most innovative approaches for the use of such information is the adaptive assessment process (Holling, 1978). In this process, planners and managers work with information specialists/computer modelers to create scenarios of resource use over time, under various economic, social, and ecological assumptions.

Ecosystem Research

Field research for land development often focuses only on three themes: soil characteristics, water resources, and agronomy. Human ecology aspects related to these themes frequently are overlooked. Sustainable development strategies demand a more comprehensive examination of the region's ecology and an accurate portrayal of farm-level ecological changes as the original ecosystem is replaced. Any type of land development creates massive ecological change. Hence baseline data gathered before a project is initiated may become some of the most valuable information for management and for monitoring good or bad trends. Unless there is a reasonable ecological inventory available to planners, it is impossible to make reasonable allocations among resource uses or to develop ecosystem and genetic resource-protection strategies. At least some of the information should be gathered at a regional level, so that information about ecology inputs may influence choices between different development alternatives.

Ecological survey research can meet some immediate needs, but there is an ongoing requirement for ecological knowledge that can be served only by good experimental and monitoring work. The land development in itself can be viewed as a gigantic and complex experiment. Although development agencies dislike thinking in such terms, they are well advised to clarify the hypotheses that are being tested by the project. For example, a project may explore the value of minimum tillage. The basic ecological work required may include an understanding of nutrient cycling, soil biology, plant competition and

Table 3.1.3. Decision matrix for environmental problems in development of ricefields from tidal swamplands in Sumatra (Hanson and Koesoebiono, 1980).

DECISION CATEGORY	KEY RESOURCE AND ENVIRONMENT PROBLEMS												
	1 Soil classification/fertility decline	2 Land instability/river shallowing	3 Low water quality/salt intrusion	4 Catastrophic flood/drought	5 Fisheries decline	6 Forest product shortage	7 Vegetation succession/competition	8 Agricultural pest outbreaks	9 Disease and vector buildup	10 Stable infrastructure and environmental impacts	11 Multiple allocation of same resource	12 Underutilization of resource base	13 Insidious environmental degradation
a. Forest use allocation						●		●			●	●	
b. Land clearance timing/methods/location	●	●	●	●	●	●	●	●	●			●	●
c. Crop varieties/patterns/methods	●	●	●	●		●	●	●				●	
d. Agricultural intensification	●		●		●			●					●
e. Fishing right allocation					●						●	●	
f. Choice of fishing gear					●								●
g. Canal location		●	●						●	●			
h. Canal size	●	●	●	●							●		●
i. Field level water control			●		●		●	●	●			●	
j. River alteration	●	●	●	●	●						●		●
k. Population density	●			●	●	●	●						●
l. Settlement size	●	●	●	●					●	●			●
m. Drinking water supply			●										
n. Vector control					●				●	●			●
o. Shipping canals/channels		●	●		●								●
p. Port location	●	●			●				●				●
q. Road location/construction methods	●	●							●	●	●		●
r. Reserve designation	●	●	●	●	●	●	●	●					●
s. Soil conservation	●	●					●	●					●

succession, groundwater hydrology and soil microclimate, survival requirements of important protection plants, and impacts on the physical environment. There is a need to consider distant ecological impacts that may create damage outside of the immediate project area (e.g., downstream flooding; loss of estuarine spawning habitat, forest fires resulting from drying and accumulation of slash).

Increasingly, there is recognition of the need to develop regional, as well as national, research units capable of providing ecological information for land development and settlement. Ideally, these units should focus on specific life zones. Failing that, they may operate at a provincial level, where decisions may cover several eco-units. In Indonesia, for example, a network of agricultural field research stations has been established on the basis of key ecological zones, such as coastal peat swamplands in Sumatra, upland vegetable-growing areas, and the peneplain zones where new land development is likely to be based on tree crops. In addition, the government has established environmental study centers at all provincial universities. These are intended to provide ecological expertise for local development of all types. Regional research units require a mix of ecological, economic, and social expertise to adequately address certain of the problems of land development.

The source of information most often overlooked is the local residents who may have developed successful strains of plants adapted to local circumstances; almost certainly these people will have valuable traditional knowledge relevant to ecological cycles and limiting factors. Their approach to resource management may be superior to and more integrated than anything that will be proposed by outsiders. Unfortunately, historical colonization patterns may have destroyed some of the traditional knowledge base. In Latin America, for example, Iberian models (based on European cultivation) overwhelmed the highly evolved local systems; sophisticated terracing, irrigation, and ridged field agriculture and polyculture disappeared. The cultivation patterns of present-day tribal groups, dependent on slash-and-burn techniques, are a far cry from those of earlier days. Finally, the new settlers also will bring knowledge and prejudices that require analysis by social scientists, with the aim of understanding impacts on the area's protected zones and the land development itself.

Inputs in Relation to the Project Cycle

Ecological inputs are important during the early stage of project design, hopefully as early as the pre-feasibility stage. Land-development activities usually are phased, thus many individual projects can be found at different stages: planning, implementation, operational, and transfer. When designed into the project, a periodic evaluative component can be one of the key means for identifying harmful trends. Unfortunately, post-project evaluations often have paid little heed to environmental effects. Hence, knowledge is lost that should feed into the design of related projects. Consultative processes with those affected by the development should be a part of the project cycle activities.

Land development may be subject to formal environmental impact assessment (EIA) procedures, also with consideration of social impacts. An EIA provides a convenient means for bringing together existing information, plus whatever field data can be gathered over the time available for the preparation of the statement. The EIA also may help to foster coordination and cooperation among agencies, and to establish channels for inputs by affected groups. The weakness in the EIA process becomes evident if the information generated is shelved at the conclusion of the planning phase. Although once considered a "project-stopper," the EIA should be thought of as the first stage in the development of appropriate environmental management.

Information needs will vary according to the project phase. Table 3.1.4 shows a suggested pattern based on transmigration in Indonesia. The operational phase offers the best opportunity to begin testing advanced concepts, particularly integrated resource management. Special attention should be paid to the transfer stage, for this is the time when coordination among agencies is most likely to fail. It is also about the time when longer-term ecological problems begin to appear. In preparation for transfer of management responsibility to departments of local and central government, there should be extensive training regarding principles of ecology and resource management; outstanding questions about land ownership should be resolved; a functional environmental protection strategy should be in place; and the necessary funding and personnel should be identified to continue the monitoring and research programs.

Table 3.1.4. Inputs to land development at various project phases (Adapted from Hanson and Goodland, 1979).

Planning Phase

- Environmental inventory (project area and related region)
- Environmental impact statement (including social analysis)
- Land capability overlays
- Specific study topics:
  - soil resources
  - water and aquatic resources
  - identification of existing agroecosystem, optimal proposed systems, and significant limiting factors
  - conservation and special areas; reserve designation settlement design, including waste disposal, drinking water, and other concepts to safeguard environment and public health
  - activities and land use/ownership patterns of existing settlers and their participation in project design
- Identification of potential option foreclosure situations
- Economic and social analysis for resource allocation

Implementation Phase

- Boundary designation for reserves, etc.
- Land preparation procedures
- Identification of adaptive land use, water resource, and agricultural practices
- Community ecology studies for crop assessment and vegetation/pest management
- Procedures for full use of materials (e.g., forest remains, local housing materials)
- Settlement and infrastructure location and construction to minimize disease build-up and physical instability (e.g., location of roads in erosion-prone areas)
- Controls to avoid wanton destruction of wildlife and to ensure their location
- Mechanisms to avoid or resolve conflict with existing residents and resource users
- Designation of spoil sites
- Program for monitoring ecological changes

Table 3.1.4. (continued).

Operational Phase

- Experimental analysis and monitoring
  - soil fertility and land abandonment
  - integrated pest and disease management
  - farm-level water-resource regulation and use
  - production intensification
  - development of appropriate technology solutions
- Integrated resource management strategies
  - complex agroecosystem development
  - appropriate management of forestry, fisheries and other resources in the area
  - adaptive environmental assessment, especially for interaction among resource users, and consideration of project in regional development context
- Infrastructure and settlement
  - monitoring of environmental effects
  - development of environmental control measures (e.g., for local industry operations)
  - environmental impact assessment of new infrastructure and additional settlements
  - environmental services to spontaneous (unsponsored) new settlements
- Monitoring of project impacts on other areas (e.g., downstream in watershed, estuary in coastal zone)
- Periodic project evaluation

Transfer Phase

- Development of coordinated ecological monitoring and research plan, to include operation of field stations
- Integration of resource management decision-making with local councils and provincial authorities
- Complete outstanding land claim/ownership issues prior to transfer
- Mechanism for ongoing training and education of settlers, resource managers, and local residents

Integrated Planning and Regional Development Approaches

Regional planning theories and practices are not always compatible with ecological approaches; however, both aim at sustainable development as an objective. Land settlement should take place within an integrated planning system, and that system should strive to incorporate ecological ideas. Water-basin development and coastal-

zone management are examples of regional planning based on environment, as are some integrated rural development projects. Regional planning should identify resource-use options and offer alternatives among projects and their locations. It also is the approach required for dealing with issues such as spontaneous migration into land development areas.

Spatial layout of development is a dominant theme for physical planners to which ecologists have contributed several important concepts. One of the least explored in actual projects is ecological design of reserves based on size and shape. Reserves can be considered as islands that eventually will reach some equilibrium between local species recruitment and extinction. If the reserves are too small, they may not serve their intended purpose. A long, narrow reserve along a river valley may have a different value than a circular reserve of the same area. More attention should be given to the creation and functioning of buffer zones surrounding reserves. Buffer zones may be the essential element in the protection of natural areas, for they allow a compromise to be reached between the economic needs of settlers and environmental protection of the reserve.

Ecologists also have developed far more sophisticated and comprehensive analyses of remote-sensing information than have other land-development professionals such as soil scientists. It is possible to create not only detailed land-use maps, but also resource capability maps to serve regional planning needs. Maps can be combined to provide overlays that show natural transportation corridors, areas requiring special protection, and the lands most suitable for wildlife, forestry, and agriculture. The overlays provide the fundamental regional information required to "design with nature."

Ecological and Socioeconomic Monitoring Programs

This chapter has emphasized the need for a continuing flow of environmental information to be used in adaptive planning and management. In this way, feedback about performance of the project is returned in time for corrective measures and improvements that will sustain systems and ultimately lead to a higher level of social benefits. Unfortunately, monitoring programs can develop a life of their own when data are collected without follow-up analysis. Hydrometric and other field instruments may become semifunctional, so that collected data are meaningless. A program for soil analysis, or another single-purpose objective, may absorb the available

research and monitoring funds, thus precluding more general and valuable geomorphological analyses. Hypotheses may become fixed around the types of data collected, rather than dealing with the evolving problems they should be addressing. These inadequacies occur commonly in land-development projects, but they can be prevented by good research managers. Project leaders should recognize that strong vested interests or narrow disciplinary views held by research managers may lead to recommendations for continuation of programs long past their point of effectiveness.

CONCLUSIONS

Land development in the tropics can be exploited within a style of frontier development that temperate-zone nations would prefer to forget having experienced within their own boundaries. The "taming of the West" in North America took place at great ecological and social cost a hundred years ago, and today the frontier is a subject of great concern in the northern parts of Canada, the United States, and some European countries. Acceptable development in the eyes of Western nations may be very different from what governments that are hard pressed to feed and provide land for their people willing to try. Yet if the end result is failure and land abandonment, conditions in the tropical nations will worsen. Furthermore, such negative land-development impacts on indigenous minorities may tarnish the international image of countries for generations to come, and may lead to internal social dissent. Thus, it will sometimes be better to pursue land development as a last resort, rather than as a first course of action. It is especially important to compare the benefits derived through agricultural intensification as an alternative.

Where it does make sense to proceed with new land settlement, the most important investment will be in training and education that prepares the needed technical experts, as well as the people who will be participants in the experiment. These are the farmers and local project managers who, in the end, control the rate and direction of ecological change. It has been argued that few, if any, examples can be found of proper tropical forest management. Fortunately, the same is not true of tropical agricultural systems. In all parts of the world, highly skilled farmers have developed multiple-crop agroecosystems that serve as a model in many ways superior to the croplands of the temperate countries. If this

knowledge can be adapted for use on the best of the marginal lands, successful projects will emerge.

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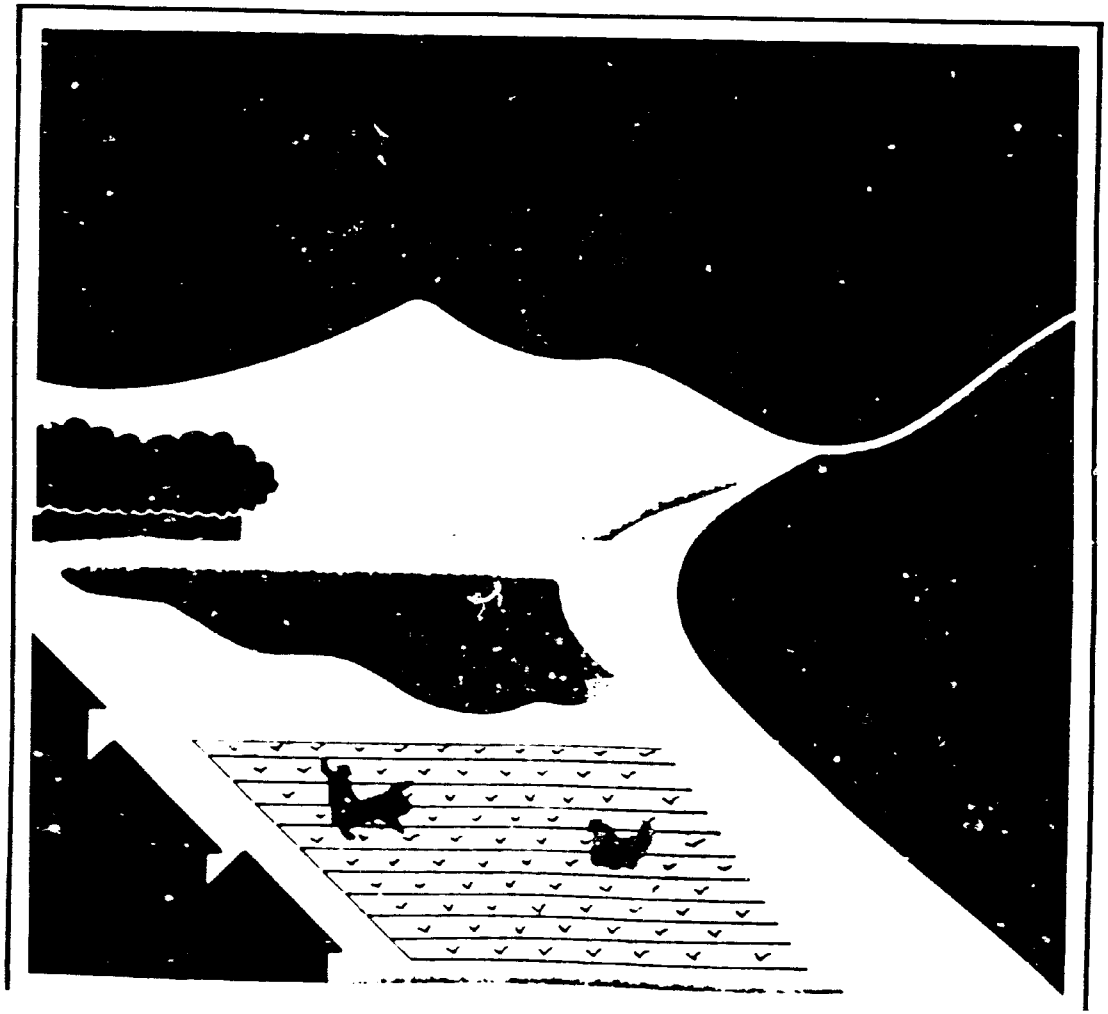
Implementation for Sustainability

Lessons from Integrated Rural Development



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CHAPTER ONE

Linking Implementation and Sustainability

Why do some development projects result in long-run improvements, whereas others introduce only a temporary change in local activity? Many people have asked this question and numerous answers have been offered. Recently, those answers have shifted away from purely strategic explanations toward an awareness of the crucial role of the tactical aspects of organization and management in project success. Sound schemes alone fail to induce development. When people and materials cannot be coordinated or when bureaucratic procedures block performance, good ideas deteriorate into bad experiences. The widespread occurrence of these events suggests that an important area of concern should be implementation.

But this raises another question—namely, implementation for what? It is difficult to assess the relative merits of different implementation strategies without identifying the objective of the implementation process. In fact, some observers question whether common success measures such as per capita income, roads, or food production are adequate to capture the essence of development. Temporary infusions of project resources often generate employment and income benefits that do not last beyond outside funding; roads can deteriorate rapidly if they are not maintained; and quick production jumps may benefit powerful landowners rather than poor farmers. These critiques of the development record emphasize the need to go beyond inventories of artifacts to encounter the need for changes in local capacities to make improvements self-sustaining. Thus, an analysis of implementation practices should be based on the contribution they make to sustainability.

Sustainability

It is important to define the meaning of sustainability. Previous literature on the subject of institution building has often equated success with the perpetuation of an organization.[1] That is, the recognizable continuation of a formal body,

such as an institute of tropical agriculture, was considered a measure of success. In this book, however, success is not the perpetuation of an organization. Instead, it is the continuation of benefit flows to rural people with or without the programs or organizations that stimulated those benefits in the first place. The classic example is the farmer who learns about a new technology from an agriculture extension service and then is able to apply it successfully. Of course, the bottom line is that this application leads to enhanced production of marketable produce and that institutions exist that can refine the technology and maintain the higher production and income levels, but the original organizational channel that was used may no longer exist or no longer provide the needed services.

An organization may cease to exist because another body has assumed its functions. In fact, this is the explicit intention of many program designers who expect cooperatives or other local community organizations to take over a project's marketing operations. Conversely, some organizations stumble along well after the demand for their services has subsided. This is especially true of public sector units based on an unobtrusive line item in the national budget. The Philippines, for example, is dotted with empty low-profile organizations with distant origins. In some situations, success may result in the private sector providing marketing or input supply services originally started by a public sector intervention. Clearly, neither the form of an organization nor its survival may be equated with sustainability. If either is overemphasized, there is inadequate recognition that benefits continue or fail to continue as a result of what people actually do, within or without the initiating organization.

Looking at sustainability demonstrates a concern for what happens after a project terminates. The need for this emphasis is rooted in a development mode that relies on temporary projects using outside resources.

If development were a one-time procedure like a vaccination with a lifetime effectiveness there would be no reason to be concerned with sustainability. But development is not such a procedure. Simple infusions of outside resources rarely generate self-sustaining improvements in productivity and life quality.

For progress to be made in the practice of development, then, attention must be concentrated on the process of converting resources into development gains. The connection between implementation and sustained outcomes must be understood.

For the purpose of assessing this connection, the degree of sustainability may be considered as the percentage of project-initiated goods and services that is still delivered and maintained five years past the termination of donor resources, the continuation of local action stimulated by the project, and the generation of successor services and initiatives as a result of project-built local capacity. Ideally, this assessment would include a visit to each project site five years after its termination to determine the magnitude and nature of the inheritance left behind.

These visits did not take place. However, momentum resulting from successful practices often appeared capable of continuing past external funding. At the same time, it was possible to observe examples of disintegration that occurred before termination, making it unlikely that benefits would last even to the end of outside support. Although there is more certainty about failure than about success, tentative statements may be made about both and about the way particular implementation practices and design characteristics are related to each of them.

Characteristics of Integrated Rural Development

Integrated rural development (IRD) is usually understood to be a multisectoral, multifunctional development initiative placed in one or several different locations. Integration is basically a response to the judgment that the rural farmer's poverty stems from a host of problems requiring a package of coordinated responses – from health services to agricultural extension to credit and technology dissemination.[2] As a result of their relative size and complexity, most IRD projects are donor assisted and have had their conceptual origin with donors.

The IRD projects in this sample range from small community-based efforts by private voluntary organizations (PVOs) such as the Save the Children Federation, through area-based or district programs targeted on a few thousand hectares and a corresponding number of people, to large regional and national development programs. Projects studied for this book varied in budget from only $200,000 a year to more than $10 million yearly, such as Columbia's Integrated Rural Development Program. Generally the projects cluster around budgets of $2–3 million a year over a funding period of three to five years, although a recent trend is toward longer time horizons, sometimes up to 10 years. This great empirical variability usually goes unrecognized by those writing about IRD.[3]

The focus of these IRD projects also varies. Roads, clinics, literacy, land, irrigation, and livestock are typically emphasized. At the higher end of the budget range, IRD tends to involve a few social service components tacked on to a program of infrastructure development. Since most of the budget goes for the physical products, this facet overwhelms the attention of management and dominates the implementation process. Sometimes institutional development is an explicit objective, such as in the Provincial Area Development Program in Indonesia. Usually, however, the institutional element appears as the introduction of a cooperative or similar local organization to perform necessary project functions. Marketing, credit, labor mobilization, and irrigation system management are typical activities in which these organizations are engaged.

The development literature is moving toward more precise distinctions among rural development, agriculture development, and integrated rural development. The basis for this volume is not the literature however. It is instead based on field observation.

At first glance, the variation in the components, organizations, and objectives

of these projects may seem contrary to this movement toward precision and clarity. But the combination of an agricultural production component with other service-oriented elements characterized all the field efforts.

Furthermore, our interest is in the organization and management of development programs in general, and the common patterns observed within this group of projects suggests that their variety is not a hindrance to this effort. IRD, as reflected in these field examples, provides an open window for looking at the organization and management of development initiatives encompassing a wide range of scope and substance.

In addition to scope and substance, the context in which IRD is implemented has significance for management and organizational choices. Common factors to consider are discussed below.

First, IRD projects often are located near international borders. When farmgate prices are held low or when desired goods are more available on the other side, the proximity of these borders may result in the siphoning off of livestock or agricultural produce, such as crops intended for marketing through parastatal bodies. Borders may also be politically sensitive because of disagreements with neighboring states or illegal flows of immigrants.

Second, IRD projects that emphasize food production may occupy a particularly important position in a national policy setting that gives priority to providing cheap food for urban populations. As a result, the prices IRD participant farmers receive for their produce may be significantly higher than the depressed prices charged in nonproject settings.

Third, IRD projects frequently are situated in an area with a history of political disaffection toward the national government. This may be a region, tribal territory, or a district or municipality within an otherwise politically supportive area. Political opposition makes it difficult for project designers to understand local cultures or to design projects that are sociologically feasible.

Fourth, IRD projects often impose changes in the local authority structure by introducing temporary arrangements for project management and by using technical criteria to replace traditional patterns of decision making. IRD's significance as a penetration mechanism is seldom lost on local leaders. Many implementation problems arise from attempts by those who are losing control to slow down or reverse the process.

Fifth, IRD projects are often part of a process of decentralization by the national government. When these policies are stated, development of subnational capacity for project management is sometimes an explicit objective of the IRD effort.

Sixth, IRD projects are usually administratively complex. They impose heavy requirements for coordination on project staff with limited leverage over line ministries and other agencies whose cooperation is critical to a multisectoral effort.

These characteristics may be interrelated. For example, the establishment of an IRD effort based on irrigated rice production could be used simultaneously to seal a border, produce food, provide an increased government presence in an unruly region, and transfer land allocation authority from the village head to the new project management unit. At times, multiple objectives are mutually supportive. At other times, however, they can be contradictory. Thus, a project may use subsidies to induce growers to produce, risking a recurrent cost burden that constrains institutional development in the responsible agency. Or, the rhetoric of decentralization linked to an implicit attempt to gain greater control over the hinterlands may create distrust leading to unproductive local management behavior. Unfortunately, these situations occur frequently in rural development efforts.

Three points emerge from an awareness of these characteristics of IRD. First, formal statements of program objectives, the philosophy of IRD, or the technical dimensions of integrated approaches seldom adequately explain what worked or what did not and why.[4] Second, the process of IRD implementation often contains basic contradictions.[5] Among the most difficult is the tradeoff between immediate measurable results and capacity building in implementing agencies. This is no less true of the development enterprise in general; identifying these contradictions and their manifestations should help shed light on reasons why apparently sensible solutions seldom seem to make a difference.

Third, program failure is not primarily a result of lack of political will. Instead, it results, at least in part, from wills in conflict and the impact of this conflict on the organization and management of the development process. Examining experience with this process and suggesting ways to improve it constitute the tasks of this book.

Its primary focus is on organization and management factors and their effect on sustainability. Since IRD implementation obviously has a strong political dimension, politics are important too. Even sustainability has political overtones. Willingness to maintain a road, availability of funds to cover recurrent costs, adoption of appropriate technologies, and desirability of giving resources and power to subnational bodies all reflect political priorities.

At the same time, these issues are more than just political. Roads across deserts cost less than those across swamps, and sustaining the vitality of an organization in a place with no resource endowment is more difficult than keeping a well-placed organization, such as an irrigators' association, in business. Thus, improving the craft of rural development requires more than bemoaning political difficulty. It calls instead for a bolder approach that harnesses past experience and, recognizing both contradictions and uncertainties, directs that experience toward promising new pathways. But to do this, a framework is necessary to organize the experience.

A Conceptual Framework

There are many ways to look at the project implementation process. The

choice of analytic perspective naturally influences the observer's judgments. This book suggests a conceptual framework that emphasizes the process of development and the importance of sustaining the benefits of that process.

Broadly stated, development projects involve the deliberate use of resources to achieve self-sustaining improvements in human well-being and capabilities. Project implementation is the process of transforming those resources to achieve that objective. Ideally, local demand for development should be the initiating factor for project activities. In reality, the impetus commonly comes from outside. In either case, the typical project pattern brings external inputs to a local situation to address welfare and capacity goals.

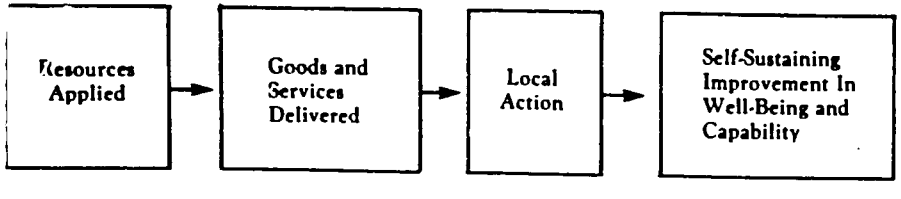
Implementation normally takes place within an organizational setting. For example, an irrigators' association manages labor, information, finances, and physical resources to give farmers a water supply, which helps increase rice yields and thus contributes to higher income levels. Similarly, integrated area development projects organize funds, facilities, equipment, and staff to train farmers in improved cultivation practices, leading to higher yields and greater incomes.

The changes that are sought are usually complex and uncertain as well as largely uncontrollable. Since individuals are unable to induce the changes single-handedly, organizations are needed to facilitate and manage them. Project management units, line ministries, political parties, cooperatives, formal village associations, and informal seasonal agricultural work groups are all examples of organized effort in the development process.

The jump from applying resources to obtaining sustained welfare improvements, however, is a great one. In fact, if intermediate stages are not identified, this jump remains little more than a leap of faith. Fortunately, a common pattern emerges from development experience. First, the resources are used to provide some type of goods or services. Second, people respond by using (or ignoring) the services. If the response is positive and produces benefits that can be sustained, the result is development.

Thus, two intermediate objectives may be inserted between the application of resources and the achievement of sustained development. The first one is the delivery of goods and services, and the second is people's responses to them. This sequence of objectives is displayed in Figure 1.

Figure 1
IMPLEMENTATION AS SEQUENTIAL OBJECTIVES



Implementation, then, is the process of managing the achievement of sequential objectives. For example, delays in road construction plague many rural development schemes and block the conversion of resources into the delivery of a good, such as improved market access. When farmers refuse to adopt new technologies, agricultural extension agents experience firsthand a nonresponse. When farmers do try new methods but yields or prices fall, they suffer from the failure of their response to lead to improved well-being.

Moreover, the sustainability of an initiative has important human implications. The inability to maintain a road not only leads to physical decay, but also erodes human confidence and undermines the credibility of future development initiatives. Similarly, when a farmer has taken a risk and switched to production practices requiring fertilizers, tools, pesticides, and new work patterns, and these inputs later prove unavailable or inappropriate, he or she feels betrayed or exploited. This experience is likely to constrain that farmer's subsequent adoption of extension advice. Thus, the links between the sequential objectives must be forged in ways that improve chances for sustainability.

The key dimension of Figure 1 is represented by the arrows—that is, the process of achieving the sequence of objectives. This is where organization and management can make a difference since they are major components of the deliberate effort to turn targets into accomplishments. Moreover, different implementation processes can have different effects on sustainability. Since this is the primary concern of this book, it will guide the discussion of alternative tactics for organizing and managing rural development programs.

The logic of the conceptual framework posits a flow through time, from left to right, from one objective to the next in the sequence—it is impossible to deliver services without human or financial resources or to use services before they exist. Nevertheless, the latter stages of the sequence—local response and benefit sustainability—must be considered when implementing the earlier stages. For example, beneficiaries will not use new services if they expect that their welfare, as they define it, will decrease as a result of this use. Different projects attempt to do different things, but all require effective linkages between resources, service delivery, local response, and sustainable benefit flows. Measuring the success of a project in terms of impact essentially means assessing the quality of these linkages.

This perspective is necessary to ensure that each linkage is managed in ways that lead to self-sustaining impact. Not only what is accomplished but also how it is done is important. Project managers must consider the possibility that the processes they use to apply resources, deliver goods and services, and evoke response will, in fact, lower the possibility that these processes will continue after the project has ended. Without a conscious effort to focus on post-project issues, a shortsighted service emphasis tends to dominate decisions. This problem is exacerbated by the contradictions and nonlinear relationships that characterize

interactions among the various elements in this seemingly simple sequence. The contradictions are explored in greater detail below.

A Sequence of Contradictions

Goods or services must be delivered for people to use them. What is needed to deliver them, however, may be the very thing that precludes their use. If management authority is fragmented, for example, coordinated service delivery is made difficult. Yet the positive response of villagers is made more likely by their participation in program decisions – an approach that diffuses authority. This contradiction is inherent in the implementation process. One stage requires concentrated authority, whereas another calls for shared authority.

A second contradiction emerges in discussions of the relative merits of using temporary as opposed to permanent organizations to implement development projects. Temporary units are good at physical construction such as building roads, ports, clinics, or other facilities, but they usually are not structured to provide permanent funding and management. Thus, a focus on long-term sustainability supports the use of permanent institutions. At the same time, the seeming impossibility of getting anything done inside existing institutions drives project designers toward temporary task forces or management units. If nothing is started, there is nothing to sustain.

Other occurrences that generate contradictions are:

- Inaccurate statements or promises by politicians create false expectations of immediate benefits rather than an understanding of longer-term development processes.
- Foreign donors prefer financing new projects to underwriting recurrent costs of past initiatives or carrying earlier efforts to the point where they become viable.
- Promised host country resources are not forthcoming, either because the resource level required is unreasonable or because the government chooses not to provide them, but staff is nonetheless exhorted to work harder.
- Project staff pay little attention to sustainability issues as a result of pressures for immediate delivery of goods and services.
- Local action in the form of ongoing participation, resource commitment, or other appropriate response to project initiatives is absent because the emphasis on staff performance relegates secondary status to beneficiary initiative.
- Low rates of financial return or insufficient cash flow render income-producing activities untenable while new organizations are expected to assume responsibility for performing these activities.
- Project satellite organizations are often established to control beneficiary behavior while they are expected to evolve into mechanisms for representing beneficiary interests.

These and other contradictions will be examined in later chapters. In some cases, resolutions will be offered; in others, there are none. In all instances, however, the overriding objective of sustainability will be employed to assess the relative merits of alternative solutions within the context of rural development management.

The Context of Rural Development Management

The experience base for this book encompasses a time span of five years in the late 1970s and early 1980s. Thus, it is not immune from the particular myths and insights or the global political economy of that time. Much the same may be said of IRD itself, which emerged from the experience of the late 1960s and early 1970s.

In the 1960s, Third World development was viewed largely as a problem of national planning. Borrowing from a European model of technocratic elites determining optimum resource allocation to achieve economic objectives, such as industrial development and import substitution, governments gave major priority to comprehensive national plans. First stages emphasized physical infrastructure as the prerequisite for generating engines of growth. Roads, ports, and hydroelectric projects were to establish linkages that would generate production gains and widespread income benefits.[6]

As equity concerns emerged in the early 1970s, decentralization and a focus on poverty gained in importance.[7] Planning descended from its national focus to emphasize subnational areas that could act as growth poles.[8] Integration at this level reflected a balanced growth strategy writ small – infrastructure, agricultural production, cottage industry, education, health services, and employment generation made up a package to alleviate poverty in selected areas. When this package was combined with the discrete project approach to development investment applied in rural areas, the strategy was often called IRD.

Most of the IRD projects discussed in this book had their roots in a transition period, when comprehensive blueprints for development evolved from a concern with building physical infrastructure to an emphasis on benefiting the poorest segments of the population in selected geographic areas. The transitional environment surrounding the conception of these projects should be kept in mind when examining contradictions in the implementation experience and the difficulty of achieving sustainability. This environment promoted contradictory designs – rhetoric emphasized alleviating poverty, but resources were spent on capital-intensive physical infrastructure; goals stressed the process of institutional development and local capacity building, but immediate targets and donor evaluations focused on physical production and resource disbursement. Managers were often given conflicting tasks, but not the means to resolve the conflicts. The result was a preoccupation with project service delivery at the expense of adequate consideration of post-project viability. It is necessary to examine the various approaches taken to service delivery to understand how this happened.

Notes

1. Most of that literature is summarized in Melvin G. Blase, *Institution Building: A Source Book* (East Lansing, MI: MUCIA, 1973); and in Joseph W. Eaton, ed., *Institution Building and Development: From Concepts to Application* (Beverly Hills, CA: SAGE Publications, 1972).
2. Coralie Bryant and Louise White, *Managing Development in the Third World* (Boulder, CO: Westview Press, 1982), 290.
3. A recent example of this failing is Vernon W. Ruttan, "Integrated Rural Development Programmes: A Historical Perspective," *World Development* 12, no. 4 (1984): 393-401.
4. This point is made in Robert Chambers, "Rapid Rural Appraisal: Rationale and Repertoire," *Public Administration and Development* 1, no. 2 (1981): 95-106; and in George Honadle, "Rapid Reconnaissance for Development Administration: Mapping and Moulding Organizational Landscapes," *World Development* 10, no. 8 (1982): 633-649.
5. The first one to identify the conceptual confusion that preceded the empirical variation was John M. Cohen. See "Integrated Rural Development: Cleaning Out the Underbrush," *Sociologia Ruralis* 20 (1980): 195-212. This article is highly recommended.
6. Albert O. Hirschman, *The Strategy of Economic Development* (New Haven, CT: Yale University Press, 1958).
7. Edgar Owens and Robert Shaw, *Development Reconsidered* (Lexington, KY: D.C. Heath and Co., 1972).
8. See E. A. J. Johnson, *The Organization of Space in Developing Countries* (Cambridge, MA: Harvard University Press, 1970); and Dennis A. Rondinelli and Kenneth Ruddle, *Urbanization and Rural Development. A Spatial Policy for Equitable Growth* (New York: Praeger, 1978).

CHAPTER FOUR

Sustaining Benefits

Local action in response to project initiatives is one key to success. But if the action does not lead to the actor's betterment, then it is not likely to be sustained. Unmarketed produce does not raise farmer income, nor does it provide an incentive to continue planting that crop.

Unfortunately, the IRD experience is filled with examples of the withering away of hard-earned gains from project activities. Sometimes climatic shifts, such as droughts, hasten the retreat from success. Other times, however, the cause is more closely related to the ill-conceived or incomplete strategies followed by development planners and supporters.

In East Africa, for example, expatriate scientists worked nearly 15 years to develop better varieties of maize. But when the last technicians left in the mid-1970s, research ground to a halt. Although technical assistance had been provided, institutional capacity to continue had not been built. Unfortunately, this is an all too common fate.

Most IRD strategies cast production, whether of roads or crops, as the star in the development drama. Concern for sustaining that production by maintaining physical or institutional infrastructure is left for supporting actors. The result is an implementation style that pays lip service to sustaining functions and benefits while yielding the resources and the spotlight to immediate production. Thus, this chapter is concerned with factors that are too often viewed as complementary or supporting rather than as central.

At the same time, the dreary record of unsustained advances was well known before the IRD projects reviewed in this book were designed. In fact, all of them contained components, or made assumptions, that were directed toward sustaining the initiatives of the project. To appreciate the lessons of that experience, one must understand the logic of outside intervention and induced change, identify the major constraints to sustained benefit flows, and determine what strategies the IRD projects used to ensure long-term results.

Logic of Intervention

Induced rural development assumes that outside resources can be used to

provide a push to local action and the marshaling of local resources. It assumes that if a new technology is introduced people will use it, take charge of their own destiny, and begin a self-sustaining development process.

The linear flow from resources to improved well-being and capability is only the initial phase. A more accurate rendition would show the project as providing just a nudge to a cycle in which an increase in the resources available locally would make new goods and services available, induce response, and then generate a greater resource base. An analogy might be the ignition of a diesel engine – a project acts as a starter motor. This perspective is displayed in Figure 3. The key element, however, is the transition from starter motor to main engine.

Projects, by definition, are time bound. One way or another, they end. Therefore, planning for projects tends to be equally time bound in focus. The end of a project is logically seen as a termination, but it is actually just a beginning. What begins, if anything, at project end is ultimately more important than the project itself; what continues represents the real contribution of the project.

In this context, every planning and implementation decision should be made in the light of the sustainability issue. An emphasis on immediate production goals leads to project designs, organizational choices, and management practices that block any chances for turnover. The transition from starter motor to main engine never takes place.

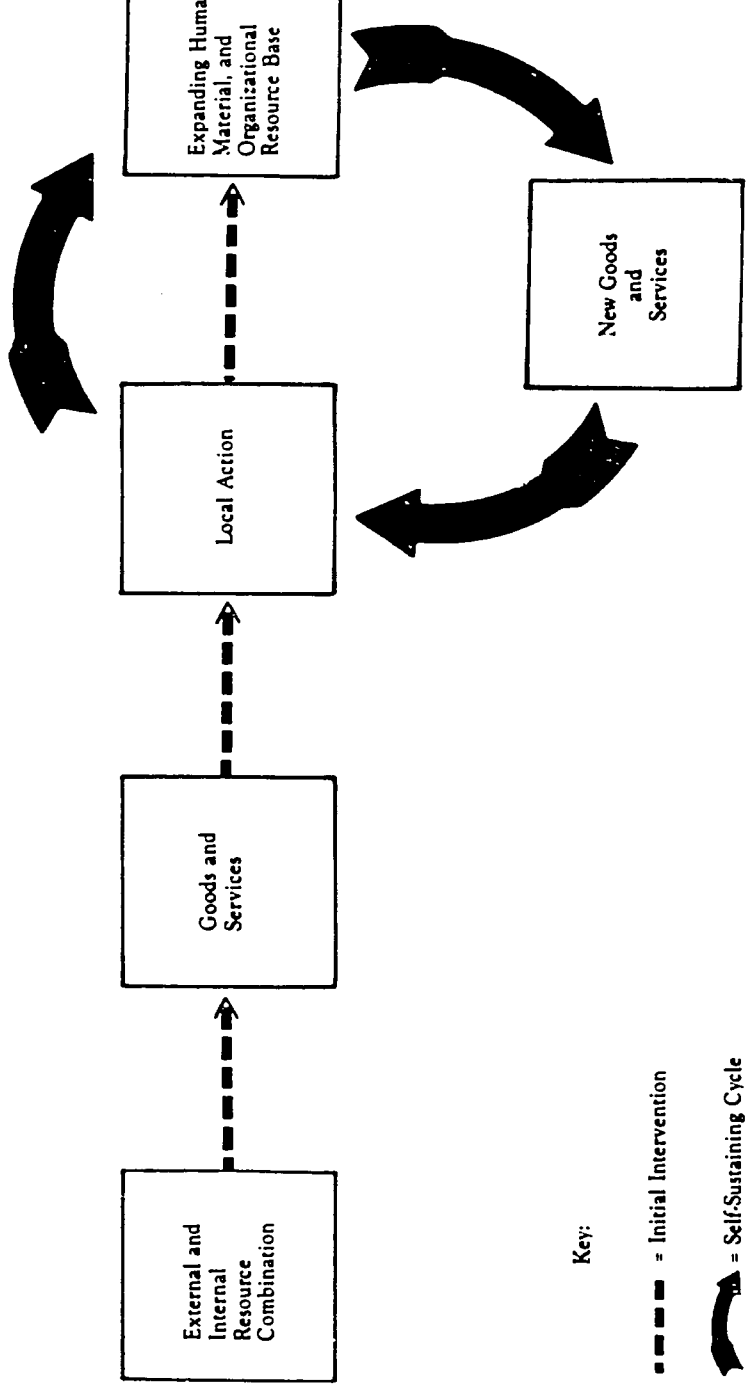
One example of this situation occurred in the Second Integrated Rural Development Project (IRDP II) in Jamaica. This project was conceived and begun as a major soil conservation effort. Later, it added a focus on local farmer organizations. Then it recognized the need for an integrated extension-marketing strategy if production and income targets were to be attained. The result was a disorganized mix of objectives in search of a common approach. Adding to the difficulty was the lack of effort made to develop indicators of farm welfare in the project area, or to measure impact beyond the achievement of physical component targets.

A primary measure of project performance was the completion of farm plans for those farmers participating in this watershed-oriented effort. Management emphasized the development of new plans at the expense of follow-up with those farmers already enrolled in the program. The threat to sustainability is obvious – the transition from project activity to a more permanent set of actors requires that they have the resources, knowledge, and desire to continue local action. But in this project, it was not known what levels of staffing (if any) could be maintained by the Jamaican government or whether any special project services, such as extension outreach in marketing, credit, and home economics, would be continued. Since project watershed boundaries were not contiguous with those of Jamaican political jurisdictions, and there was no resource base for a special district, administrative continuity of any kind was unlikely.

Project staff were aware of the difficulties, but the focus on immediate production targets caused them to ignore what would happen after the project

FIGURE 1

INTERVENTION TO PROMOTE SELF-RELIANCE



terminated. The emphasis was on immediate action at the expense of the transition to a sustained local effort.

The need for this transition places great importance on the resource control, perceptions, and general situation of local people. In Mbeya Region of Tanzania in the 1960s, for example, the word "serikali" was used to describe the local cooperatives.[1] Since this is the Swahili word for government, it suggested that these organizations were seen as arms of the central government rather than as controlled by the villagers. Not realizing this fact could easily lead development planners astray in their search for an organizational host for a development effort in the area. Thus, knowledge of rural people's interpretations of their circumstances is a key element in ensuring the sustainability of interventions supported by outsiders.

Similarly, the unwillingness of some Indonesian villagers to band together and rebuild a bridge destroyed by a flood was criticized by an outsider. However, the lack of action was not the result of fatalism. Instead, it derived from power relationships within the community. As long as the bridge remained unmended, those who had boats would profit by ferrying people across the river. Since the village headman benefited by having relatives provide the service, there was a vested interest in delaying the reconstruction of the bridge. Strategies for achieving sustainability, then, must be well grounded in the context of local decision making, and they must be based on an awareness of local constraints.

Constraints to Sustainability

Choice of an inappropriate technology is often touted as a major cause of failure in development programs. But the IRD record suggests that the technology itself is only part of the problem. The difficulty also lies with the support system required by the technology, or with the administrative focus on immediate production to the exclusion of longer-term institutional, environmental, and cultural concerns.

These issues may be separated into four major categories: financial constraints, organizational constraints, policy constraints, and side effects. Each category is discussed below.

Financial Constraints

Projects often fail to induce sustainable processes as a result of financial factors. High-cost subsidized goods and services are used without generating the ability to cover the cost of maintaining and replacing them. Thus, the possibility that these goods and services will continue to be provided after outside funding ends is reduced or eliminated.

Project planners sometimes design projects as though the availability of donor funds and host country resources were unlimited. And this tendency is reinforced by pressure on donors to use foreign assistance and capital-intensive solutions.

Many developing countries also express a preference for more sophisticated capital equipment than is needed. In fact, they often view the infrastructure dimensions of a project as the most important.

Technicians trained in developed countries also prefer to use familiar methods and state-of-the-art equipment. One evaluation of the United States Agency for International Development (AID), for example, observed that a rural roads project in the Philippines had a strong bias toward sophisticated methods that emphasized capital-intensive construction and excluded community participation as a result of the availability of excess U.S. equipment at artificially low prices.[2] Similarly, excessive costs result from trying to do too much too soon.

Although the recurrent cost needs of an individual project may not seem excessive, the aggregate demand for recurrent funds implicit in a large number of donor projects may become a severe burden. For example, the fiscal year 1983 AID Country Development Strategy Statement for Upper Volta noted that the total recurrent cost burden imposed on the Government of Burkina Faso budget by AID-sponsored projects will be almost one quarter of the projected national budget by 1987. Burkina Faso will be unable to finance these costs from anticipated revenues. A similar situation has already arisen in Tanzania, where the government is in default on development loans, many of which were provided through donor-supported project investments.

This problem is exacerbated when the true costs of a project are hidden. For example, one feature of the Indonesia Provincial Area Development Program (PDP) in the province of Nusa Tenggara Timur was the construction of food-storage buildings to serve several nearby villages. Previously, farmers were forced by market conditions to sell their produce at depressed harvest-time prices and later to repurchase it for personal needs at dry-season prices, which could be double or triple what they received earlier. The PDP warehouses, in contrast, planned to buy the produce at a fair price and resell with a modest markup to cover costs of the warehouse staff and routine maintenance. Thus, the farmer incurred a reasonable cost for the service of storage.

But, in reality, it was a PDP-subsidized cost because the markup did not include any allowance for amortizing the cost of warehouse construction. These subsidies helped ensure that the warehouses could offer a better deal than outside traders, but the subsidies did not help to build a sustainable system. It appears that, in the future absence of outside funding, existing warehouses will fall into disrepair and no new ones will be built as a result of the lack of an institutionalized source of capital. If, in contrast, depreciation costs had been included in the markup, then a sustainable system might have been created because farmers would have paid real costs and would have been able to judge the merits of the system. Of course, if the resulting markups led to a system that was non-competitive with the traders, then the whole concept would be best abandoned anyway. Few things work more against the possibility of sustained response than hidden subsidies.

In this example, realistic treatment of costs in pricing services would have had the effect of transferring some benefits from the individual beneficiaries of the project back into the system so that it might be sustained or even expanded. There are many ways a portion of revenue may be recycled to maintain the benefit flow—fees for services; realistic interest rates on loans; or some agreed-on return of a percentage of project-related production or income gains, when these are readily quantifiable.

Often, however, the impact of development expenditures on recurrent costs are underestimated. More political capital accrues to a local government for providing new facilities than for maintaining existing ones. This emphasis on capital stock makes it that much more difficult to consider adequately the financial constraints to sustainability.

Moreover, just as donors have often succumbed to an edifice complex, so too recipients commonly equate the proliferation of modern infrastructure with development. Sustainability yields to visibility unless organizational pressure can prevent this from happening. Thus, what economists have labeled the recurrent cost problem is simply a symptom of a deeper failing—a lack of supportive institutional response to project initiatives.

Organizational Constraints

Few project ideas are so compelling that they will perpetuate benefits without organizations equipped to carry them forward. Usually, the organizations must be created or strengthened during the implementation process. When external resources end, local actors must be able to continue activities, often with fewer resources than before. Institutional capacity, therefore, is a key element in project sustainability.

In many projects, however, relatively little emphasis is given to the problems of institutionalization, institution building, and training. Indeed, projects are often designed to avoid the need to build capacity. The creation of special project management units (PMUs), divorced from the regular host government bureaucracies, for example, is a favored implementation approach of large donor agencies. This bypass approach is often justified on the grounds that existing institutions are too weak to implement planned activities and achieve their objectives within the required life of the project.

Autonomy avoids many bureaucratic constraints that can hinder a project, and it can ensure a greater accountability to the donor over the resources and funds spent. Moreover, PMUs, because they are independent of the country's civil service system, can pay higher salaries and attract more capable staff than would otherwise be possible. Often, however, these individuals come from ministerial positions where they are also needed. Thus, a temporary device initially created to bypass institutional weaknesses actually exacerbates them. Furthermore, because of the isolation of IRD projects, PMUs have little effect on the performance of permanent institutions.

Incentives must also exist for local hosts to do what is necessary to deliver benefits. Project activities may result in bureaucratic opposition that undermines the continuation of the project and the sustainability of its benefits. This was the case, for example, with an AID-funded agricultural research project in Thailand. There, the Ministry of Agriculture and Cooperatives (MOAC) initially supported the creation of a regional agricultural research center, even though it was to be housed in another agency. However, MOAC officials soon viewed the research center as a competitor for resources (budgets, personnel, and external aid), and their initial enthusiasm for the project died. As long as AID controlled budgetary funds for training, research equipment, and commodities, open political maneuvering against the project was restrained. When AID's role in the project ended, however, the opponents of the research center moved openly against its budget and mandate, and it was subsequently stripped of most of its resources and authority. Thus, institutional incentives militated against sustained benefit delivery. They promoted the dismantling of project resources and the rejection of project innovations.

Similarly, the sustainability of Liberia's Lofa County Integrated Agricultural Development Project was adversely affected by incentives not to build capacity. The PMU was supposed to build up cooperatives and then dissolve, leaving them in control. But the cooperatives have not become self-sustaining. In fact, from the project's inception the PMU concentrated on developing its own ability to provide services to farmers, rather than on strengthening the cooperatives' ability to assume responsibility for those services.

Political constraints to the creation of sustainable cooperatives were numerous. First, the cooperatives were controlled by the wealthy and powerful, whom the farmers did not fully trust. Second, the middlemen were resistant to the cooperatives. These individuals had leverage because they were moneylenders as well and could stop providing banking services to the people, a function the cooperatives were not able to carry out. Third, the Liberian Produce Marketing Corporation was a relatively strong elite-run agency, which would have been displaced by a build-up of cooperatives. Thus, opposition was mounted from various directions.

Inadequate capacity, then, is often a reflection of inadequate incentives. Scarce resources combined with institutional competition may create an environment that will thwart most attempts at capacity building.

Policy Constraints

All development projects exist within national political and economic settings that affect their performance and potential. Indeed, the chances for success are low for even a carefully designed and well-implemented project when it exists in an unfavorable political and economic environment.[3]

Development problems frequently result from the interaction of several policies. A typical example from Africa involves price controls and high export duties on domestic agricultural products. Both policies favor urban populations over rural groupings and are frequently imposed to attain this distributional effect. In other instances, a combination of policies will be used to bring about stabilization. One Asian government, for example, severely devalued its currency at the urging of the International Monetary Fund. However, it failed to adjust its rice procurement price to offset the increased price of agricultural imports such as fertilizer. Normally, farmers could have sold their produce on the unregulated market. However, the limited capacity of grain storage facilities in the private sector prohibited the level of market demand at harvest time that was needed to create an adequate return to the farmer.

Other examples of macro policy at odds with area project objectives and influencing local response may be cited. In Bolivia, a national policy of subsidized interest rates and lax repayment requirements have principally benefited large farmers and limited the supply of capital for small farmer credit programs. Currency exchange regulations in Zaire encouraged imports of food into a food-deficit area while a project attempted to increase local food production. In Ethiopia and Indonesia, import restrictions and free-market controls aggravated the storage of critical project inputs such as fertilizer and spare parts. This in turn limited project effectiveness at the district, community, and village levels.

Developing countries have historically suffered from serious economic problems such as shortages of domestic savings and hard currency, as well as internal demand and supply imbalances. These difficulties have led, in turn, to slow growth, unemployment, and high rates of inflation.[4] In many cases, governments chose, or were forced, to address these problems in ways that inadvertently hampered the implementation or impact of projects. This was the case, for example, with the failure of a project to construct a rice mill in Papua New Guinea. When the government lowered the official price for rice, the farmers in the region no longer found it profitable to market their output. Consequently, they switched from rice to other crops. The newly constructed government rice mill had been built based on assumptions that were no longer reasonable. As a result, the mill eventually went bankrupt.

Macroeconomic policies can impinge on both implementation and sustainability. Domestic price ceilings, designed to promote exports and maintain low food prices in urban areas, often lower or eliminate the incentives for farmers to increase production or adopt agricultural innovations. Import tariffs or quotas to foster domestic production of agricultural inputs may increase production costs and lower incentives to increase production. Foreign exchange controls may restrict the importation of critical inputs, such as fuel, needed to continue project activities. For example, a project in a West African country was prohibited from importing light-weight plows in favor of heavier, domestically produced ones. However, the heavier plows were poorly adapted to the soils in the project area and had to be pulled by oxen, rather than less expensive donkeys. As a result, there was little demand for the project-supplied plows.[5]

Restrictive monetary policies can limit the access of beneficiaries to credit, and tight budget restrictions may lead to shortages in personnel and administrative support. Unless projects are designed with these macroeconomic limitations in mind, or the policies themselves are changed by the host governments, the success of development projects and the sustainability of the benefits they generate will continue to be undermined.

Economic policies may support development projects, but in ways that cannot be sustained. For example, the reliance on a technological package requiring the heavy use of chemical fertilizer may not be sustainable in a country in which fertilizer is imported using scarce foreign exchange, or where the rural infrastructure is inadequate to ensure its timely distribution.

A parallel market for project outputs can also obstruct project objectives and threaten sustainability. In the Niger Cereals Production Project, for example, a seed multiplication effort was failing because of the low official price and high parallel market price for grain. Rather than delivering the new seed to the project, the farmers who contracted to mass produce it sold the seed for twice the official price to buyers smuggling it into Nigeria, where it was consumed rather than planted.[6]

A political policy of particular significance to rural development is agrarian reform. Its proponents argue that it is essential to increased agricultural development. Equity arguments aside, it is thought that title security and intensive production, both of which are seen as resulting from a meaningful agrarian reform, will lead to significant production and income increases. Two problems with agrarian reform policies warrant further attention. First, there is the danger that these policies, implemented in a country with rapid growth, will result in such a high degree of land fragmentation that small holdings become uneconomic.

Second, there are transition costs in any agrarian reform. Production declines as the new landholders take charge. These declines can be large when the transition period is stretched out, when it occurs through violence, or when the reform is poorly conceived or implemented. Moreover, unforeseen side effects can negate the reform. Even so, agrarian reform is often an essential element for sustained equitable development—when the tillers of the land cannot keep its bounty, they have no reason to conserve, improve, or even continue to till it.

The political distance between central planners and local people frequently manifests itself in project designs that are imbued with a lack of knowledge about local conditions and a lack of accountability to local people. Since resources also tend to be centrally controlled, the result is often a portfolio of national policies and implementation strategies that serve other than rural interests and that culminate in efforts with detrimental side effects.

Side Effects as Constraints

Despite careful planning and expert management, IRD projects may produce many effects that are neither planned nor foreseen. Unanticipated effects are usually perceived as negative, although positive side effects may also occur. One observer's review of project experience in the 1960s identified "the centrality of side effects."[7] Although they may not always assume this much importance, side effects certainly can pose strong threats to sustainability.

Many unanticipated project effects result from social, economic, and technological changes that accompany the investment of project funds, delivery of goods and services, and stimulation of responses in a community. The resulting transformation can severely disrupt the traditional order. The established distribution of power and wealth, and existing social stratification, have a stability that interventions upset, either intentionally or accidentally. In the aftermath, alternative social organizations that are timely and adequate are seldom provided. The resulting social disruption is a likely source of negative side effects.

A case in point is the agrarian reform issue noted above. Land, in many societies, is not just a commodity. Instead, it is a focal point for a complex set of human interactions. When outsiders misinterpret the nature of these interactions and fail to understand who gets what from them, then those outsiders are apt to prescribe courses of action that lead down unintended pathways.

For example, poor farmers in the Philippines have sometimes been made worse off by land tenure reforms that were presumably intended to improve their lot. Under the traditional system, a sharecropper received assistance from the landowner when the former's house was destroyed by a typhoon. Since the new system of freehold title dissolved the patron-client relationship, the rural poor lost this assistance. In many areas, a house was wrecked about every five years, and thus this was no small service lost.

The foundation for a policy of breaking up estates and converting tenants to owners made sense at the time—tenants could not be expected to risk scarce capital for inputs or increase their labor using new methods if most proceeds went to the landlord. The problem, however, is that outside observers often mistake anchor chains for prison chains. That is, what appears to an outsider as a constraint to accumulating material wealth or implementing a specific policy may appear to insiders as a price that they will willingly pay for a different social privilege, material good, or religious comfort.

From the indigenous calculus, the tradeoffs may be worthwhile. Thus, a shallow understanding of the social system surrounding a resource often leads to false judgments about the implications of new uses for it. Side effects may block sustainability, either temporarily or permanently.

Side effects may be physical as well as social. In a potable water project, for example, health benefits can accrue from an increased volume of water or they can result from its improved quality. But if net benefits are not as great as expected, the reason may stem from burdens resulting from contamination. The availability of the water may even produce environmental degradation, resulting in a situation worse than that before the project began. The reduction of soil fertility as a result of the intrusion of a dam, or an increase in schisto-

somiasis due to the introduction of irrigated production practices, is among the many consequences of IRD programs in such places as Liberia.[8]

Figure 4 illustrates the complexity of the benefits and burdens that can be expected as a result of a potable water project. The foundation for this benefit tree is IRD experience in Tanzania.

Strategies For Achieving Sustainability

The preceding constraints to sustainability were not always addressed directly by the projects reviewed in this book. Even so, all the projects had either definite strategies or specific assumptions related to the prospects for long-term success. These strategies and assumptions may be grouped into three categories—institutional, organizational, and technological.

Often projects simultaneously embodied two or more of these approaches. In fact, different components were usually designed to pursue each strategy, some at a program level and some at the project level. Selected field experiences exemplify the way success and failure with any particular approach varied with local circumstances and the project's ability to deal with a complex web of constraints.

Institutional Strategies

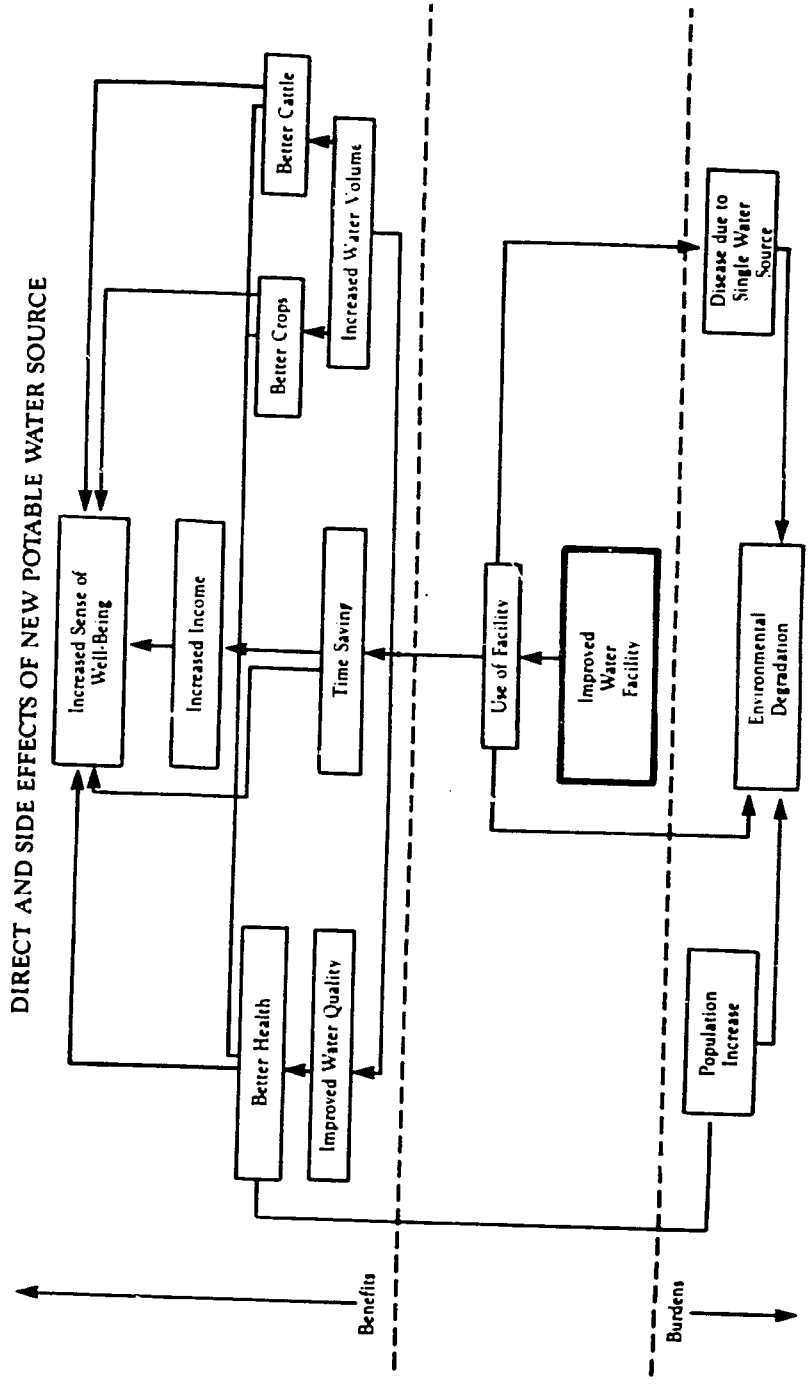
An institutional strategy emphasizes the need for large-scale pre-existing institutions to assume project responsibilities. Some projects fail because they cannot institutionalize new functions and the capacity to carry them out within government bodies. For example, the need for rural representation in national policy making and for a permanent mechanism to coordinate rural development were to be addressed by a rural development authority in Liberia, but the fate of that effort was sealed in interministerial combat (see Chapter 3 for details).

A more successful experience is represented by the Bicol River Basin Development Program Office in the Philippines. Here a regional planning, monitoring, and coordinating unit was established before projects were developed. Its function was not to execute development projects, but to offer design and support services to the line ministries implementing IRD projects in the region. A strong staff from the area was assembled and trained, and long-run resources were obtained through the acquisition of a line item in the national budget. Most important, however, the unit acquired a place in the local institutional landscape by augmenting, rather than competing with, the agendas, priorities, and programs of the line agencies. Rather than displacing the ministries, it strengthened the regional offices in their competition with other areas for the ministerial budget. The difference between the Liberian and Philippine examples is a key determinant for explaining the different levels of success.

Strengthening of governmental machinery also characterized projects dealing with subnational units, such as PDP in Indonesia and the Arusha Planning and

FIGURE 4

DIRECT AND SIDE EFFECTS OF NEW POTABLE WATER SOURCE



Village Development Project in Tanzania. Training, critical examination of bureaucratic procedures, and experimentation with subprojects were key elements in these programs. In addition, they were program-level interventions and not just single projects. The need to build capacity within a permanent institution in the public sector was seen as necessary to achieve sustained development in the country. This goal required a program strategy instead of a pure project orientation.

When a pure project approach was taken, institutional strengthening seldom resulted. For example, IRDP II in Jamaica encountered difficulty in finding revenue sources to cover recurrent costs as well as to continue supporting project initiatives after the end of external funding. An inability to address the larger environment certainly limited any prospects for sustainability—the use of a PMU precluded successful institutional strengthening.

Also integral to an institutional strategy was a focus on policy reform. Examining institutional incentives and the context of decentralization often highlighted policy inconsistencies or obstacles to new objectives. Topics such as pricing policies, interregional equity, marketing arrangements, and legal restrictions on revenue generation all emerged as concerns of IRD implementers.[9] Even though these issues arose, and projects sometimes had organizational linkages to high levels, in the short run only regional deviations were accomplished. Experience in Indonesia, the Philippines, and Zaire supports this conclusion. Sometimes small changes did take place at the national level. In Tanzania, for example, innovations in incentive allowances became national policy.[10] But this was rare and marginal.

The general weakness of vertical linkages was a contributory factor in this failing of IRD, especially when the projects used PMUs. Seldom did micro change induce macro change, but this situation resulted more from the rigidity of those macro systems themselves than from poor project performance. Control-oriented civil service regulations, chaotic decision making, and oppressive political use of bureaucratic machinery were not easily remedied by expanding a practice introduced into a single field location. In fact, they were seldom influenced at all.

Recent emphasis on the private sector has been advanced as one way around this blockage. The assumption that ownership is the primary determinant of behavior, however, is not always supported by experience. Thus, the private sector focus should not be accepted unquestioningly. For some functions, in some places, it makes sense. The danger is that emphasis on the private sector will become another nonworking panacea rather than an option with selective potential. In Zaire, for example, it is sometimes hard to identify just what falls into which sector.[11] The public purse is often found in private pockets.

Based on work with IRD and policy analysis in Egypt and the Philippines, one observer has suggested a way around system rigidities. If institutional capacity is separated into the ability to do something (internal capacity) versus the ability to get something done by someone else (process capacity), the strengthening of the ability of public institutions to obtain services from private organizations can receive more emphasis.[12] This process-capacity approach is appealing in many circumstances, and it implies a dual effort, bringing public and private actors together to improve overall performance by refocusing bureaucratic attention.

In general, bureaucratic reorientation was not a central tenet in the IRD scripture. When the environment in a developing country was seen as hostile to a target group of intended beneficiaries called the rural poor, there was a tendency not to pursue a strategy of improving the effectiveness of formal public sector units. Instead, the building of villager organizations was seen as a way out of the governmental trap.

Organizational Strategies

An organizational strategy creates new small-scale organizations to carry on project activities. Establishing villager organizations and then devolving responsibility for selected project functions to them is a common IRD strategy for avoiding the problems of recurrent cost and institutional inadequacy within the public sector. At the same time, organizational strategies share a central element with institutional approaches—the preparation of those who will inherit project functions, assets, and liabilities to execute the functions, care for the assets, and discharge the liabilities. Capacity building within project-initiated inheritor groups, then, is the keystone of organizational strategies. Theoretically, the image of self-reliance and local equity that accompanies this approach is appealing. But the record suggests that the way it is implemented often thwarts the goal.

The timing of a transition from project operation of a facility to local control, for example, may affect the ability of a farmer association to assume responsibility and perform effectively. A study in the Bicol region of the Philippines showed this is the case in an irrigation facility that was to be turned over to a farmer organization.[13] At certain times of the year, the organization would experience a severe cash-flow problem and could not operate without assistance. At other times, however, the organization would have a surplus and no difficulty assuming the financial burdens of the system's operations.

Thus, timing was one element of the way IRD implementation influenced the effectiveness of this strategy. Another element was the degree of resource concentration or dispersion. Seldom was a concerted effort put into one beneficiary organization. Instead, technical assistance and resources were spread out among numerous small and geographically removed groups. The result was that none achieved the critical mass of resources and skills needed to perform well. The development effort was diluted rather than concentrated. This was the case in such countries as Indonesia, Jamaica, and Liberia. When things did go well, such as in the National Irrigation Administration in the Philippines[14] and in the Save the Children Community Based Integrated Rural Development Project in Indonesia,[15] the emphasis on one focal organization was present.

The inability to concentrate effort resulted from both design and manage-

ment factors. Political pressure to include many locations in a project often produced designs that scattered the focus. Since project designs were often the result of compromises among the various actors, multiple agendas frequently led to a diluted strategy. At the same time, those pressures did not cease with the beginning of implementation – they just moved to a new arena. When this situation was combined with the sheer inability of field-level project managers to set priorities and order the sequence of activities, the effect was a further erosion of the capacity-building effort.

During implementation, administrative interpretations of policy objectives can also make a difference, especially if multiple objectives are pursued. A case in point was identified in Indonesia.

An explicit objective of an Indonesian government's five-year plan was equity. Expenditure per province was allocated on a per capita basis with an instruction to reach the poorest segments of the population. The implementation of this objective, however, made the prospects for sustainability questionable.

To achieve equitable distribution of funds over the entire island of Madura during the plan period, local administrators divided the villages not yet receiving direct assistance into three groups, with each village to receive help during only one of the three remaining years of the plan. A PDP-funded gardening subproject fell victim to this approach.

The gardening project was established with a revolving fund to pay for the costs of two new extension agents. A percentage of the revenues generated by vegetable sales would pay for inputs, while another portion would replace the funds used to pay the agents' salaries. The rest would remain with the growers.

To keep the revolving fund solvent, slightly more than 50 percent of the growers would have to achieve a specific production level. The actual success rate, however, was less than 35 percent. This rate was not bad when a learning curve is taken into account. But the rule requiring extension agents to move on to new villages each year potentially guaranteed that the target would not be reached, the learning curve would not be climbed, the fund would not revolve, and the extension services would not pay for themselves.

In this case, an administrative interpretation of an equity objective produced the dispersion of resources that made sustainability less probable. Compounding this problem of scattered effort was a phenomenon that might be called the new development machismo. That is, the proof that a project was reaching the rural poor was related to the difficulty of access to the project site – the more kilometers of bumpy trail, the more fords of flooding rivers, the more hours in small boats, the more hills climbed, or the more days walking to the project location the better the project and the more status accorded to those providing technical assistance.

This attitude may be good if it protects beneficiaries from predatory groups that might otherwise siphon off benefits. But as part of a larger effort, it may make management of the project almost impossible. When scarce management or technical assistance talent spends most of its time either traveling among remote sites or recuperating from the effects of the travel, little capacity gets built.

Although technical assistance and training were common features of projects using the organizational strategy to achieve sustainability, IRD field experience suggests that they are not always appropriate or sufficient. A combination of seven elements, however, does appear to signal a high chance of success. Five of these are process factors; the other two are substantive, or structural, in nature.[16]

The first process characteristic is a collaborative style. This characteristic is well documented and needs no further elaboration here. The relationship between providers and receivers of technical assistance affects degrees of trust, client commitment to recommendations, and mutual learning.

The second process element is an emphasis on learning how to make things work and to solve and define problems rather than relying on a predetermined technology or solution. Successful programs are able to generate an excitement about engaging in a learning process.

Collaboration and learning are closely linked because of two dimensions necessary to the learning process – engagement and reflection. Engagement involves learning by doing, enlightenment through action. Analysis, abstraction, and prescription are not enough. Unless those who build capacity are willing to become players in the drama, they are not likely to succeed. Their immersion demonstrates a collaborative spirit and reinforces how little they, as outsiders, actually know about the harsh realities. The learning process is mutual, and it is in the fires of organizational battles that truly collaborative ties are forged.

Reflection is equally necessary. Activity will implicitly define capacity, and unless objectives are made explicit and scrutinized, larger issues will be lost. Moreover, engagement without reflection may produce euphoria over apparent but actually superficial progress, while more important structural obstacles are missed and possibly even reinforced.

The three other process elements are closely linked to the first two: risk sharing, the involvement of multiple levels, and an emphasis on demonstration. Risk sharing is needed because there is a greater chance that innovations will become self-sustaining and that client commitment will be high when the client and service provider share the risk of failure. The involvement of multiple levels of actors is one outcome of projects funded by several donors. But it is intrinsically important. Attempts to bypass local leaders or senior staff and deal only with small-scale farmers or junior staff are bound to be nonsustainable. If the capabilities of extension staff are to be improved, for example, supervisory personnel and project leadership should be involved. If they do not support intended behavior, there is little chance that initial changes will continue. Thus, capacity-building activities that focus only on one organizational or societal level may be expected to falter. Unless higher levels are incorporated into the capacity-building process, the existing power structure can block changes that threaten

that structure.

The final process element is demonstration. Unless new behaviors are demonstrably more effective than old ones, skeptical farmers or civil servants will not adopt them. The success of the green revolution has been largely the result of the ability to show the superiority of new technologies. This also implies that, when training is a major component of a capacity-enhancing program, it too should be of demonstrable value. Thus, the training should involve actual groups working on real problems and not be based on artificial exercises with participants drawn from all corners of the globe.

Although these five pr[illegible]derations are important, structural barriers can negate even the best executed processes. The first structural consideration, incentives, has already been discussed. The second is the resource base.

The local resource base includes indigenous technical knowledge, community folk-management skills, and informal networks used to make things happen. But it has a physical and financial aspect as well as a human and organizational one. In instances in which physical and financial resources already exist, so much the better. In the more frequent case in which a new resource base is provided (whether through increased income from agricultural production or local taxing power, for example), the source and reliability of the new base must be examined carefully. For example, if taxing power is to be given to a village-level entity, the certainty of the citizenry's future income and the predatory inclinations of higher government levels must be evaluated in measuring the adequacy of future revenue for village projects.

In addition, the nature of the resources themselves should be considered. Project-related capitalization for a cooperative or a line item in a provincial budget, for example, is not a reliable source of funding for an organization without previous power. However, a monopoly over physical resources such as irrigation water, wells, a forestry preserve, or a village woodlot provides a much sounder financial basis for future activities.

In fact, it can be hypothesized that an essential element of successful capacity building in nondominant groups is the acquisition of control over a central set of natural resources. Thus, capacity-building efforts based only on providing social services or improving management practices are unlikely to be sustainable. Success commonly requires a link to income-producing activity and sufficient control over the disposition of that income.

For the organizational strategy to work, the local organization must obtain an appropriate resource base, technical assistance should use a mobilizer approach, and management capacity should be built by concentrating the effort on a few focal organizations rather than spreading it thinly among many. An explicit objective should be to strengthen a selected organization and prepare it to offer services to other rural groups. This has worked even when outside technical assistance was not involved.[17]

This need for concentrated effort parallels the need for concentrated authority necessary to deliver goods and services. But an organizational strategy for achieving sustainability does not profit from the use of performer technical assistance. Instead, teachers or mobilizers are more appropriate. This results partly from the uncertainty of the technologies available for capacity building.

Technological Strategies

Three approaches to technology may be derived from the IRD record. Each contributed to sustainability, or lack thereof, in a different way.

One approach has a wide following in the appropriate technology movement. In the IRD legacy, this has meant reducing dependence on external energy sources to lessen future foreign exchange requirements and the recurrent cost problem. For example, the use of animal traction for crop production in Botswana, Indonesia, the Philippines, Malawi, and Tanzania; of organic fertilizer to increase maize yields in Zaire, and of gravity- over pump-fed irrigation systems in Asia all represent this approach.

Relying as much as possible on local materials and resources is a sensible path to follow. When this approach was used in IRD, it did avoid, or lessen, some problems of achieving sustainability. In the Philippines, concrete roads were built to reduce maintenance and recurrent cost needs to a minimum.

But this was not the most common project assumption about the optimal technology for rural development. More widespread was the tendency to borrow pieces of green revolution technologies that required new varietal seeds, chemical fertilizers, and foreign exchange. The focus on sustaining these technologies was limited to three areas—continued subsidies for inputs, adaptive research, and strengthened links between research and extension. This amounted to refining and fine tuning a technological blueprint for increasing crop production.

Unfortunately, the blueprints were often faulty. Extension was commonly begun before there was a technology worthy of extension. This situation was especially true in dryland areas and in projects emphasizing rainfed crops. In Botswana, for example, the differences in rainfall within just a few kilometers could require different plowing and planting practices. In Tanzania, those technical packages that were successful succeeded only in the high rainfall areas. Similar limitations affected IRD projects in Liberia and Indonesia. But IRDP II in Jamaica showed the most persistent example of pushing poor technology.

Those projects involving irrigated rice production, such as the efforts in the Bicol, had more certain technologies. Nonetheless, there were usually weaknesses in the production technologies used in IRD. Both technical and managerial weaknesses were exaggerated when projects were based on the driving force of a preexisting package of inputs; rigid designs were left helpless when the package did not work.

Occasionally, however, project strategies showed less faith in the power of these technologies. These strategies embodied a process approach as opposed to the blueprint approach.[18] This process approach is essentially a merging of

institutional, organizational, and technological approaches into a perspective that measures success as the capacity to carry on and not as just immediate production gains.

Thus, when the uncertainty of social technologies and of rural environments is combined with a capacity-building view of rural development, a flexible, adaptive, learning-oriented approach is needed. This is called a process model.

The elements of a process model vary among individual programs—some are more process oriented than others. For instance, the Local Resource Management (LRM) Project in the Philippines, the Rural Sector Grant (RSG) in Botswana, the Arusha project in Tanzania, and PDP in Indonesia all contained process elements, even though their configurations varied. Nevertheless, general characteristics of a process orientation may be identified as:

- An emphasis on an extended, collaborative design process that builds a coalition of local actors committed to the project;
- A program-level effort using subproject learning laboratories;
- A design broken into discrete phases;
- An ability to provide flexible mixes of short-term technical assistance;
- An emphasis on the mobilizer model for long-term technical assistance;
- Frequent use of management workshops and action-oriented training among both staff and beneficiaries;
- A concern for participatory decision making and the use of temporary task forces or working groups instead of complete reliance on rigid management hierarchies;
- A reward system consistent with a learning orientation and an evaluation focus that goes beyond resource disbursements and production targets to emphasize the accumulation of local capacity;
- An applied research component with a learning repository located in a local institution;
- A redesign orientation, such as periodic revisions of project organization, project objectives, and job descriptions of project personnel; and
- A management and planning focus on the type and source of resources needed to continue benefit flows after the end of project funding, and the institutionalization of the capacity to provide them.

The process approach has been demonstrably more effective than the more rigid blueprint approach.[19] But is should not be used to justify management by abandonment.[20]

Indeed, the fear of inadequate accountability pervades discussion of the potential for using more process-oriented project models. Many pay lip service to the need to move away from blueprinting, but few will take the risks involved.

For the practice, as distinct from the theory, of rural development to move forward, design officers and donor agencies must be presented with a menu of workable options that allow flexibility within a framework of accountability.

Some options have been noted in earlier chapters. For example, RSG in Botswana used a rolling redesign process to produce annual budgetary blueprints within an evolutionary project design. Accountability was not lost. Instead, it was pushed forward into implementation so that resources could be rechanneled as learning occurred. This approach was different from the block grant image that leaps into many minds when the process model is mentioned.

Other projects also illustrate approaches that preserve various types and sequences of accountability. For example, the LRM project in the Philippines, the Training for Rural Development (TRD) Project in Tanzania, and the Agricultural Management (AGMAN) Project in Kenya all represent different types of process projects. LRM has an initial phase that is so flexible that it is nearly unguided in its attempt to build coalitions and identify local initiatives worthy of support in phase 2. TRD is training oriented with the range of target and resource institutions evolving with experience. AGMAN is two phased and designed with a flexible assistance fund used to act as a matchmaker for intermediary organizations in the agricultural sector and resource institutions that can help those organizations improve their performance. Illustrative activity budgets, redesign at the end of an initial phase, and periodic checks of direction changes are among the process characteristics that keep implementers accountable without tying them in red tape secured by rigid design targets.

Table 6 suggests a menu of project profiles to combine flexibility with accountability. The taxonomy is based on the perceived speed of project evolution and spending. The quickest is the elevator—the image that the term "process approach" often evokes. This mode raises the fear of disbursement without control or of block grants that do not perform.

The escalator moves quickly, but it is more sensitive to accountability needs since it is based on rolling blueprints. RSG in Botswana typifies this model.

The third approach, the quick step, is a bit slower than the escalator. With two phases, it begins with a heavy reliance on outside assistance and moves toward reliance on local centers of excellence. Kenya's AGMAN project fits into this category.

The slow step approach begins with a lengthy coalition-building orientation during the first phase, which is essentially the design of phase 2. LRM in the Philippines is an example of this approach.

A key aspect of the process concept is the artificiality of the distinction between design and implementation. Rolling redesigns and subproject planning exercises are among the mechanisms used to cross this boundary. They also involve the same people in the entire process.

This is important because in blueprint-type projects there is no continuity between the people who plan and the people who execute projects. Designers do not have to live in the houses they build, and thus the focus of accountability is on controlling implementation excesses rather than on rectifying design mistakes. Process approaches try to overcome this weakness by incorporating

TABLE 6

Avoiding Blueprints: Alternative Process Strategies

Approach	Example	General Description of Design	Budget	Evaluation and Redesign	Subproject Role	Donor Role
Elevator Model	PVO Grants – Worldwide	Pool of money General guidelines, time frame, and implementing arrangements	High flexibility between categories Total based on illustrative activities	Annual In terms of guidelines Done internally	Varies	Provide money Provide TA as needed
Escalator Model	Rural Sector Grant – Botswana	Design has first year subprojects blueprinted with subsequent years showing budget total only	Each year's budget specified in detail at beginning of each year Total determined at beginning based on illustrative activities	Annual redesign process develops rolling blueprints Annual exercise evaluates previous year's subprojects	Total focus on supporting specific subprojects Implementation of subprojects through public sector	Participate in annual exercise Provide TA
Quick Step Model	Agricultural Management Project – Kenya	Phase I: • Blueprint for physical components • Rest as in elevator model • 2-3 year phase Phase II: • Budget total only • 5-8 years	TA set aside 20-25 percent flexible Total determined at beginning	Redesign exercise at end of Phase I Emphasis on learning in resource institutions	May act as matchmaker with evolving task groups and both public and private sector focus Temporary subprojects major focus for management assistance teams Intermediary organizations in agricultural sector are clients	Participate in design Redesign Participate in Phase I steering committee Provide TA
Slow Step Model	Local Resource Management Project – Philippines	Phase I: • 2-4 years • Project to design a program • Coalition building • Identify local initiatives Phase II: • 5-8 years • Implementation of program	Phase I flexible Phase II based on illustrative activities and determined at end of Phase I	Determined during Phase I Emphasis on continuous learning	Support of local initiatives major focus Community-based emphasis	Provide money Provide TA Approve Phase II Participate in Phase I working groups

design into implementation, and vice versa, in practical, operational ways rather than by making unrealistic appeals for less staff turnover in local bureaucracies. Process approaches, then, represent practical attempts to make things work.

Table 6 suggests the implications of the different models for budgetary flexibility, evaluation role, and other dimensions. But this is only a beginning. The IRD experience is that it is necessary to move beyond strategies that assume certain technologies that can be blueprinted. This move requires programming options that avoid simplistic blueprint versus process distinctions. The implementation experience indicates some preliminary directions, but much more remains to be done.

Summary

Financial, organizational, and policy constraints often impede local action leading to self-sustaining dynamics. Social and physical side effects can have a similar impact.

Institutional, organizational, and technological strategies were tried to overcome these constraints. One finding is that program-based rather than pure project-based efforts experienced more success. The need to build on established institutions permeated the entire IRD experience.

But no matter which approach was used, when technical assistance or capacity-building efforts were widely dispersed, little capacity was built and the prospects for long-term success plummeted. Similarly, when it was assumed that a project blueprint and a pre-existing package of technology provided a certain solution to local inadequacies, new problems overwhelmed management's capability to deal with them. This was especially true when the core technology did not involve irrigated rice production.

This exception was not just the result of technology, however. Local organizations need renewable resource bases, such as irrigation water or forestry preserves. Without this base, organizational strategies to attain sustainability usually fail.

While resource bases are built, a few focal organizations should be equipped to help others. The technical assistance approach for this effort should move away from performers toward mobilizers, organizational incentives should be scrutinized and adjusted, vertical linkages should be established with policy-level actors, and project designs should combine accountability with flexibility. Only then is it likely that issues of recurrent costs, capacity, and sustainability will receive serious attention.

Notes

1. P. M. Van Hekken and H.U.E. Thoden Van Velzen, *Land Scarcity and Rural Inequality in Tanzania: Some Case Studies from Rungwe District* (The Hague: Mouton, 1972), p. 47 and note 15, p. 124.

2. Irwin Levey et al., *Philippines - Rural Roads I and II*, AID Project Impact Evaluation Report no. 18, (Washington, DC: Agency for International Development, 1981).

3. World Bank, *Accelerated Development in SubSaharan Africa* (Washington, DC: The World Bank, 1981). This is often referred to as the Berg Report.

4. Robert Bates, *Markets and States in Tropical Africa: The Political Basis of Agricultural Policies* (Berkeley, CA: University of California Press, 1981).

5. Agency for International Development, "Project Evaluation Summary – Operation Milk Mopti (79-2)" (Washington, DC: Agency for International Development, 1979).

6. Marvin Miracle, "Evaluation of Some Aspects of Niger's Cereal Project," Project Evaluation Summary 79-5 (Washington, DC: Agency for International Development, 1979).

7. Albert O. Hirschman, *Development Projects Observed* (Washington, DC: The Brookings Institution, 1967).

8. Even though there is a common awareness of this fact, organizational and professional imperatives often lead to a glossing over of this issue, just as social soundness analyses neglect key project assumptions. The incentives are to move money, not to become involved with local realities. Recent trends such as policy dialogue make this situation even worse by deemphasizing even the rhetoric of collaboration.

9. This was true no matter which geographic region or country within which the project took place.

10. See *Tanzania Agricultural Policy* (Dar es Salaam: Ministry of Agriculture, 1983).

11. See David J. Gould, *Bureaucratic Corruption and Underdevelopment in the Third World: The Case of Zaire* (New York: Pergamon Press, 1980).

12. See Jennifer Bremer, "Building Institutional Capacity for Policy Analysis: An Alternative Approach to Sustainability," *Public Administration and Development* 4, no. 1 (1984): 1-13.

13. George Honadle, *Farmer Organization for Irrigation Water Management* (Washington, DC: Development Alternatives, Inc., 1978).

14. See Francis F. Korten, *Building National Capacity to Develop Water User Associations: Experience from the Philippines*, World Bank Staff Working Paper no. 528, 1982.

15. See Jerry VanSant and Peter F. Weisel, *Community Based Integrated Rural Development (CBIRD) in the Special Territory of Aceh, Indonesia*, IRD Field Report no. 4 (Washington, DC: Development Alternatives, Inc., 1979).

16. G. Honadle, *Fishing for Sustainability: The Role of Capacity Building in Development Administration*, IRD Working Paper no. 8 (Washington, DC: Development Alternatives, Inc., 1981).

17. See Chapter 2, notes 26-28.

18. This dichotomy and the preference for the process model have become an orthodoxy among many development specialists. This is unfortunate. Delivering goods and services and using performer types of technical assistance are sometimes necessary components of good strategies, and they should not be denigrated when they are needed. The problem is the imbalance, not the existence of these elements.

19. See Donald R. Mickelwait et al., *Personnel Requirements for Project Development in East and Southern Africa* (Washington, DC: Development Alternatives, Inc., 1977).

20. George Honadle and Jay Rosengard make this argument – process does not mean unfocused. See "Putting 'Projectized' Development in Perspective," *Public Administration and Development* 4, no. 3 (1983): 299-305.

Tropical Forested Watersheds

Hydrologic and Soils Response to Major Uses or Conversions

by Lawrence S. Hamilton
with Peter N. King

A Westview Replica Edition

13
Rethinking Some Watershed Policies*

In many developing countries, land-use policies for forestlands are being suggested on the basis of the forest's assumed roles in influencing certain hydrologic, soil-erosion-protection, and sedimentation-minimization characteristics of watersheds. In some cases, these roles have been proven scientifically; in some cases they are folklore or myth—or misinterpretation of research. Whatever the case, it seems desirable to conclude by shedding some light on a few of the four Ms (myth, misinterpretation, misinformation, and misunderstanding) about the effects of using or converting tropical forestlands, in a watershed land-use context.

For instance, it is suggested that cutting of rainforest will result in desertification. There is no evidence that rainfall on the area will decrease to the point where the area becomes arid. It also is suggested that reforestation or afforestation of open lands, including extensive grasslands, will cause well levels to rise, springs to flow again, and low flows in streams to increase. All evidence from temperate zone research, however, indicates the reverse. Is this research inapplicable to the tropics or are we using the wrong arguments for the right reasons? Floods in the lower stretches of major rivers, such as the floods in Bangkok and New Delhi, are blamed on tree harvesting or shifting cultivators in the uplands far away. This relationship has never been proved, but could it still be correct and therefore a basis for land-use policies? Or are urban people refusing to look at their actions in flood plain occupancy, channel constriction and alteration, and the effects of such important sediment-producers as roads?

Some of the policies discussed in this chapter have been promulgated or advocated with claims of a sound rationale of soil or water conservation, but which in fact have no scientific basis, or worse, have a countervailing scientific basis.

*This chapter presents some of the author's thoughts, which are not necessarily endorsed by the participants of the watershed workshop that initiated this publication.

CUTTING FORESTS REDUCES RAINFALL?

It is being advocated that we save tropical forests, particularly tropical rainforests, because cutting them will convert the areas into deserts and create droughts. The World Wildlife Fund/IUCN Tropical Forests Campaign was initiated in October 1982 at Bali in Indonesia. It suggested that following logging, the "land of green gold" is turned into "useless desert" and that "take away the trees and you get withering drought in the dry season" (WWF/IUCN 1982). Suggestive of the same thinking was the title of an influential book, *Amazon Jungle: Green Hell to Red Desert?* (Goodland and Irwin 1975). The leader of the Tree Hugging Movement (Chipko) in India has claimed that cutting of the forest results in droughts (Anonymous 1981). In an article entitled, "The Desertification of Asia," it is claimed that "deserts can develop with great speed even in the heart of a tropical jungle" (Sharp and Sharp 1982). In these cases, there may be some slippery semantics in the words "desert" and "drought," but a dictionary suggests that a desert is "arid land with insufficient precipitation to permit plant growth," and that a drought is "lack of precipitation or moisture." It is hard to see how a tropical moist forest area receiving upwards of 1,800 mm/yr of rain can be converted into a desert by logging.

Early forest influence research, showing little or no relationship between presence or absence of trees and the precipitation falling on that area, was synthesized and brought into the policy arena in the tropics by Pereira in 1973 (Pereira, 1973). Yet the idea persists that local rainfall is reduced by cutting forests, and the author has encountered folklore to this effect, particularly among banana growers in Central America and policymakers in South Asia. It is true that there is some recent work in the Amazon Basin suggesting that for this large area with its unique hydrometeorology, the forest does regenerate some of its own rain (Salati et al. 1979) and that possibly, therefore, *large-scale* and *permanent* deforestation (not just logging) could reduce or alter rainfall in parts of it (Salati 1981). This speculation has not yet received a ringing scientific endorsement.

Saving fine examples of complex tropical lowland rainforests from the logger is indeed a worthy cause. Indeed, there are many compelling, scientifically sound, and philosophically rewarding reasons for trying to preserve a large amount of the world's remaining primary tropical rainforest, but fear of reduced rainfall is not one of them.

One exception to that rule occurs, however, in certain physiographic situations. For example, in coastal fog belts or at high elevations characterized by frequent or persistent cloud, forests can "capture" and condense atmospheric moisture. This so-called "occult" precipitation is added to the effective moisture received by the area and may represent a substantial percentage of the total. For example, in Hawaii it represented an extra 760 mm above a nonforested 2,600 mm of rainfall (Ekern 1964). Cutting down the forest results in loss of this occult precipitation, though it is restored as the forest regrows. If the area is converted to another use, this moisture is removed from the water budget of the watershed, including water outflow from the immediate watershed (Zadroga 1981). Therefore, saving cloud forests and fog forests makes good hydrologic sense.

CUTTING OF FORESTS DRIES UP WATER SUPPLIES?

There is a widespread belief that logging of tropical forest watersheds has caused wells, springs, streams, and even major rivers to cease flowing, at least during the dry season (Eckholm 1976, Sharp and Sharp 1982). Policies to set up protection forests that may not be cut are being advocated because of a supposed "sponge" effect that soaks up water in the wet periods and lets it release slowly and evenly in the dry season to keep water supplies adequately restored. It is difficult to reconcile such policy with small watershed cutting experiments that almost universally have given *increased* total water yields over the year, with the greatest increases usually in the low-flow months. Bosch and Hewlett (1982) have reviewed 94 controlled-catchment studies and reinforced this relationship. They have even indicated some predictive quantification as to the amount of increase. Moreover, most cutting experiments have shown increases in groundwater levels (Boughton 1970).

Perhaps some of the dilemma arises because of semantic problems. The catchment experiments involved forest cutting and logging, *not* conversion to another use such as grazing or annual cropping. The real-life problem in the tropics is that forest harvesting is often the precurser to a conversion, and the term "deforestation" (which is often used) may refer to the sequence of logging, clearing, and then unsustained agriculture or grazing without soil and water conservation. If compacted surfaces with intervening and frequent gullies are the end result (and one finds such landscapes all too commonly in the upland tropics), then it is possible that there may result such things as lower water tables (less reliable springs and wells) and lower dry-season flows in streams. There are no large-scale, long-term experiments to support this intuition and professional judgment. Correlations of land area deforested over time and decreased streamflows are not cause and effect, though such a relationship has often been claimed by writers using such statistics.

One problem is that most controlled watershed experiments are in the temperate zone. The few reliable tropical paired-catchment experiments that do exist, however, do not indicate any different results.

In some instances, there are valid reasons for establishing totally protected watershed forests with no forest harvesting permitted, but concern

that cutting will result in dried up wells and springs and ephemeral streams where perennial streams once prevailed does not have a scientific basis. Conversion and subsequent land degradation on a large scale may be a different story.

CUTTING OF FORESTS CAUSES FLOODS?

There is indeed an intuitive feeling (based, however, on some scientific evidence) that forest cover on a watershed does offer the best guarantee against local flash flooding. However, one must become somewhat uneasy when hearing statements that "forests guard against flooding" (European Environmental Bureau 1982) because the persons saying this are referring to major floods on large rivers. Belief in this statement about the hydrologic safety of forest cover gets misinterpreted to mean that if forests are cut, major floods will be the consequence. Thus, monsoon floods in the Ganges and the Indus (which have always occurred) have been attributed to tree cutting in the uplands (World Water 1981). A statement by Openshaw (1974) that "the principal cause of the recent floods in the Indian subcontinent was the removal of tree cover in the catchment areas for fuelwood," was recently repeated at the 1978 World Forestry Congress (Avery 1978). In the Philippines following the great Agusan flood of 1981, the state minister placed "30 percent of the blame on logging" of headwater forests, even though "flooding is an annual event, and major floods are expected about every 20 years" (Corvera 1981). There followed in the same newspaper an interview with a top official in the Philippine Bureau of Forest Development on the subject of actions by that organization to control logging and encourage reforestation. It has been suggested that "overlogging is now officially recognized as the cause of last July's severe flooding of the Yangtze" in China (Sharp and Sharp 1982).

Are these popular concerns about forest cutting and floods valid, or are they misinterpretations of research findings? Are people looking for a scapegoat so that they do not have to consider that floods have always occurred, but that damage is truly increasing because of greater flood plain occupancy, greater channel constriction, and alteration by human structures?

Findings from paired-catchment research in which one catchment has been logged indeed usually (but not always) show greater stormflow volumes, higher peakflows, and earlier peaks in streams emanating from the logged area (Douglass and Swank 1975, Reinhart et al. 1963). Flooding may be increased close to the area cut, but as water is routed down a major river basin, this effect is rather quickly reduced to insignificance amid other processes of paramount importance, such as the nature and intensity of the precipitation, the direction it moves across the basin, and the size

and morphometry of the basin. Hewlett (1982) has recently examined the evidence worldwide from forest watershed research and reported that there was no cause-effect relationship between forest cutting in the headwaters and floods in the lower basin. Even if a whole basin were under a forest harvesting regime, normally it would not be logged off all in one year. Those portions that are logged rather quickly return to a prelogging hydrologic regime as the forest regenerates and full canopy is restored, even though it is young growth. Moreover, a substantial part of this stormflow/peakflow effect is due to poorly located and designed roads, skid trails, and log landings, all of which speed water off-site. Thus, proper conservation logging can reduce any small effects on upstream flooding. Floods occur due to too much precipitation falling in too short a time or over too long a time (prolonged), beyond the capacity of the soil mantle to store it and the stream channel to handle it.

The previous discussion has referred to the impacts of forest harvesting on floods, not on the effects of forest harvesting followed by conversion to agriculture and grazing and subsequent degradation by misuse. Such degraded areas, encompassing whole river basins, may indeed aggravate flooding and be one of the principal causes of serious flood damage. However, if converted to controlled grazing lands or agriculture under a sound soil and water conservation regime, such watershed land use should no more *cause* floods than would careful forest harvesting.

SHIFTING AGRICULTURE IS RESPONSIBLE FOR MASSIVE EROSION AND ACCELERATED RESERVOIR SEDIMENTATION?

In the press, in environmentalist writings, in political pronouncements, and even in some literature from land-use professionals, shifting agriculture has been condemned as causing many of the environmental ills in the tropics (European Environmental Bureau 1982).

Aside from eliminating primary tropical forest (an inevitable consequence of shifting agriculture that does have serious policy implications) this ancient land-use system is most specifically targeted as causing massive erosion in the uplands and accelerated reservoir sedimentation in the valleys (as is reported for the Ambuklao reservoir in the Philippines [Chanco 1981]).

The mistake in pointing the finger of blame at shifting agricultures (e.g., swidden, kaingin, milpa, conuco, jhum, bush fallow, slash-and-burn) is a semantic one. In its traditional meaning, the label applied to a system of forest cutting, cropping, and fallowing that was sustainable because the cultivator was a long-term resident in one place and the cropping area was rotated (shifted) in the surrounding area. The fallow period was long enough in secondary forest to permit rebuilding of the nutrient budget on

one site prior to its again being cut (and usually burned) for the next cropping period. With relatively low population density, low technology, and a subsistence economy, these were stable systems, ecologically well adapted to the tropical environment. Even on fairly steep slopes, the small area of soil disturbed in order to plant and cultivate annual crops accelerated erosion only slightly. The small area cultivated at any one time (typically less than 3 percent of the total area) in relation to the mosaic fallow area also meant that any soil moving from the cultivated area was usually trapped by the fallow, and sediment levels in streams did not necessarily increase in response to shifting agriculture (see Chapter 2). Many tribal peoples in the tropics are still practicing this *stable* system, though they represent a decreasing minority when compared to a more recently developed *unstable* system, which is also referred to as "shifting agriculture." The distinction between these systems has been clearly identified by Watters (1971) and by Kundstadter and Chapman (1978).

The newer system is an outgrowth of increased population pressure, landlessness, increased technology, and a shift to cash cropping rather than subsistence. These new shifting agriculturists are indeed often true shifters or migrants in that they move into a new area, clear it by slash-and-burn methods in substantially larger blocks, cultivate it until it is worn out, and then they move on to a new area. They are, in essence, perennial "new colonists" attacking the edge of the pristine forest and leaving behind degraded land that has suffered serious erosion because soil conservation methods are not part of the strategy of the landless and poor. Moreover, since there seldom is a mosaic of uncut forest and fallow patches of scrub, much of the eroded soil does move into stream channels as sediment and causes a host of adverse consequences.

It is inappropriate to group these two different systems under one blanket term and to attribute the well-documented environmental ills of one system to both. This has had disastrous consequences for tribal peoples in many parts of the tropical world. They have sometimes been evicted from their lands in the public domain in the name of preventing forest, soil, and water degradation. A more humane, thoughtful, and ecologically sound strategy might be to assist them gradually to improve their practices, perhaps in an agroforestry context, with the introduction of new food tree crops. A recent program of forest occupancy management begun in the Philippines is indeed an important step in this direction (Duldulao 1981). Let us be more precise in our language when discussing erosion and sedimentation from shifting agriculture. Even with the unstable form of shifting agriculture, the erosion consequences may be somewhat overrated, or it may be at least dwarfed by the erosion resulting from road construction, urban development, drainage outlets, and other civil engineering, rather than agronomic, activities (Sanchez 1979).

GRASSLAND IS BETTER COVER FOR WATERSHEDS THAN FOREST?

In forest watershed research, it has been shown in several experiments that conversion of forest to grass as the dominant cover has usually resulted in greater water yield (e.g., Hibbert 1969, Queensland Department of Forestry 1977), higher groundwater levels in deep soils (Boughton 1970, Melzer 1962) with only small increases or no increases in stormflow volume, peak flows, or storm duration flow, depending on grass density and productivity (Hibbert 1969, Helvey and Douglass 1971, Queensland Department of Forestry 1977). The grasslands in these instances were not grazed, for the experiments were designed to compare the hydrologic effects of the different vegetative covers. Once the grass was established, there was no difference in erosion rates or sediment production from the area (Coster 1938, Helvey and Douglass 1971).

Some politicians, water development engineers, and planners have read or heard about these results and suggested that grass would be a better cover than trees on watersheds because increased water yields in streams and rivers are important in water projects for water supply, hydro power, and irrigation. They have been told that deep-rooted forests are heavy users of water, and now they suggest replacing them with grasslands that use less water but still give hydrologic safety. Such a policy, if widely adopted, would be inappropriate for at least two important reasons.

First, these experiments were conducted on moderate slopes not prone to mass wasting. The importance of tree root shear strength in maintaining slope stability on steepland areas prone to landslip and slumping has now been well documented (for example, O'Loughlin 1974). On such areas, forest cover gives the greatest protection against this most damaging form of erosion and its corresponding increase in sedimentation.

In addition, these aforementioned experimental results were obtained from grasslands that were not grazed and not burned. In actual practice in the tropics, any area of grassland is likely to be grazed, and usually overgrazed, and is also likely to be burned to maintain it in grass. While controlled grazing and prescribed burning at appropriate intervals need not have serious adverse impacts on the hydrology and soils of a watershed, such control is practically impossible to achieve in most tropical countries where populations are increasing rapidly and food production needs are high. Overgrazing and indiscriminate burning, especially over long periods, result in a well-known series of adverse hydrologic and soil movement effects (Cochrane 1969, Raeder-Roitzsch and Masur 1968). The extensive degraded grasslands of the tropics are unravelling testimony to this situation.

Forests are hydrologically and erosionally safer because they are less susceptible to intensive use—as long as they are maintained as forestlands. Harvesting minor forest products from them has an insignificant effect on

watershed values (see Chapter 1). Commercial wood harvesting, even when clearcutting is involved, is carried out at relatively infrequent intervals compared with continuous grazing, and any hydrologic or soil impacts are rather quickly restored to preharvest levels (at least in the more humid tropics) through vegetation regrowth. Of some concern, however, to watershed relationships will be the increasing emphasis on plantations of rapidly growing trees that are harvested totally, with large equipment, on very short rotations, as either chips for pulp or for bioenergy.

REFORESTATION OR AFFORESTATION WILL STOP FLOODS, AMELIORATE DROUGHTS, CAUSE STREAMS TO FLOW AGAIN AND RAISE WATER LEVELS IN WELLS?

Large-scale programs of reforestation or afforestation are being called for and to some extent carried out in tropical watersheds of most countries. As a strategy to establish "wood factories" to meet needs for fuel, timber, and other wood products, this makes good sense. Hopefully it will relieve some of the pressure on remaining bits of natural forest. Moreover, as a rehabilitation device to make unproductive lands more productive, to minimize erosion, and to rebuild nutrient budgets, such efforts are indeed well conceived. The fuzziness appears when the clarion call goes out that through planting trees, rainfall will increase (droughts cease), springs, wells, and streams will flow once more, and floods will be prevented.

In most respects, putting trees back on open land (reforestation) or planting them on areas long without or never with forest (afforestation) produces the opposite effects to taking trees off. The effects of forest cutting have been discussed previously but will be summarized here in terms of reverse effects. There is no evidence that planting forests will increase rainfall except in those special cases of physiography where fog or cloud capture of moisture may result. In those special circumstances, establishment of forest may result in additional *effective* precipitation, which under many geologic and soil situations will appear as increased groundwater and baseflow. While this does not influence local or regional rainfall, it may therefore improve well levels and springs and increase stream yields, including low-season flows. In most experiments, however, reforestation of open land has resulted in lower water tables, less reliable springs, and reduced streamflow, especially in the dry season (Banks and Kromhout 1963, and others cited in Chapter 12). An example of the policy dilemma has occurred recently in Fiji, where contrary to conventional wisdom and expectations of a decade ago, the large reforestation program of the Fiji Pine Commission is resulting in decreased streamflows (Drysdale 1981, Pers. Comm.). And finally, while stormflows may be somewhat reduced, most experiments have shown rather small effects (Hewlett 1989) ...

tainly for major floods on the lower reaches of rivers, it is doubtful if there is much impact of even rather large-scale forest planting programs, *unless* a major portion of the catchment was in a degraded, severely gullied, soil compacted state, where almost all precipitation was quickly channeled to the streams and rivers, but where sediment derived from upland erosion was a major contributor to flooding. In such cases (and there are many landscapes in the hilly tropics that have been so abused they would seem to qualify), the establishment of forests might indeed slow and reduce surface runoff to the point where there would be some flood *reduction* effect, though not elimination of floods. It would certainly reduce erosion rates and resulting contribution to river sediments.

CONCLUSION

Problems in achieving sustainable development and conservation of soil and water resources in the tropics are legion enough, without being plagued by myth, misunderstanding, misinformation, and misinterpretation. Semantic fuzziness adds to the scene. Words such as deforestation, shifting agriculture, marginal lands, and desertification usually need to be defined or avoided in favor of more precise words or phrases. The consequences may be seen in fruitless disagreement between interest groups, propaganda instead of education, bad policymaking because of shaky scientific bases, or even good policymaking for the wrong reasons—an action that may backfire. Perhaps foresters have been guilty of aquiescing by silence to the use of some misinterpretations and misunderstandings, because the arguments or rhetoric being used were aimed at protecting forest resources or at establishing new forests—surely actions worthy of nations and statesmen. But, if we close the watershed forests to human use and reservoirs still silt up, and when we have totally reclothed the basin in planted forest and we still have floods, and if on top of that the streams still dry up or dry up even more . . . then there may be a well-deserved backlash and the credibility of foresters and other watershed professionals may be called into serious question. There are many eminently sound reasons for forest conservation and reforestation in the tropical developing countries. Let us not condone the use of unsupportable or questionable hydrologic and erosional relationships in this important policy scenario.

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Settlement in the Humid Tropical Life Zones of Latin America

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INTRODUCTION

Flying into the valleys of Cali, Quito, or Cajamarca, one observes ample ranches, dairy farms, and fields of grain and sugarcane. One sees also the minifundia that give rise to the migrants: four moving to the cities for every one to the frontier. This study analyzes migration to the tropical frontiers, in full knowledge that the fate of the migrants is interwoven with that of the 75 percent of the Latin American population expected to be living in cities by the turn of the century (United Nations 1980). This urban population will place unprecedented demands on the natural frontier base for food, forest products, water, and hydroelectric energy, while at the same time competing with the frontier zones for scarce national development funds.

Migration to the agricultural frontiers of the humid tropics occurs because of a decline in well-being in the home region—push factors—or the perceived attractiveness of new lands—pull factors. Occasionally the push is dramatic as in the case of political upheaval and rural violence or a major drought. Migration is more often a response to the slow but inexorable pressure of a growing population on a degrading resource base. The pressure may be the result of (1) deeply rooted tenure patterns that have long prevented access to more inherently productive land (Crist 1983); (2) of inherited cultural attitudes toward the land and its management (Dickinson 1981); or (3) of the incapacity or unwillingness of governments to extend to *campesinos* appropriate agricultural technology, credit, marketing assistance, and social services including education, health care, and family planning.

Much of the pioneer settlement of the humid tropics to date has resulted in only ephemeral increases in economic production, achieved all too often through a decapitalization of the tropical resource base that results merely in an extension of rural poverty to new areas. The traditional grain and pasture agriculture of the drier zones is ill adapted to the moist and wet tropics. Government ability to deliver services to the humid zones is further limited by poor roads, dispersal of migrants, and conditions of heat, humidity and isolation unattractive to agents from the capital. Enough is now known about tropical resource management and the settlement process to achieve sustainable development. No composite model exists, but a critical mass of discrete experiences can be drawn upon by interdisciplinary development teams and adapted to local circumstances.

Elements of two distinct options are open to policy makers seeking to increase agricultural productivity in tropical Latin America. The first is to promote the concentration of small- and large-scale commercial agriculture on the potentially most productive lands with ready access to urban markets and sources of services—the intensification option. The second is to promote the full occupance of all national territory, much of which is situated in the moist and wet tropics, and the utilization of all resources, even those at the ecological and economic margins—the frontier settlement option.

ECOLOGICAL FACTORS AFFECTING POPULATION DISTRIBUTION

Where people have settled can be defined in terms of ecological Life Zones (Holdridge 1967). These units are based on simple climatic parameters, including mean annual temperature, precipitation, and potential evapotranspiration (PET) (fig. 1). The Life Zone concept is employed in human ecology to define land capability for various uses including agriculture. Much of the ensuing discussion revolves around the location of a particular Life Zone relative to the "unity line" labeled in the figure. Unity refers to the 1 : 1 ratio between precipitation and evapotranspiration. Moving to the left of the line, Life Zones are increasingly arid (evapotranspiration exceeds precipitation by ratios of 2, 4, etc.); to the right of the line humidity increases, potential evapotranspiration (PET) being only a fraction of precipitation ratios of 0.5, 0.25, etc.

People have tended to concentrate where climate, soil, and topography combine to create desirable

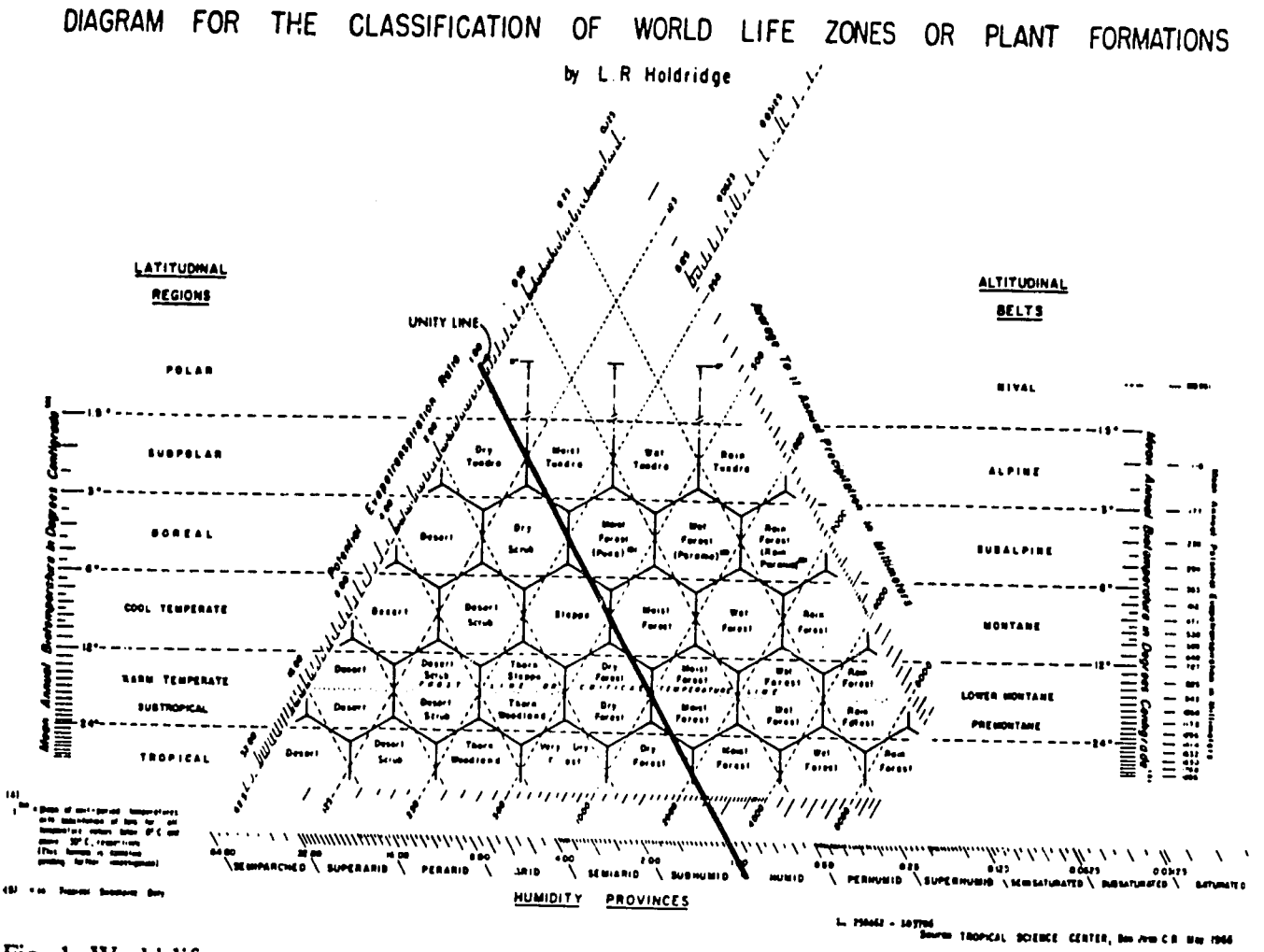

Fig. 1. World life zones.

conditions for urban and agricultural development. Some 80 percent of the Latin American population is found in cities, in intermontane valleys, river floodplains, and coastal plains, which receive 500 to 2000 mm of rainfall per year and which are located between sealevel and nearly 4000 m elevation (Economic Commission for Latin America 1979). Looking at the Life Zone diagram in figure 1, one sees that most of this population is concentrated in the parts of the zones closest to "unity line" where rainfall and evapotranspiration are nearly equal. Lower Montane and Montane Moist Forest and Dry Forest/Steppe Life Zones are closest to the unity line. Only two capital cities in Latin America, Lima and Santiago, are located outside this climatic band. In both cases, the cities are in drier Life Zones with exotic streams providing adequate water for urban development and agriculture (Holdridge 1967, 16).

Traditional European and modern high input agricultural systems tend to be easier to sustain near the line, especially on the drier side, than in more humid areas. Much of this land, unfortunately, has steep slopes and concentrated population, which create a potential for rampant erosion. In Ecuador, for example, 33 percent of total agricultural production, excluding coffee and subsistence crops, comes from steep lands. The figure is 26 percent in Colombia, and in Peru, with its irrigated coastal valleys, 19 percent (Posner and McPherson 1982).

THE AGROECOLOGICAL CONTEXT

The Drier Life Zones. Arid areas have been the scene of both failure and success in agricultural development. Sporadically deficient rainfall results in crop failure. Grazing and firewood cutting is commonly carried out at levels in excess of the recuperative capacity of the natural ecosystems. Rainfall that does occur is often "aggressive," coming in violent thunderstorms with resultant heavy erosion of lands bared by overgrazing and cultivation. Life Zones with PET ratios between 1.5 and 2.5 in figure 1 have been the traditional source of the most desperate migrants. Because of the historical land tenure inequalities, peasant farmers have limited access to the more level, better watered, and fertile lands.

Areas suitable for irrigation have been made highly productive. In Mexico, for example, 80 percent of the increase in agricultural production during one period in the sixties took place on less than 4 percent of the production units, mostly in the irrigated north (Dourojeanni 1980). Much of the success in expanding irrigation is dependent on high levels of organization, technical skill, and capital investment. In Peru, for example, poor water management has resulted in salinization affecting the productivity of more than 30 percent of the fertile irrigated coastal lands. The rate of increase of lands affected by salinization matches or exceeds the rate of gain of land to agriculture through costly irrigation projects (Dourojeanni 1980, 105). Advances in agriculture in the dry tropics have been achieved largely by overcoming physical stress: the lack of sufficient moisture to grow crops. Given water for irrigation and suitable soils and topography, midlatitude technology in agronomy, water management, and integrated pest management can be effectively applied.

Life Zones Flanking the Unity Line. Optimum conditions for rainfed agriculture are found when PET approximates precipitation. There is adequate rainfall for at least one crop per year and neither salt accumulation nor leaching are a serious problem. The dry season is analagous to the midlatitude winter, a die back of pests and weeds occurs, oxidation of organic matter slows down, and minerals leached into the subsoil tend to return to the upper soil horizons as soil moisture evaporates. In the lowland tropics rainfall along the unity line between Dry and Moist Forest Life Zones ranges from 1500 to 2000 mm. Rainfall on the unity line is 500 mm at 3500 m elevation. Crops adapted over the entire range of altitudes can be grown: plantain, cassava and avocado, and many others in the lowlands, and potatoes, quinua *(Chenopodium)*, and a few midlatitude crops at the 3500 m level. It was at these higher elevations in the intermontane valleys of the Andes that the Spaniards found conditions for living and agriculture similar to Iberia. As in the case of irrigated dry lands, midlatitude technology could be applied in the higher unity line Life Zones with relatively few limitations. The major problems have resulted from the conversion of land once dedicated to food crops into extensive pasture land for sheep and cattle and the substitution of exotic crops, such as long day length, midlatitude wheat varieties, for the highly nutritious, locally adapted quinua.

The Wetter Life Zones. The primary challenge in the humid tropics has been to overcome biological competition; year round competition between crops, including pastures, on the one hand, and weeds and pests on the other. The traditional agriculturist has historically employed two strategies in keeping with his limited resources to produce food. One is shifting agriculture, which uses fire to release nutrients and kill back weeds and pests, permitting several harvests before competition becomes unacceptable. The other is the intensively managed garden, which imitates the structure and diversity of successional forest. In Asia, farmers routinely incorporate a detritus-based fish pond subsystem in their garden systems. Conventional crop and pasture monocultures have been difficult to sustain at high levels of productivity in the more humid tropics.

On the right-hand side of figure 1, Wet Forest and Rainforest Life Zones are found at all elevations. At altitudes above 1000 m, these Life Zones occur in relatively narrow bands along the steep eastern slopes of the Andes. Lowland Wet Forests are very limited in extent with the dominant Life Zone being the Tropical Moist with rainfall averaging closer to 2000 mm than to the upper limit of 4000 mm at the margin of the Tropical Wet Forest. As the PET ratio decreases from 0.7 toward Rainforest conditions of 0.25 to 0.125, the problems of biological competition become all the more severe, as do the problems of soil management. The principal limitations are summarized below:

1. The growing season extends throughout the year for both crops and for pest and disease organisms as well as for competing weeds. Conventional control measures are increasingly costly and ineffective.

2. In addition to erosion and mass movement of soils exposed to heavy rainfall, extensive areas of soils with low cation exchange capacities are subject to chemical degradation, owing to leaching and oxidation of organic matter. Grazing results in further degradation owing to compaction of soils. Fertilizers applied are rapidly leached out, physically removed in runoff, or rendered chemically unavailable to crops (Food and Agriculture Organization of the United Nations 1979, 19). The incidence of aluminium toxicity is high.

3. The very humid tropical forest is rich in plant nutrients that are found primarily in the living biomass. An efficient root system rapidly recycles nutrients from dead organic matter back into the above-ground living component. Clearing for agriculture and pasture results in rapid loss of nutrients from leaching, runoff, and volitation.

4. Because the very humid tropics have not been attractive to settlement in the past, there is only limited infrastructure in the form of roads or facilities providing health care, education, research, extension, and marketing services.

Development administrators must recognize that the humid tropics require a radical departure from traditional midlatitude approaches to resource management if sustainable development is to be

achieved. The forest products industry has developed uses for only a small fraction of the tree species. Screening of organisms for medicinal and other uses is promising but slow (Wilson 1984; Meyers 1983). Indigenous cultures have evolved sound management practices that are relevant to modern development needs. Although widely documented, these practices have yet to be effectively incorporated into extension practice (Clawson 1985; Dickinson 1972; National Research Council 1982; and International Union for the Conservation of Nature 1975).

TYPES OF SETTLEMENT

The settlement process ranges from the spontaneous migration of individual families to recruitment and settlement schemes totally directed by government. Settlement in Amazonia and elsewhere historically has followed rivers, taking advantage of the ease of riverine transportation and the relatively sustained productivity of floodplain alluvial soils. In recent decades the bulldozer has provided the means for opening roads through the tropical forest. In some cases roads have been built to provide settlement access, but more often other goals were paramount with spontaneous settlement being incidental. These goals have included timber extraction, petroleum exploitation, national defense, and the linking of urban centers. The high cost of bridging large floodplain rivers assures that highways will follow the interfluvial uplands as much as possible, thus avoiding rather than connecting the areas of better soils.

Government services for spontaneous settlers eventually follow the opening of a new road. Planned colonization projects generally involve the anticipation of the needs of selected settlers recruited elsewhere in the country. A notably generous example was the Altamira project, part of Brazil's Trans Amazonian highway program, which offered settlers 100 hectares of land, six months of salary, housing, primary and secondary roads, credit, and marketing services (Moran 1982). It has been found in Bolivia that the spontaneous settlers attracted to subsidized colonization projects have been more successful than the intended beneficiaries because of their higher level of motivation, lack of a debt burden, and freedom to choose better soils rather than being restricted to arbitrarily assigned lots (A. M. Stearman, personal communication).

Intermediate in the level of government involvement between highway-related spontaneous settlement and directed colonization has been what could be called semi-directed settlement. The government anticipates certain needs of spontaneous settlers, providing assistance in land titling, extension, credit access, and feeder road construction. Government assistance occasionally has had unanticipated negative consequences such as in Bolivia and Peru where, to the embarrassment of the national governments and international donors, highways constructed in the Andean piedmont for the avowed purpose of opening new areas for settlement stimulated, instead, the cultivation of coca for the international cocaine trade.

Independent from the settlement types mentioned above are the modern plantations exemplified by bananas and, more recently, oil palm. Profitability is predicated upon low labor and land costs as well as upon a lucrative export market that can support heavy investment in fertilizer, pesticides, extensive transportation systems, and elaborate handling and shipping facilities. The availability of chemical fertilizers has reduced the importance of natural soil fertility of plantation lands while increasing the value of good soil structure for mechanical operations. These highly developed enclaves, or "factories in the field," are irrelevant to the *campesino* with his limited resources.

SETTLEMENT VIABILITY

In a thorough study of 24 cases in the Latin American tropics, Nelson (1973) observed that "failure is directly related to the degree of government involvement in a project, transport costs, and the degree of pioneer colonization involved relative to consolidation with peripherial expansion into new areas," and further that "evidence is on the side of those who would restrain expansion in the hope that higher returns would result from a sequence that places initial emphasis on consolidation, education, the accumulation of knowledge, and improvement in public administration. The prudent approach to movement into pioneer areas is a gradual one designed to attract spontaneous settlers and, within the limits prescribed above, private investment and enterprise" (Nelson 1973, 265, 291). The wisdom of Nelson's observations has been amply demonstrated in Brazil where the costly failure of directed colonization has been exhaustively documented (Wesche 1983; Moran 1982; and Smith 1981).

It is estimated that only 6 percent or one hectare in fifteen of the Amazon Basin has soils of even moderate fertility (Sanchez 1982, 822). This 32 million hectares is roughly equal to the arable land base of Peru but is spread over a 484 million hectare area, mostly in alluvial deposits of limited extent. The failure of the massive Trans Amazonian Highway settlement project in Brazil was closely linked to the limited areas of fertile soils and to the excessively high cost of providing inputs, services, and marketing support for farmers scattered along

thousands of kilometers of road. Had settlement followed rivers rather than lines on the map, a much higher proportion of good soils (and pre-existent settlement) would have been encountered at a considerably lower cost.

Among the various inappropriate justifications for directed colonization has been a desire of international multilateral and bilateral development institutions and governments to have projects that facilitate auditing and control and produce clearly identifiable results. Nelson (1973) identified some of the chronic problems that tropical settlement has faced because of deficiencies in public administration. He advocated a gradual approach to expanding the settlement frontier. This makes sense in terms of soils and ecological considerations as well.

It can be assumed that almost all of the inherently fertile soils of tropical America have been fully occupied. These include arid lands suitable for irrigation, the cooler intermontane valleys and, in the more humid lowland tropics, alluvial material from the Andes and outcrops of terra roxa soils and basalt. Most migration to date has been to sites with poorer soils relative to the undegraded state of the place of origin. Occupation of a new settlement zone in no way implies, however, that anything approaching optimal agricultural output has been achieved, owing to the fact that the new settlement regions are planted to extensive cattle pasture, to crops only marginally suited to the Life Zone, or are beyond effective access to services and markets.

Given limited personnel and budgetary resources, anticipated return on investment in frontier colonization should be compared with alternative development strategies. Major increases in well-being and productivity could be achieved through soil conservation, redistributing land, and providing production incentives in settled areas where an overall service infrastructure already exists. In some countries more efficient use of irrigation or even the exploitation of new sources of surface or subsurface water could greatly increase the productivity and carrying capacity of heretofore sparsely populated arid areas. In Peru, irrigation water is inefficiently used and subsurface water is virtually untapped.

AGRICULTURAL MODELS

In the Latin American tropics both historic settlements and better soils are concentrated along the unity line. Descending the unity line into the lowland tropics, soils tend to become poorer as the rate of organic matter oxidation increases at higher temperatures and as higher rainfall results in physical removal of soil nutrients from tilled land. The *campesino*'s accumulated experience during centuries of living in uplands as well as the unmodified technology introduced from the temperate latitudes become decreasingly appropriate. These are the ecological factors supporting Nelson's recommendation of caution and the accumulation of knowledge and experience by settlers and the institutions responsible for research and extension. The problems of sustaining agricultural production become all the more formidable as the settler moves away from the unity line in figure 1 into the wetter Life Zones.

The challenge in the humid tropics has been to overcome biological competition, not physical stress. The agricultural strategies used are fundamentally different; one revolves around soil management and the other, ecosystem management. In the midlatitudes and higher elevations in the tropics, the majority of the nutrients are in the soil. In the lowland humid tropics the opposite is the case: most of the nutrients are in the above-ground biomass of the forest. When whole systems are compared, dry and wet Life Zones may be equally rich in nutrients. What is important in management is where the nutrients are concentrated.

Peoples indigenous to the humid tropics have evolved various techniques of surviving. These techniques are imitated, usually in a much degraded form, by migrants. One is shifting agriculture and the other is the intensively managed dooryard garden. Indigenous peoples depend primarily on hunting and fishing for protein. Migrants depend more on domestic pigs, chickens, and ducks. Such agricultural systems can sustain a high level of subsistence security, but at a relatively low population density with only limited potential for crop export without outside subsidy. Such systems are distinguished from those adapted to the dry side of the unity line by exploitation of nutrients in the vegetation (shifting agriculture) or imitation of the nutrient conservation strategies of the diverse forest (dooryard garden).

Cattle production may be the single most destructive human activity in the tropics of America. Near the unity line ranching perpetuates the control of extensive areas of potential crop land by a small elite. In the humid tropics, the perpetuation of an Iberian heritage and national and international markets for beef result in continual expansion of the pastureland frontier. Intermediate activities may be timber extraction and shifting agriculture.

The opportunity cost associated with cattle raising is high. Export production is achieved through decapitalization of the forest resource. The extensive cattle ranching found throughout Latin America has reduced timber production that could result from managed forests, has lowered the level of nutrients stored in the biomass, reduced the output of minor forest products such as medicinal plants, and de-

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pleted the natural flora and fauna utilized by indigenous peoples. Maintaining a fixed cattle population in the lowland tropics often requires expansion of the land base due to rapid pasture degradation. The human carrying capacity of the land is reduced owing to both the large size of the holdings and to the relatively low productivity per unit area. Given the time lag in the arrival of roads, government services, and appropriate technology, selective lumbering, shifting agriculture, and ranching have unfortunately been the only widely known means of achieving subsistence or immediate income from the humid tropics.

Three land management models exist that have demonstrated a capacity to generate sustained, long-term agricultural production from the humid tropics. The first is the "Yurimaguas model," which is based on tropical soil management studies in eastern Peru. It involves three annual crop cycles a year using high levels of inputs and sophisticated technology.

The second is the Costa Rica-based Tropical Science Center system of sustained forest production based on total wood utilization in narrow strips followed by natural regeneration. It would be operated by individual families or small communities with a central wood product processing facility. The third model is a composite system combining elements of the above concepts as well as technology adapted from agroforestry research and successful indigenous practices. This farm systems perspective provides an integrative structure. All three models are dependent on a good transportation system, effective public administration (principally secure land titles), and access to efficient government services. All are dependent to varying degrees on outside inputs including agricultural chemicals, machinery, and fuel.

The Yurimaguas Model. More than a decade of controlled experimentation in the upper Amazon Basin in eastern Peru has demonstrated the productive potential of relatively infertile but well structured tropical soils under intensive managenent (Sanchez 1982). Yurimaguas lies just on the humid side of unity line on the Life Zone diagram marking the division between dry and humid climates. Average yields were between 2.3 and 3.46 tons per hectare for rice, corn, soybeans, and peanuts, with a combined yield of 7.8 tons per hectare over a year of continuous cropping. Three tons of lime were applied every three years, 80 to 100 kg of nitrogen to corn and rice, and 25 kg of phosphorus, 80 to 100 kg of potassium, and 25 kg of magnesium applied to every crop. Traces of copper, zinc, boron, and molybdenum were applied as indicated by soil analysis to correct deficiency problems. This work demonstrates that midlatitude crops and soil management technology can be transferred to the humid tropics under close supervision by highly trained soil scientists and agronomists.

Such a model of intensification offers an attractive alternative to the prevalent process of tropical forest decapitalization, with low agricultural yields and income, resulting generally in the conversion of land to poor pasture. Were the countries of the region to develop a highly motivated research and extension service, an integrated market economy with a foreign exchange surplus, and an efficient transportation infrastructure, then the high input technology would have wider applicability. Unfortunately the settlement frontiers of the region offer few of the requisite conditions. Near major markets, particularly in subtropical and cool tropical highlands, and in areas with an irrigation tradition, the technology could find more ready application. It is on the fringe of urban centers that sophisticated and productive entrepreneurs are operating today. Because the system is dependent more on the integration of technology and production inputs than on adaptation to a particular set of ecological constraints, governments can promote the technology where circumstances permit.

The Tropical Science Center (TSC) Model. The TSC approach is based on the assumptions that sustained yield forestry can be an economically viable use of the tropical forest and possibly the only sustainable use of the Wet Forest Life Zones. It is based on the novel concept that forestry can be carried out at the scale of individual family or community management units feeding into a central processing facility.

Under this system, relatively narrow strips are successively cut through mature forest each year, always leaving mature forest next to the newly cut strip as a source of seed. All timber is transported to the road head by teams of animals, leaving the strip bare as a seed bed for the relatively light, wind dispersed seed of many of the more valuable timber trees that pioneer naturally in light gaps created in the forest by falling trees. All the cut timber is used, either for lumber, furniture, poles, craft work, charcoal or firewood.

The system requires heavy initial investment in wood processing equipment. Beyond equipment maintenance, the system requires minimal expenditure, but considerable labor to prepare areas for felling, cutting, hauling, and the cleaning and culling of strips in successional growth. A cutting cycle of about 40 years is anticipated, with 1 hectare strips cut each year in a management unit of about 40 hectares.

A commercial demonstration of the system is being conducted in the Palcazu Valley of Peru by the Tropical Science Center under Agency for International Development funding (Tropical Science

Center 1982). A family holding of 400 hectares appears large. In the area selected, with 6,000 mm of rain, leached high aluminum soils, and broken topography, no other legal use has a higher per hectare economic return. To be successful, considerable discipline is required, both by the landowner in maintaining the cutting cycle and by the state to protect the property from invasion.

While the system is unprecedented and therefore risky, it is based on solid experience in forest ecology. Given the record of wasteful forest exploitation and conversion of potentially valuable forest lands into poor pasture, this concept deserves a thorough test. One advantage is that this management strategy preserves the greatest number of options in land use should superior sustainable uses subsequently be discovered.

The Composite Farm Systems Model. The farm systems model is based on several socioeconomic, technical, and ecological assumptions. Basic among these is the assumption that in a developing country the capability of government and the private sector to deliver goods and services in support of agriculture is deficient, particularly at the frontier margins. This precludes high levels of inputs to *campesino* agriculture. Agricultural systems must be ecologically engineered to imitate useful characteristics and processes in natural systems.

More than three quarters of the Amazon Basin, excluding the sandy soils, has a rather high nutrient status per hectare if the minerals contained in the living biomass are included (National Research Council 1982, 57; Odum 1975, 105). Traditional dooryard gardens (Denevan 1984) and scientific approaches to agroforestry are designed to imitate the mineral cycling and conservation of the humid tropical ecosystem. This moderately productive alternative has the advantage of being adaptable to a wide range of ecological settings and levels of inputs. Such production systems rely more on longer cycle crops than annuals.

Multiple cropping of short cycle annuals requires comparable investments in fertilizer, pesticides, fuel, and labor for each crop (Sanchez 1982). Annual yield is comparable if not higher in the mid-latitudes with only one crop because of the longer day length and lower night time respiration. Longer cycle crops, including yuca, taro, plantains, and sugarcane, produce many more calories per hectare per year than do corn or other grains because they capture solar energy continuously over a longer period (Cock 1982). There is no inherent reason why fertilizer and genetically improved germplasm cannot be used to increase yields. With labor intensive cultivation and harvesting it is not necessary that crops be planted in single species rows. The forest products industry has developed uses for only a fraction of the species found in the tropical forests. Potentially even greater benefits can be derived from much of the tropical forest in situ in the form of medicinal plants, animals, water conservation, genetic research, and recreation (Myers 1983).

Emphasis should be given to animal protein production integrated with the overall agricultural production scheme. The basic goal is to find alternatives to total dependence on extensive cattle production. Swine are particularly strong candidates for utilization of crop residues, unmarketed crops, and crops grown specifically for feed. Experience is being gained with use of pasture-legume mixtures for cattle combined with valuable timber trees.

A tropical farmer may plant annual crops, practice intensive horticulture, small and large animal husbandry and silviculture, extract forest products, hunt, fish, and process goods for market. The needs of such farm families are not served by specialized commodity programs geared to the needs of large enterprises. The farming systems approach has promise of improving the economic lot of a large segment of the region's society and increasing production as well. The focus should be on ecologically adapted cropping systems, the organization and management of the individual farm unit, and on the structure and appropriateness of government support.

LESSONS FOR SETTLEMENT AND DEVELOPMENT

We may conclude that settlement of frontier lands is not necessarily synonymous with development. Government efforts to promote settlement, particularly through directed colonization, have been generally unsuccessful and expensive. Resettlement to relieve poverty in core areas usually results in the spread of poverty. The Trans Amazonian highway program succeeded in resettling less than one percent of the target Northeast Brazil population (Smith 1981, 755). Resettlement is not an alternative to resolving core area inequities in land tenure or access to basic government services such as health, extension, and credit.

Settlement in the lowland humid tropics is inevitable, although the Wet Forest and Rainforest Life Zones should be avoided except for very special uses. If settlement is to result in actual qualitative development, a net improvement in human well-being, then planners should consider the following guidelines:

1. The potential of the target area should be assessed utilizing existing climatic data and geomorphological interpretation of maps, aerial photography, and satellite imagery coupled with field reconnaissance drawing upon local knowledge

of the area (Holdridge 1967). Given the potential for unanticipated problems, more costly detailed studies should be undertaken on an incremental basis for areas actually being developed (Nelson 1973, 183).

2. The organizational, technical, and financial capability of government to undertake a project should be assessed. The motivation and morale should also be considered. The scope of the project should be geared to overall capability.

3. Both the target and affected populations should be identified. The experience and proven capabilities of potential migrants should be evaluated in light of the conditions found in areas where colonization is to be encouraged. Where cultural differences exist between migrants and people already in the area, the implications of these differences should be assessed. The land requirements and cultural integrity of indigenous peoples should be respected. The resource management practices of these people may provide highly valuable models for new settlers.

4. With reference to the Life Zone concept, migration should be encouraged within a given environmental type, rather than promoting traumatic changes where land use is likely to be unfamiliar and adverse health and comfort effects encountered. Ideally a project should be adjacent to and compatible with established settlements.

5. Rather than laying out a rigid grid, development should be selectively focused on the best soils as determined by local experience as well as by formal survey. It has been found that a geomorphological survey can yield more useful information on potential land use than can a soil survey of equivalent cost (Dickinson 1982, 323). The size of individual holdings should be determined by land capability and resources available to the farmer rather than by some predetermined policy. The titling of land should be encouraged and granted *expeditiously*.

6. A farm systems approach should be applied but with a balanced cultural, ecological, and microeconomic perspective.

7. Serious consideration should be given to the development value of the tropical forest as a forest, both as a renewable source of timber and in situ as a source of water, for science and medicine, tourism, and recreation.

8. Because many of the values of the tropical forest benefit and are appreciated by all the world's people, mechanisms should be sought to allow the world community to compensate in perpetuity the tropical peoples for not converting these intrinsically valuable tropical ecosystems into ash to grow corn and pasture.

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THE CONCEPT OF SUSTAINABILITY: ORIGINS, EXTENSIONS AND USEFULNESS FOR POLICY

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The concept of sustainability with respect to resources and the environment is used extensively by a broad spectrum of individuals and organizations. The term is found in government policy pronouncements, publications of international aid agencies, the professional literature, and the popular media. The World Commission on Environment and Development (1987), the Brundtland Commission, uses it as a key concept. (For comprehensive reviews of past and current usage see Clark and Munn, 1987 and Brown et al., 1988.) In this variety of contexts it is invariably used to describe a goal which, superficially at least, is indisputably desirable.

Upon closer examination however, it is found that "sustainability" has evolved from a fairly narrow, and precise, origin into a much broader, and very nebulous, concept. This note briefly examines the development of the concept of sustainability and why it creates such controversy when attempts are made to apply it to resources management and development policy.

The word sustain comes from the Latin, sustenere, meaning to hold up. In the context of resources and the environment then, to sustain would literally mean to maintain or prolong the productive use of resources and the integrity of the environment. While the idea that there are possible natural resource constraints to human development dates back at least to Malthus, the concept of sustainability, as such, came into popular usage relatively recently.

Initially, the concept was defined in the context of a special class of biologically renewable resources such as fisheries and forests, to define physical limits to exploitation. In this usage the scope is limited to discrete flow resources considered in isolation: sustainability means using the incremental flow without reducing the physical stock.

The logic underlying the concept is simple. Fisheries, for example, due to natural growth and reproduction have some annual increase in the amount of fish available for harvest. If the annual harvest is just equal to the annual natural increase, a steady-state equilibrium can be reached. In theory this pattern of harvest and regeneration could continue indefinitely; the biologically optimal harvest rate is called the maximum sustainable yield, MSY. Similarly, this concept is applied to other flow resources such as forests (maximum allowable cut) and groundwater (maximum allowable pumping rate). In all these situations, sustainability is a physical concept, the goal being the management of a renewable resource stock (fish in the sea, trees in the forest, water underground) by regulating the rate of harvest (yearly fish catch, annual tree felling, annual groundwater pumping). In theory this management goal can be reached if we understand the biology (or hydrology) of the resource in question. However, there are severe limits to its practical application because this simple view ignores the impact of external events which are quite common (e.g., pollution, ecosystems interactions). In addition, whether or not such sustainability is a desirable goal is a policy question.

More recently, the concept of sustainability was extended to a broader system of resources variously called the ecosystem or the natural system. Again, the achievement of sustainability is measured in physical terms, but now, rather than just a single product (e.g., fish, trees), there are a variety of goods and services to be considered. As a result of system interactions, what would have been considered sustainable management of an individual resource may actually be unsustainable within the context of the system. For example, sustained yield forestry may create problems with soil erosion and water yield. The nature and complexity of the interactions among the components of the ecosystem bring up the question of tradeoffs associated with development alternatives. To physically sustain the overall system would require that some parts of the system be less than fully utilized. In addition, not all parts of the ecosystem can be managed in harmony. Some resources may be maintained, while some are enhanced and others are degraded.

A further extension of the concept has now evolved, one of "sustainable development," where the goal is not a sustained level of a physical stock or physical production from an ecosystem over time, but some sustained increase in the level of societal and individual welfare. (The Brundtland Commission defines sustainable development as the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.) There seems to be little debate over the desirability of this as a goal. The debate is over how to pursue it and how to measure progress towards the goal.

Part of the problem in this debate is that the term "sustainable," which was originally developed in a biological/physical context, is now being applied in a much broader, social context. The confusion is understandable since the policy implications derived from the concept as it was used initially (isolated physical stocks) may not give correct signals when used in the broader, economic/social system context.

For example, when physical stocks are used in an economic activity they may be maintained at their present level, increased (enhanced), or reduced (degraded). They may also be converted from one use to another (destroyed). Some environmentalists and physical scientists would argue that "maintenance" of stocks is the correct path towards sustainability. However, from a socioeconomic perspective, because of population growth, both maintenance and reduction lead to decreasing per capita availability over time. The only difference between these two options is in the rate of decline.

A further complication is that in the broader, economic/social system context, sustainability must also relate to the use of stock or non-renewable resources. Given any reasonable positive rate of use, the availability of stock resources, by definition, will decrease over time. The question is, What rate of decline is the most socially desirable? A physical definition of sustainability may well work against attainment of sustainable economic growth.

The crux of the issue appears to be the uses to which resources are put, and hence, human welfare and the sustainability of the socio-physical-economic system. However, it is difficult to say ex

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ante what would be a sustainable economic activity--it is far easier to show *ex post* what was not. (For example see Repetto, 1985.) Furthermore, sustainable *development* does not require that any particular economic *activity* continue indefinitely. In fact, it may require that structural changes eventually occur in an economy and new economic activities replace old ones. The implication seems to be that for development to be sustainable an adequate portion of any rents collected from current economic activities must be reinvested in other productive activities (rather than being "consumed").

This then raises some very interesting and fairly intractable questions which any rigorous assessment of the sustainability concept must answer. These include the following:

1) Equity, both *intra*generational and *inter*generational, may be the key question for resource management. Who benefits from and who pays for greater or lesser rates of resource use now or in the future is as much an ethical question as it is an economic or technical one. Poverty is frequently the root cause of exploitive resource use. Overfishing and excessive harvesting of forest products are two commonly observed examples of this problem. The implication is that resource issues cannot be discussed without regard to development issues. The development question thus is, How can the pressing needs of this generation be met while not leaving future generations worse off?

2) What do we leave to the future generation to ensure that they are not worse off? Should we leave the same physical stock of resources, the same amount of resources per capita, or the potential for being at least as well off in an economic and social sense as the present generation? Each of these goals will lead to a different pattern of resource use, some of which may not be "sustainable" in the physical sense.

3) To whom do we leave it? Obviously what people do today will change constraints and opportunities that later generations face. One of the most significant impacts of the current generation

will stem from our rate of population growth rather than from behavior directly related to resource use. The implication is that resource issues cannot be discussed without regard to population issues. The population question is, thus, What measures can be taken to effectively reduce the rate of population growth?

4) How far into the future do we worry about? Is our concern with next week, next year, or the next century? Each of these time horizons may lead to different patterns of resource use. Individual time horizons will probably be shorter than the preferred social time horizon. What can be done to bring individual time horizons into line with the preferred social time horizon?

5) Are there some patterns of resource use that should be accepted irrespective of the potential cost? For example, is species extinction or genetic loss always necessarily bad? Pathogens are eradicated in the wild (although specimens are kept in laboratories) because of their immediate human health effects without regard to any longer-term value they may have. Can the logic underlying this be extended to include activities which result in positive, net social welfare at the cost of extinction of a harmless or even a beneficial species? Can we define a safe minimum standard for the use of any single resource, habitat, or environment? Which of these should be saved, which could be lost?

6) The conservationist vs. possibilist debate (see, for example, Burton and Kates, 1964) rages on, and the question remains, To what extent can technology intervene in the process of development <u>vis a vis</u> resource use? The appropriate role of markets in allocation of resources is also a matter of debate. Some people argue that in the face of much uncertainty over what constitutes sustainable development and the problems with predicting the future, it is best to allow market forces

exclusively to dictate the pattern and rate of resource use. This view is flawed because of various distortions including:

- market imperfections or market failures,
- short individual time horizons,
- lack of information/knowledge,
- greed, rent-seeking behavior and other imperfections, and
- uncertainty about future developments--technology, substitutes, new needs.

In the light of these and other concerns it seems that while the concept of "sustainability" and its extension, "sustainable development," engender superficial agreement, on a substantive level each individual continues to operate on his or her own agenda. When it is applied to the management of natural resources and the environment, this concept fails to yield useful policy guidance. For example, if narrowly defined at a physical level, it produces useful, but very limited, policy results. At the broader, developmental level, sustainability is defined by the assumptions that the analyst makes, especially with respect to intra- and intergenerational equity. And, obviously, the time horizon is a critical assumption that will influence the results. The numeraire employed will also define the result. A physical numeraire does not normally provide useful policy guidance. If it is a monetary one, then many different patterns of resource use (some of them conflicting) can be defined as sustainable.

Obviously, a clarification of the concept of sustainability and/or sustainable development is important to understanding which resource questions are, in fact, critical. We understand which resources are at "risk," but do not understand whether or not they should be protected or enhanced. The broader, sustainable development concept sees resources and the environment as inputs into the complex process that generates the goods and services that enrich our lives. This view is people-driven and uses welfare as the numeraire. However, it brings up complicated, if not intractable, problems of measurement.

It would be easy if sustainability were a "motherhood" issue--easily defined and clearly desirable. Unfortunately, although there

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is near unanimity on its desirability, sustainability and sustainable development have proven especially difficult to define. If these terms are to escape becoming the empty "buzz words" of the late 1980s, careful thought must be given to clarifying their exact meaning; only in that way can they be useful as a touchstone for sound policy making. Clearly, we favor a socioeconomic definition of sustainability--one that revolves around economic well-being and retention of future options. Further debate may not settle the question of what sustainability is, but it certainly will help all who are i `ved to understand what is at issue.

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NATURAL RESOURCES AND ECONOMIC POLICY IN DEVELOPING COUNTRIES

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Abstract

This paper argues for the need to design broad economic policy instruments to reverse the trend in many developing countries toward increasing degradation and destruction of natural resources. The natural resource base, often critical for economic development, is in many cases threatened by a rapid population growth, the effect of which is compounded by inadequately controlled land and water use.

Policy interventions which have a pervasive effect must be established to influence the environmentally-related behavior of countless, relatively small-scale, resource-using activities which take place throughout a nation's economy. Natural resource management should thus become a standard element of macro-economic and sector analysis, and the physical linkages between sectors need to be critically examined.

Governments must overcome major institutional and political obstacles. New approaches, providing incentives and rewards to policy makers, must be developed to increase interagency cooperation while avoiding overlapping jurisdictions and to prevent vested interests from paralyzing new initiatives.

1. INTRODUCTION

1.1 The effects of poor natural resource management are being demonstrated dramatically in many developing countries, in which land and water resources, which are in principle renewable, in fact are declining at rates which threaten the basis upon which already fragile economies rest [11, 14, 15]. The poorest countries, which tend to be heavily dependent upon their natural resource base,

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and whose problems are compounded by relatively high rates of population growth, are the most vulnerable to the problems caused by environmental degradation, in part because shortages of capital and trained manpower severely limit their ability to switch to other economic activities when their natural resources can no longer sustain them. Moreover, it tends to be the poorest people in those countries who suffer most from environmental degradation. There are, of course, innumerable ways in which the problem is manifested, and generalizations are difficult to make. Air and water pollution are of staggering proportions in cities such as Cairo, Bombay, Lagos, Mexico City and Sao Paulo. However, it is clear that in many developing countries the most critical environmental problems are those which relate to a complex network of events involving over-grazing, commercial logging and fuelwood harvesting, land clearance, deforestation, burning of crop residues and dung, soil erosion, sedimentation, flooding, and salinization. Direct economic consequences include severe reductions in domestic energy availability and agricultural productivity, the indirect consequences having profound and far-reaching effects on human well-being. It is also clear that addressing these problems calls for approaches that question some basic assumptions about economic development, and raise generic issues including the relationships between macro-economic planning and sectoral analysis; the handing of externalities; and the welfare of vulnerable groups and future generations.

1.2 The urgency of the problem is increasingly being recognized and attempts are being made to address them. Ambitious projects are underway to plant trees where trees have been cut down; to clear dams that have silted up because of soil erosion upstream; to pump groundwater for irrigation to help stem the advancing desert; to clean up the poisoned ground and the polluted air. However, in many developing countries, the situation is clearly getting worse, and many of the efforts to remedy the situation are failing. In addition to lack of resources—poverty itself sometimes being both a cause and a consequence of environmental damage—there are a number of reasons for this, including political and financial vested interests, institutional overlaps and bureaucratic inefficiencies, and the myopic view of decision makers. But perhaps the most important reason is the sheer difficulty of dealing with a myriad of relatively small-scale natural resource-using activities which together are responsible for the bulk of environmental degradation that is taking place.

1.3 The traditional approach to environmental management is to invest in projects which have primarily environmental objectives, such as reafforestation or sewerage schemes, or to ensure that components of other projects contain elements designed to mitigate adverse environmental impacts. This essentially project-by-project approach is important, and must be continued. Alone, however, it is clearly inadequate, and needs to be supplemented by more comprehensive, wide-ranging policies. By concentrating on curative, piecemeal solutions rather than on the underlying causes, the traditional approach—in industrialized as much as in developing countries—fails to confront the real issues which have much more to do with the way society works, and less with the technical aspects of natural resource degradation. Environmentally related behavior and policy toward it is in fact at the very heart of social, macro-economic and sector policies—relating to agriculture, energy, industry, domestic and foreign investment, fiscal, monetary and trade policy, income distribution, and regional planning.

1.4 It appears, therefore, that the project-by-project approach should be supplemented by one which integrates environmental and natural resource management directly into economic and social policy. This can be done in two ways: (a) through the design of investment programs supporting environmental and natural resource objectives, and (b) through promotion of economic, social and institutional policies and incentives that influence the environmentally related behavior of government agencies, major resource users, and the countless small-scale resource-using activities which occur throughout a nation's economy. While our understanding of technical ameliorative measures is clearly not perfect, and continued efforts are needed to improve it, the foregoing also implies a need to devote much more effort to develop understanding of:

- the nature, dynamics, and severity of natural resource degradation in light of economic and social criteria, including the welfare of vulnerable groups and future generations;
- the underlying causes, both human and naturally-occurring, of natural resource degradation; and
- the range of feasible economic, social and institutional policy interventions that are appropriate to a given situation.

These issues are elaborated on in the remainder of the paper.

2. THE COSTS OF NATURAL RESOURCE DEGRADATION

2.1 National Accounts and Resource Degradation

2.1.1 The problem of inadequate land and water management is acute not only in ecological terms, but also in terms that economists habitually use; indeed the disciplines of economics and ecology should be seen as mutually reinforcing. In developing countries, the effects of high debt burdens and deteriorating terms of trade are being compounded by the severe and escalating economic costs of natural resource degradation. Nevertheless, there are abundant examples of specific environmental protection measures—both policies and projects—which show acceptable rates of return even according to narrowly defined benefit-cost criteria. In general, however, the status of the stock of renewable natural resources is rarely considered in a systematic, comprehensive way at the macro-economic level, where the major strategic planning decisions are made. It is even more rare for explicit linkages to be established between national income accounts and the renewable natural resource base upon which so many economies depend.

2.1.2 It is increasingly being recognized that conventional measures of national income, such as GNP per capita, give misleadingly favorable estimates of economic well-being or economic growth. These measures do not recognize the drawing down of the stock of natural capital (be it renewable or non-renewable), and instead account for the depletion of resources, i.e., the loss of wealth, as net income. Growth built on resource depletion is clearly very different from that obtained from productive efforts, and may be quite unsustainable. Unless net capital formation is larger than natural resource depreciation, the economy's total assets decline as resources are extracted or degraded: this appears to be exactly what is happening in many of the poorer natural resource-based economies.

2.1.3 By definition, while exploitation of non-renewables such as oil or coal involves depletion, land and water use does not necessarily do so. The complexity of the physical linkages between activities, and uncertainty as to the ability of land and water resources to regenerate, have in the past tended to mask what has been happening. Costs of natural resource depletion have not been estimated and, along with all other forms of depletion, have certainly not been reflected in national income accounts. Policy makers, relying upon GNP as a criterion for national well-being, and perhaps being overly preoccupied with short-term considerations may, therefore, have been lulled into a false sense of security. Indeed, the numbers may be large: for example, rough estimates show the economic costs of unsustainable forest depletion in major tropical hardwood exporting countries ranging from 4 to 6 percent of GNP, offsetting any economic growth that may otherwise have been achieved [7, pp. 29-31].

2.1.4 The point of the foregoing is not to suggest reform of national income accounts (although they have a number of serious shortcomings in additions to the one noted here). Rather, it is to emphasize the importance of natural resource depletion in an overall country planning context. That is to say, the macro-economic impact of natural resource utilization and depletion calls for macro-economic policies to regulate it. A critical step in this process is to refine our understanding of relationships between physical events and their economic consequences. Attempts need to be made to quantify the physical nature and extent of the degradation processes to the greatest extent possible, and to express them in monetary terms where feasible. This would help to highlight the consequences of different patterns of resource utilization for future economic growth, and provide a better basis for making strategic decisions concerning resource conservation, augmentation, or further exploitation.

2.2 The Marginal Opportunity Cost of Resource Depletion

2.2.1 A useful tool for conceptualizing, and measuring the physical effects of resource depletion in economic terms is the marginal opportunity cost (MOC). This refers to the cost borne by society of depleting a natural resource, and ideally, would be equal to the price that users have to pay for resource-depleting activities. A price less than MOC stimulates over-utilization: a price greater than MOC stifles justifiable consumption. MOC may be described in terms of its three elements [6]:

(a) the direct cost to the user of depleting the resource;
(b) the net benefits foregone by those who might have used the resource in the future (applicable to renewable resources if they are not harvested on a sustainable basis); and
(c) the costs imposed on others, either now or in the future (so-called external costs).

2.2.2 Although the concept has been extensively employed in analyzing the costs of depletable commercial energy resources, calculation of MOC is never easy [6, 7]. This is particularly true of the kind of natural resources discussed in this paper. Nevertheless, several useful efforts have been made, including estimates of the value of agricultural output losses due to deforestation or soil erosion [1], and of foregone electricity output due to dam sedimentation [13]. Of greater importance than the final result itself, however,

is the discipline that is required to painstakingly evaluate all physical interrelationships and analyze each in terms of the effects of resource use. This applies in particular to the importance of making explicit the tradeoffs or value judgments involved regarding impacts which cannot be evaluated in monetary terms. These include decisions about the income distributional consequences of alternative patterns of resource use; the impact on vulnerable groups such as indigenous peoples; the preservation of antiquities; irreversible effects; genetic diversity; and the welfare of future generations. The proportion of MOC that may be estimated unambiguously in monetary terms will sometimes be large, sometimes small; the analytical framework for arriving at the point of decision making appears, however, to be of universal applicability, and MOC may be used effectively as a benchmark to help make judgments about such things as:

- the merits of conservation or protective measures, including investments, regulations and laws;
- taxes, subsidies, and regulated prices of natural resources or their complements or substitutes.

2.3 Discount Rates, Irreversible Effects, and Future Generations

2.3.1 Economic analysis has a critically important role in determining appropriate investments and policies in the environmental area if—and only if—its limitations are recognized. In highlighting the consequences of certain events that cannot themselves be measured in monetary units, and making those consequences explicit in its own narrowly defined terms, economic analysis may be an indispensable aid to good decision making, but it may fail as a discipline if it is pushed too far.

2.3.2 This is illustrated very well in the treatment of equity considerations, of which the welfare of future generations is a special case. It is often claimed that traditional benefit-cost analysis fails in that discount rates used are too high, resulting in inadequate weight being given to the costs of resource depletion or the benefits of conservation measures to future generations. In fact, manipulation of discount rates is not the answer, for it is inconceivable that one could arrive at a discount rate which satisfactorily reflects—all in one number—the various value judgments and technical parameters (e.g., private and social time preferences; welfare of future generations; productivity of capital; economic growth and savings rates) that are involved. It is much too blunt an instrument for that.

2.3.3 There are circumstances in which intertemporal choices can be made quite satisfactorily by the use of discount rates which reflect the returns to capital in alternative uses based upon fairly short-run market criteria. This applies where there is no reason to expect one generation to be very much worse or better off than another, or where irreversible effects are not involved. Gains resulting from projects or activities which pass standard economic tests could, if future societies so choose, be reinvested for the benefit of generations still further in the future. In these circumstances, MOC alone, using market-based discount rates to estimate future costs and benefits, may be used as an adequate benchmark to evaluate investments or policies. However, where irreversible effects (not an unambiguous term, but one which certainly includes elimination of species and any loss of human life, and probably includes desertification) are

involved, or where future societies are expected to be significantly richer or poorer than the present one, MOC must be supplemented by analysis—possibly quantitative, certainly rigorous—of likely physical and income distributional consequences. The massive uncertainties involved in making predictions about events that will take place many years hence should not deter us from taking such analysis at least as seriously as we now take conventional benefit-cost analysis.

2.3.4 The future generations issue is important, not only in itself, but also because it is a good illustration of the role and limitations of economic analysis in natural resource management. In practice, however, we should not allow it to obscure or become an obstacle to the resolution of more immediate environmental concerns. The urgent problems of the Sahel, for example, suggest that priority should be given to resource management, including the treatment of lateral externalities, which have an immediate impact: irreversible effects are already taking place, and the welfare of future generations will largely depend upon measures which improve the well-being of those now living.

3. THE CAUSES OF NATURAL RESOURCE DEGRADATION

3.1 Physical and Behavioral Linkages

3.1.1 The MOC calculation requires a systematic effort to trace through the often highly complex interrelationships between resource-using activities. The underlying causes of environmental degradation may often be related to activities that at first sight are very remotely connected to the observed effects. If project and policy measures are to be viable, they should clearly be based upon a sound understanding not only of the physical linkages between events, but also the equally complex economic, financial, social and institutional linkages which parallel them. Much work needs to be done in this area: in spite of the massive literature on the physical linkages relating to natural resource degradation, relatively little attention has been given specifically to those points in the series of interrelated physical events where institutional or individual behavior plays a key role, and therefore where policy interventions might be feasible.

3.1.2 This requires still further refinement of our understanding of the magnitude and extent of the interdependence between man-made activities and natural resource systems, e.g., between deforestation, land clearance, over-grazing on the one hand, and soil degradation and erosion, watershed destruction, and sedimentation on the other. Efforts should be made to quantify the impacts at each stage of the interlinked ecological and economic system in physical and/or monetary terms in order to determine the points in the system at which it would be most socially profitable to intervene by way of explicit policy measures. One of the essential elements of this exercise would be to separate out the contribution to environmental degradation brought about by naturally occurring events, which, particularly when compounded by human activities, may often dwarf the impact of human activities alone.

3.2 Improvement of Physical Data

3.2.1 Establishment of the link between economic—particularly macro-

economic—analysis and environmental considerations has in the past typically been frustrated by the inadequacy of physical data. This situation is changing rapidly: recent developments in geographic information systgems allow us better than ever before not only to assess current natural resource endowments and trends in use, but also to better project future endowments under various scenarios of economic growth and sectoral output. In particular, in assessing physical linkages and long term trends, remote sensing from space may offer the benefit of a broad synoptic view, repetitive coverage, and uniformity with respect to the way information is collected. Combined with traditional methods of collecting physical data, and by integrating such information with socio-economic data—on population, land tenure systems and so forth—these developments suggest that systematic linking of macro-economic and resource planning can indeed become a reality. Economic planners, therefore, have a major role in helping to ensure that the collection and analysis of technical information is well focussed, and geared to operational or policy requirements.

3.3 Improved Understanding of Behavioral Factors

3.3.1 Along with better understanding of physical data, we also need to develop a better understanding of individual and institutional behavior as it relates to resource use. This requires very much of a multidisciplinary approach, and analysis of causes that are even more fundamental to the way society works than those already discussed. The range of variables that potentially affect environmentally related behavior is awesome. Taxes, prices and subsidies relating to agriculture/forest products, their substitutes and complements; exchange rate policy; income distribution, land tenure and property rights arrangements; the government and private sector institutional structure; population pressure; educational levels in general, and of women in particular; and the political power structure may all play a role in determining the rate of environmental decay [10, 7]. In addition to the range of expertise in the physical sciences, determination of policies, therefore, calls for the involvement of the economist, political scientist, sociologist, and anthropologist, as well as for legal and institutional expertise.

4. POLICY INTERVENTIONS

4.1 Project and Policy Interventions

4.1.1 As noted, the traditional approach to environmental problems is for public authorities to engage in projects such as reafforestation and pollution control, which are aimed at remedying past abuse of the environment, or to prevent degradation by building ameliorative components into industrial projects or irrigation schemes. The kind of technical, economic and social data, and the nature of the value judgments needed to make sensible decisions about such investments is also required in designing policy interventions. The kinds of empirical and conceptual problems encountered in determining appropriate economic incentives parallel very closely those related to the conduct of benefit-cost studies, and estimation of MOC is equally important in project as in policy analysis. In one area, however, the design of policy interventions is more complex than project analysis: while the success of projects rests heavily upon behavioral issues, the success of policy interventions depends even more heavily upon them, and in particular upon the prospects for changing them.

4.1.2 Much work also needs to be done in this area but already considerable evidence exists which gives grounds for optimism as to our ability to make concrete recommendations about policy interventions. Examples abound of instances in which government policies, typically in the form of direct subsidies to environmentally harmful activities, are also unwarranted even in narrowly defined, traditional economic terms. This is particularly true with regard to forestry policies, and to a variety of subsidies used in developing countries to encourage agricultural and forestry activities [8, 10].

4.2 Agricultural Pricing Policies

4.2.1 Governments throughout the world intervene in agricultural pricing markets, primarily in order to keep domestic foods prices low. A variety of direct and indirect interventions are used, most of which tend to reduce agricultural incomes and the ability to invest in conservation measures. The influence on the very poorest farmers may be particularly adverse: extremely low incomes and urgency of short term needs, implying high discount rates, make investment measures required for sustainable output particularly difficult to achieve. Although important examples exist where, because of externalities or adverse income distributional effects, government intervention may be required, in general the freeing up of agricultural markets, permitting prices to approximate international levels, tends to be consistent with environmental objectives as well as with traditional, relatively narrowly defined, economic ones.

4.3 Elimination of Subsidies

4.3.1 Governments, in part to compensate farmers for keeping output prices artificially low, frequently offer a variety of subsidy programs. Many of these are harmful environmentally, and incorrect even in standard economic terms. Thus, encouraged by subsidies, excessive use of pesticides has led not only to increased exposure of individuals to toxic substances, but also to the emergence of more resistant strains of mosquitoes and to a resurgence of malaria in many parts of the world. Resistance of other insects to pesticides is also growing, and net economic losses—even in the short term—may be a direct consequence of subsidies [9]. Returns have frequently been found to be higher when use is made of integrated pest management practices, involving minimal applications of pesticide, combined with more resistant crop varieties and naturally-occurring pesticides. Similarly, subsidies for livestock production in the form of credit at preferential rates, tax holidays, and land concessions, have often resulted in production that is justified neither in economic nor in environmental terms [10].

4.3.2 Governments have also frequently established inappropriate forest revenue systems in which concessionaires do not cover the replacement costs of exploiting forest resources. A variety of subsidies and tax concessions are used, including free provision of infrastructure, such as roads and port facilities; reduced or waived export taxes on processed wood; subsidized credit and export financing; tax holidays and unlimited loss carry-over provisions; and concessional leases [2, 10]. These subsidies encourage over-exploitation, problems being compounded by the existence of short-term leases (sometimes for as little as one year), which encourage concessionaires to exploit forests without concern for

future productivity. In a number of countries, property rights are automatically conferred upon those who clear the land and use it, thus providing further incentive not to leave standing forest untouched [8]

4.3.3 There are many more examples of incentives that lead to natural resource degradation. Typical means of providing irrigation water, for instance, tend to encourage wasteful use. Introduction of user charges covering full economic costs, rather than simply operating costs, may do much to improve the situation [12]. We perhaps accept too readily the argument that the administrative difficulties of charging for irrigation water on the basis of use presents an insuperable hurdle. Pricing of electric power is another interesting and illustrative case: typically, governments require consumers of electricity to pay charges which cover the financial costs the utility incurs. These costs, however, frequently underestimate economic and social costs; they would be lower than MOC, for example, to the extent that future exploitation of resources costs more than previous schemes (typically true of hydro systems), or that the pollution costs are not fully borne by the utility. Subsidy may be said to exist if the price paid for publicly provided goods or services is less than MOC; it will often be the case that increasing prices beyond those required to meet the financial objectives of power utilities will improve the efficiency of resource utilization and do so in a way that enhances environmental objectives.

4.3.4 The foregoing examples have a common characteristic: they all represent cases in which government policies have perverse effects in both environmental and standard economic terms. They also represent fairly direct incentives for wasteful environmental management. Greater reliance upon natural market forces and removal of the distorting influence of government interventions will in these instances be the appropriate policy stance. Determination of the appropriate policy prescriptions is such cases is, in principle, straightfoward, although, since vested interests are involved, implementation may be more difficult.

4.4 Externalities, the "Commons" Problem and Naturally-Occurring Events

4.4.1 Quite appropriately, the emphasis of policy reform in the agriculture and natural resource sector in recent years has stressed the importance of bringing about greater reliance upon market forces to provide correct signals to producers and consumers. However, the free market is a good servant but a bad master; it is characteristic of environmental problems that they frequently cannot be automatically resolved in an efficient or equitable manner by unregulated market mechanisms, which leaves no alterna-tive to some form of public intervention. Indeed, the subsidies referred to in the preceding paragraphs might justifiably be replaced by taxes.

4.4.2 Central to the natural resource management issue is, of course, the presence of external effects; thus it is frequently in the private interest of individuals to act in such a way that costs are imposed upon others, who are in no position to demand compensation. Examples are legion: the complex physical linkages between various types of resource-using activities referred to earlier typically imply a series of external effects that can only be controlled by government intervention.

4.4.3 Interference with market processes is currently a somewhat unfashionable cause to advocate, but examples of situations calling for it are abundant: for example, the "commons" problem, in which exploitation of a resource—for example grazing land—may continue to appear profitable for additional users, while actually being disastrous for all, frequently warrants public intervention. Common ownership does not necessarily imply inefficiency: tribal ownership of property in regions with stable populations is frequently characterized by sustainable farming methods [7]. The most serious problems tend to be associated with the use of land or other resources for which ownership is not clearly defined. Measures designed to induce prudent management of such communal resources may include physical restrictions, pricing policies, or the introduction of a variety of property rights, land tenure and leasing arrangements. The financial and technical assistance and water rights protection given to private pastoral associations in some Western African countries is an example of public interventions aimed at the "commons" problem.

4.4.4 There are a number of types of incentives to deal with externalities, some of which may involve extremely indirect methods. For example, a tax levied on livestock production might reduce over-grazing, leading to a reduction in land clearance, and by stemming the rate of soil erosion, exert a beneficial influence on agricultural productivity many miles away. Ideally, the tax should be such that the livestock producer faces total input costs equal to the MOC of his activity, which is determined, inter alia, from the effects on soil erosion and consequent impact on agricultural output elsewhere in the system. Export taxes on logs; taxes or subsidies varying by crop, according to their soil conserving characteristics; subsidization of energy-efficient wood stoves or of kerosene; are further examples of possible interventions that call for careful weighing of costs and possible perverse effects against the economic and environmental benefits that might result.

4.4.5 Finally, public intervention may be required to manage or ameliorate the effects of naturally-occurring resource degradation, including both catastrophic and more gradual events. Measures should be designed in light of the costs and benefits (broadly defined) of the ameliorative action. The contribution to damages made, respectively, by natural forces and by human activity, needs to be disentangled, and the set of incentives or other policies designed accordingly. For example, avoidance of flooding caused by naturally-occurring soil erosion and sedimentation might be assisted by incentives to induce industrial or residential location in less damage-prone areas; on the other hand, to the extent that commercial logging is responsible, the focus should be on incentives designed to improve the management of forest resources.

4.5 The Administrative Costs of Incentive Systems

4.5.1 One of the basic arguments in favor of an approach to natural resource management which relies upon pervasive incentive systems is an administrative one. The costs of trying to deal with widespread environmental degradation on a case-by-case basis, relying upon a benefit-cost approach at the conceptual level, and regulation or policing at the practical level, are likely to be excessive. However, the design and implementation of incentive systems is also not costless, for all, to a greater or lesser degree, involve monitoring, policing, and regulation. A system of stumpage fees, for example, may require

extensive monitoring; irrigation water charges may need metering; the bureaucratic and legal costs of administering land reform schemes may be overwhelming. The decision as to whether or not a system of incentives (or indeed, regulations) is worthwhile may be assisted by (and subject to the usual limitations of), a benefit-cost approach. The cost of the incentive system itself, say the cost of measuring water consumption and collecting fees from water users, should be compared with the estimated benefits, i.e., the savings from the change in resource use resulting from the introduction of the incentive scheme. The magnitude of the savings would depend upon the reaction of the users to the price change (price elasticity of demand), and the MOC of the activity to which the incentive scheme is formally applied.

5. THE NEED FOR PARALLEL ACTIONS

5.1 Distribution of Income and Wealth

5.1.1 The types of intervention discussed in the previous section, some quite direct, some less so, could all conceivably be introduced within existing social and institutional systems. Other influences are also of critical importance but represent more fundamental characteristics of the societies concerned, and therefore are likely to be much more difficult to change. One of these is the great inequality in income and wealth that tends to characterize many developing countries. This is often reflected in an extremely skewed distribution of land which in itself may be an obstacle to sound natural resource management.

5.1.2 As population pressure grows, the poor tend to be pushed onto areas with low agricultural potential and which are frequently ecologically sensitive (semi-arid savannas, erosion-prone hillsides, tropical forests). The situation is aggravated where large farmers respond to growing pressures to expand primary commodity exports and thus to enlarge the areas on which cash crops are grown. At the same time, there is evidence that the large landowners—particularly those engaging in monoculture—do not protect the quality of their land and soil as much as do small farmers who own their land [7, pp. 48-56]. Intuition also suggests, although hard evidence is not conclusive, that security of land tenure exerts a positive influence on conservation [3, 7, p. 46]. Having inadequate control over the land they farm, and little political weight, also means that the poor cannot easily obtain the capital and external information and technology by means of which they could reverse their plight.

5.1.3 While the issue of land reform is central to the question of natural resource management, it is also, of course, one of the most difficult to deal with. In developing countries the relevant decisions are frequently made by a small, politically influential group with interests in commercial logging, ranching, plantation cropping, and large-scale irrigated farming operations. As a result, the prevailing systems of investment incentives, tax provisions, credit and land concessions, and agricultural pricing policies tend to favor those in power, causing losses for the economy as a whole, and at the same time damaging the environment and natural resource base.

5.2 Institutional Structures

5.2.1 Another obstacle to improvement in natural resource management

may be the government institutional structure, in which the activities of public agencies may impinge on parties whose welfare is of no concern to them. For example, the costs of a hydroelectric scheme to farmers or indigenous peoples may not be adequately taken into account by a power utility; flooding downstream caused by a river development scheme may not influence a provincial government if the damage occurs outside its borders. Coordination and control of natural resource use in order to handle external effects, in particular to impose systems of incentives which impact on several sectors, may require the creation of new agencies with wide-ranging authority over certain aspects of the operations of functional ministries within a particular region. It also requires incentives to induce public servants to act in a way that is in accordance with the common good, as well as with the goals of their own agencies. The complexity of achieving such changes is obvious, but this represents one of the most important public sector management issues facing developing countries today.

5.3 Population

5.3.1 It is generally accepted that population pressure is one of the root causes of poverty in general and of natural resource degradation in particular. Accordingly, the success of economic and other incentives will depend in large part upon the success of family planning and other population-related policies. For the purposes of the present discussion, there is little to add: virtually all governments recognize the problem of population growth, and major efforts are being made on both the supply side—provisions of family planning facilities—and on the demand side—primarily by education—to address this fundamental issue. Economic considerations, whether we like it or not, play some role in individual decisions about family size and spacing; the role that governments should play in influencing choice by economic incentives or other means is a highly controversial subject, which goes well beyond natural resource management issues.

5.4 The Role of Women

5.4.1 One aspect of the population issue which does concern us directly is the role of women as household and small farm decision makers. In many developing societies, women carry the major burden in supporting the household, and in performing agricultural work [5, 7]. Without their involvement, natural resource related policies are unlikely to succeed. In Africa, about 80 percent of subsistence agriculture is carried out by women; men increasingly are involved in attending to cash crops or have migrated to urban areas. Women normally do not have title to land, nor adequate access to credit. They may, therefore, be in no position to take the steps necessary to protect the quality of the land and water resources within their control. The fact that women generally also have less education than men compounds the problem. Equality of educational opportunity; of land ownership; and of access to credit are, therefore, required if decision makers at the household and small farm level are to be able to respond effectively to incentive systems.

6. CONCLUSION

6.1 Approached from the perspective described in this paper, an agenda for action is emerging; economics has a major role to play in bringing together and

mutually reinforcing environment and development. On the basis of broad natural resource assessments, economic tools may be employed to help determine the desirability of environmentally related projects, and their design and location. Economic analysis is then vital in pinpointing the need for new incentives, or the removal of misguided existing incentive systems. Used properly, economics can identify the policy instruments which are necessary if sustainable development is to be achieved.

6.2 At the same time, the broader policy focus requires that the traditional economic approach be reassessed, and that methodologies be improved and refined. In fact, much could be gained if the tools and concepts already offered by economic theory were to be applied systematically and correctly. Economic analysis must avoid taking a static view, focussing instead on the dynamic nature of the complex environmental and natural resource problems with their multitude of linkages and indirect effects. Many of these effects either show up at far-away locations (e.g., downstream effects), or in the distant future (e.g., gradual depletion of soil nutrients), posing a major challenge to economists who must learn first to understand the many co-evolutionary processes—the physical interactions plus the human impact—and then to apply suitable economic methods.

6.3 Moreover, if economic methods are to be successful, it is crucial that their limitations be understood and continually kept in mind. In particular, it should be recognized that value judgments about distributional and irreversible effects are unavoidable, but quantification in monetary terms of as many variables as possible is important in crystallizing those issues involving implicit value judgments which may otherwise be ignored.

6.4 Economic assessments and projections will necessarily be fraught with massive uncertainty, given the complexity of the various physical and behavioral linkages involved in natural resource management. This makes it imperative that economists recognize the technical limits of their profession and collaborate actively with specialists in many other areas, including: engineers, agricul-turalists, natural and social scientists, lawyers and management experts. This is, above all, an activity that calls for a multi-sectoral and multi-disciplinary approach.

6.5 An agenda for action, to be developed at the individual country level, should consist of work in the following areas:

- assisted by new technologies, assessment of the existing natural resource base, trends and patterns in resource utilization, and prospects for the future under various scenarios of economic growth, by major sector;
- to highlight the magnitude of the problem, estimation of the impact of resource depletion on net national product;
- estimation of the economic and social consequences of major categories of resource use, based upon the MOC framework;
- use of such information to make judgments about the merits of resource conservation, augmentation or further exploitation strategies at the country planning level;
- in light of the foregoing, identification of investment programs,

and areas where widely impacting interventions need to be introduced;

- elimination of those government policies which are clearly perverse, not only in narrow economic terms, but also in terms of their direct environmental impact;
- design and introduction of more complex interventions, calling for incentives—price, tax and subsidy policies—which have an important, but often indirect impact on resource use, and which address externalities and the "commons" problem;
- continued efforts to address major underlying causes, not only of natural resource degradation, but of development problems generally, including: income and land distribution; population growth, education and the status of women; and institutional reform.

6.6 The logic underlying the above agenda is applicable to the handling of environmental problems in general, and is clearly consistent, example, with some of the arguments used to justify the "polluter-pays" principle [4]. The experience of developed countries in trying to get to grips with industrial pollution provides no grounds for complacency about the task that lies ahead: indeed, a massive effort—analytical, empirical, and persuasive—will be needed to implement the agenda. However, there are feasible ways of integrating natural resource issues into economic planning at the national level and, therefore, to give "equal time" to environmental concerns. It has been noted that the case for certain types of intervention is fairly straightforward; their impacts will be direct, and easily justifiable in conventional economic terms as well as being environmentally beneficial. Given progress in these areas, there are grounds for optimism that more ambitious steps, involving the design of more complex, indirect interventions, and even of policies which address the underlying causes of natural resource degradation, will also be successful.

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Wrap-up of the 100th Congress

SPECIAL TOPIC

Sustainable Agriculture in developing countries

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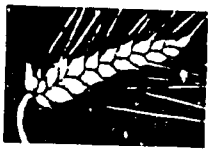

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THE INTERTWINING OF ENVIRONMENTAL PROBLEMS AND POVERTY
By John W. Mellor

In developing countries, poverty and environmental degradation are caught up in a "Catch 22" cycle of cause and effect. Breaking this cycle will require improved infrastructure, health care, and education; fair and stabilized commodity prices; and, above all, large scientific and financial investments by developed countries.

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MOVING TOWARD SUSTAINABILITY: BUILDING THE AGROECOLOGICAL FRAMEWORK
By Peter A. Oram

Most work toward agricultural sustainability suffers from the lack of systematic integration of knowledge from different scientific and socioeconomic disciplines. Only through such a system of integration, called agroecological characterization, will agricultural sustainability be achieved.

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IMPROVING SUSTAINABILITY WITH AGRICULTURAL RESEARCH
By E. T. York, Jr.

International agricultural research centers have greatly contributed to progress toward agricultural sustainability through studies of farming systems, crop genetics, pesticides, irrigation, animal traction and husbandry, soil nutrients, erosion, socioeconomics, and agricultural policies. Still more progress must be made, and all agricultural research should embrace sustainability as a fundamental precept.

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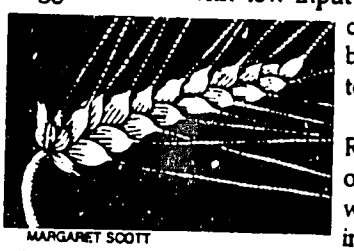
Sustainable Agriculture in developing countries

Agricultural sustainability and ecosystem protection have recently taken center stage in international aid and development programs. In both developed and developing countries, people are more aware of serious environmental deterioration and wrestle with complex tradeoffs and choices necessitated by conflicting objectives. Now, a beneficial partnership between rich countries and poor might pursue our common environmental goals. However, the quick succession of developmental assistance fads in the past two decades suggests that present environmental concerns may also fade away, leaving wasted money, wasted time, and lost momentum in their wake.


MARGARET SCOTT

To seize this opportunity for partnership, aid organizations must understand the different cultural, economic, and ecological circumstances that drive environmental concerns in developing countries as compared to those in developed countries. To oversimplify: The assault on the environment in developed countries arises from wealth, while in developing countries ecological destruction is perpetuated by poverty; for the most part, environmental problems in developing countries are rural problems of rural people. The great diversity in ecosystems is complex, and obviously different agroecological zones demand different solutions. Developing countries particularly lack strong foundations of agricultural science and environmental analysis. The need for research to solve current and future problems is acute.

The following three articles treat these pressing issues. "The Intertwining of Environmental Problems and Poverty" (on page 8) discusses how extreme poverty determines the societal objectives within which environmental concerns must fit, why certain problems receive unequal consideration in rich and poor countries, and why rich nations must share the burden of environmental research and protection. "Moving Toward Sustainability: Building the Agroecological Framework" (on page 14) describes the complexity of development issues and pleads for rapid increase and integration of all data on agroecological zones. This work would allow us to ensure food security for future populations and simultaneously preserve our environment. Sustainable agriculture is in no respect synonymous with low-input agriculture. Only with an understanding of diverse agroecological zones can we meet burgeoning food needs by tuning input levels to individual agroecosystems.

"Improving Sustainability with Agricultural Research" (on page 18) spotlights our ignorance of rural environmental solutions. It describes the wide range of projects covered by and the role of international research systems. The research described reflects the urgency of our needs and the parlous state of our present knowledge, which engenders ill-advised attempts at sustainability in fragile environments.

Developing countries encompass 82 percent of the world's population (this proportion continues to grow rapidly), 60 percent of the world's land area, and virtually all of the unadulterated ecosystems such as tropical forests and savannas still rich with flora and fauna. Yet already some of these ecosystems are beginning to suffer some of the environmental onslaughts of wealthier nations, even as the abuses of poverty overwhelm their ecological equilibriums. Will the wealthy countries understand developing countries' complex objectives, constraints, and needs? Will they join in relevant, thoughtful partnerships, or will potentials go unused or perhaps misused through ignorance and arrogance?

—*John W. Mellor*

The intertwining of

Environmental Problems and Poverty

By John W. Mellor

In developing countries, environmental problems and poverty are inseparable. At least three-quarters of a billion people in these countries cannot afford sufficient food to maintain minimum activity levels for healthy, productive lives. Such extreme poverty is especially prevalent in rural areas; in Asia and Africa, 80 to 90 percent of the poor live outside cities. Even in Latin America, the countryside is home to 60 percent of the poor. Half of these rural poor live on resources with the potential to increase substantially production and income in environmentally sustainable ways. Increasingly, however, as development raises incomes in these countries' more productive regions, rural poverty concentrates in environmentally fragile areas.

The rural poor largely depend directly or indirectly on agriculture and therefore on the environment for their income. As a result, environmental problems are inextricably linked with the problems of growing populations. Increasing numbers of people survive by subsistence farming, growing just the crops they need to eat to survive. The growing population also forces land appropriate only to perennial crops, such as tree crops or grasses, to be farmed for annual crops, particularly food crops, which the soil cannot sustain indefinitely. Thus environmental preservation depends on a complex interaction of income and population pressures that contribute to both environmental and agricultural instability.

As leaders of developing countries work to preserve their environments and eliminate poverty, they face several difficult questions. First, they must determine what environmental damage is irreversible and how much damage they can afford to tolerate for their citizens'

Erosion and inadequate irrigation on terraces, such as the ones in Nepal pictured far right, pose constant challenges to local farmers.

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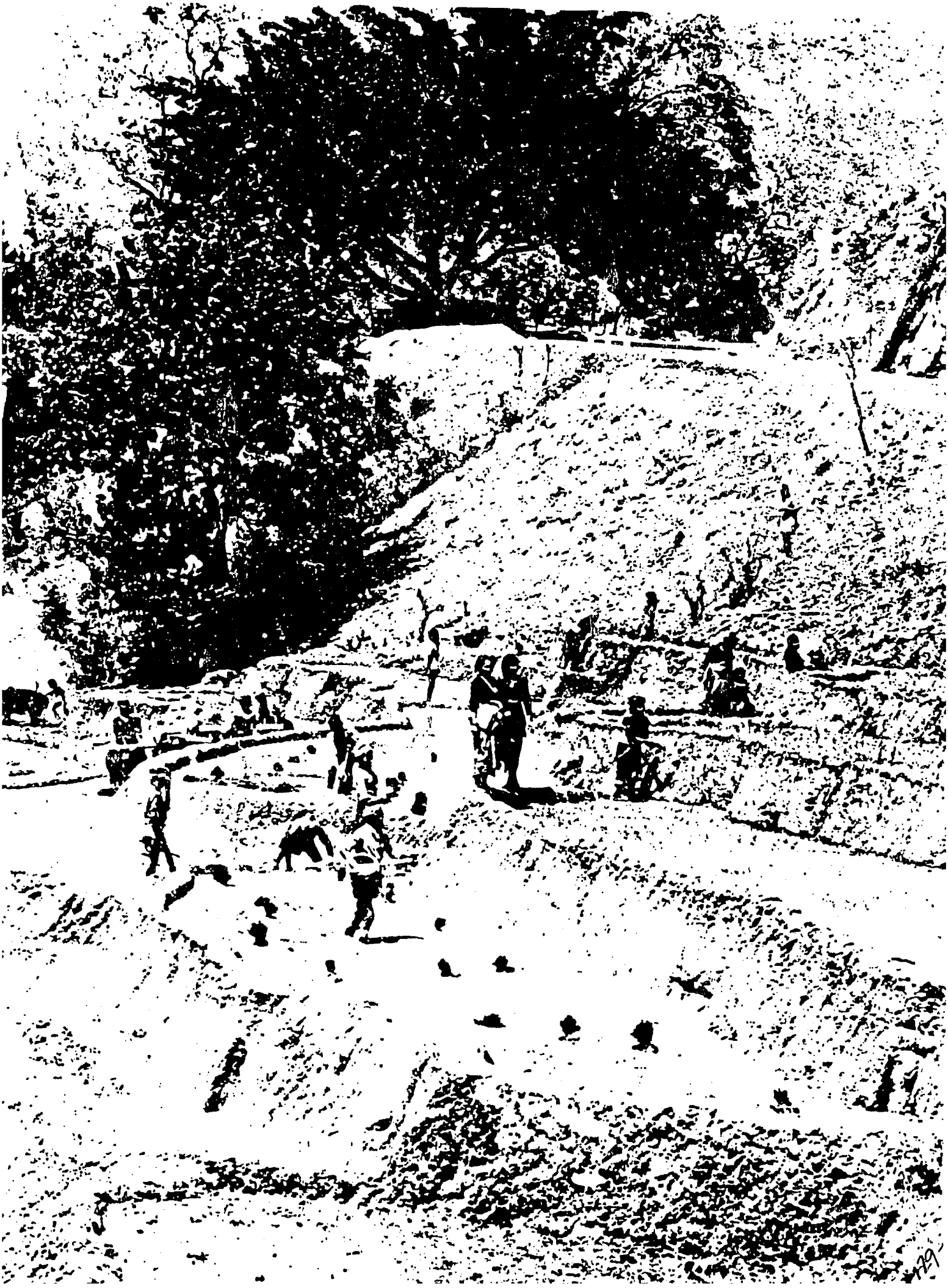


current well-being. They also must consider to what extent environmental destruction impedes their ability to ensure the well-being of future generations. In other words, people in developing countries are forced to decide how much of the future they can or must give up to ensure today's survival.

Meanwhile, the people of developed countries also must ask important questions: How does environmental damage in developing countries affect the quality of life? How much will it cost to contain the damage? What common threads connect concerns about poverty and the environment? Should concerns be focused locally, nationally, or internationally? Considering the unequal distribution of wealth around the globe, does not the universal concern for the environment require payment not only commensurate with the damage done, but also with the ability to pay? Should the richer nations provide financial assistance to the poorest people of the poorest countries to assist their progress toward sustainable, self-reliant growth to reduce environmental stress?

It is important to note that the environmental destruction in developed countries is immensely more threatening and costly than that in developing countries and has yet to be tackled adequately. Environmental destruction in developing countries mostly affects the people of those countries, whereas the destruction wrought by the rich countries—for example, destruction of the ozone layer and air pollution that causes the greenhouse effect—has major consequences for *all* the world. Nevertheless, developed countries must not forget about the environmental problems of developing countries.

Many less developed countries are falling into the extreme poverty associated with rapid population growth, poor nutrition and hygiene, and low levels of education. All these trends make population control and environmental programs less effective. As a result, environmental exploitation and abuse are increasing in ever more damaging ways. Developed nations have a responsibility to help them break this cycle and replace it with an agenda that ensures sustainable population patterns, improved education levels, and increased production and employment rates.[1]

Population and Income

The most pervasive manifestation of environmentally destructive poverty in developing countries is the dangerous exploitation of fragile resources by burgeoning populations. Deforestation and cultivation of easily eroded land and overgrazing of natural pastures are the most obvious examples. In South Asia and other developing regions, half of the poor occupy one-quarter of the land area that could most easily be developed with high-yield crop varieties. However, as the incomes of people raising high-yield crops on fertile land rise, rural poverty is progressively concentrated in pockets of land less responsive to high-yield crops. (See the box on this page.) Within growing populations, farmers are rarely able to increase the sizes of their farms; even if they do, their incomes do not necessarily rise proportionally with the extra land and effort involved. For instance, in Bangladesh the growing population has forced a decline in farm sizes, shrinking opportunities to expand income (see Figure 1 on page 12). As agricultural productivity declines, the land loses its ability to sustain a growing population, and pressures on the forests increase. With shorter crop rotations and subsequent soil erosion, incomes decrease and destabilize. In bad years, incomes in Bangladesh fall to the lowest level of poverty, which forces people to destroy more of the physical environment to provide short-term survival. This year, distant, upstream deforestation greatly increased the ferocity of floods inundating highly productive soils.

The forces of population and poverty can also be seen dramatically at work in the hill regions of Nepal. With few advances in available agricultural technology for the relatively favorable lowland soils, Nepalese farmers cannot maintain their incomes as the population rises and farms become smaller.[2] Farmers are forced to clear and crop the hillsides. Cultivating this less productive land exacerbates soil erosion problems on the hillsides and may flood and pollute the lowlands. In fact, between the late 1960s and early 1980s, the forested area in Nepal's hills dropped from between 55 and 60 percent, depending on specific location, to 40 percent of total area. The tree cover shrank even more substantially when the remaining forest was thinned. In contrast, the area under agricultural production expanded from between 15 and 35 percent to far more than 40 percent during that same period.

Nepal's forests have been pushed so far back from rural populations that it takes, on average, 1.4 additional hours each day for women to collect firewood and fodder than it did just a decade ago.

LAND CAPACITY AND ENVIRONMENTAL FRAGILITY

Environments vary greatly in their ability to sustain a high level of agricultural productivity. Parts of Western Europe, the Ukraine, the corn belt of the United States, the Nile delta of Egypt, the Ganges flood plain of southern Asia, and the rice bowl of Southeast Asia are areas that, while not without problems, have large populations without massive problems of environmental degradation. Most of these regions have alluvial soils and relatively stable climates. Other environments, extremely fragile under agricultural use, have various combinations of difficult soils, climates, and topographies compounded by mismanagement. Soils in tropical rain forests are often extremely acidic and subject to severe erosion and loss of organic matter once the tree cover is removed. Upland watersheds are also erosion-prone, when steep slopes are cultivated without conservation measures, causing silting of dams and flooding in adjacent lowlands. Light-textured soils in semiarid, marginal areas, when cultivated and overgrazed, are vulnerable to wind erosion and desertification. Poorly drained irrigated soils in arid lands easily become waterlogged and saline, unfit for continued cropping. Some countries like Bangladesh have constraints imposed by seasonal monsoons or floods and droughts.

—*Peter A. Oram*

In Java, Indonesia, as in many areas of the world, extensive soil erosion caused by indiscriminate deforestation is a problem. (Photo: H.Null—FAO)

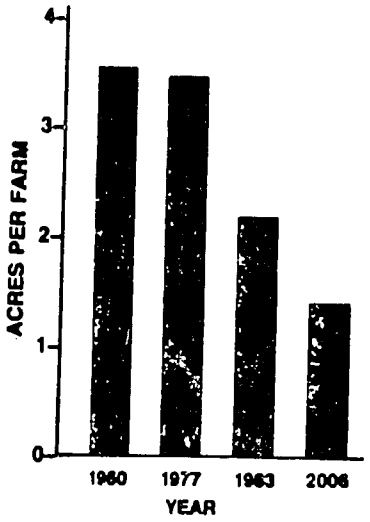
Farmers are forced to clear and crop the hillsides. Cultivating this less productive land exacerbates soil erosion problems on the hillsides and may flood and pollute the lowlands.

The extra hours are taken, in part, from women's work time in agricultural production, reducing total farm labor by as much as 24 percent per household and thus lowering household productivity. By lowering agricultural productivity, this deforestation has reduced food consumption on average more than 100 calories per capita per day. In addition, time for food preparation and child care have also been lost; this loss furthers the decline in nutrition, especially for children. Expanded planting on hillsides shifts cropping patterns away from rice and other high-quality calorie sources, reducing the nutritional content of the families' diets even more. The combined effect is a downward spiral of incomes and health, as malnourished individuals are less and less able to overcome the problems caused by deforestation.

To relieve population pressure on the environment in developing countries, population control must be combined with increased intensity of land use in high-potential agricultural areas. Therefore, a long-term strategy for poverty abatement must be planned and should include an adequate agricultural research and extension system that can develop new, high-yield crop varieties for developing countries' flat valleys. This new technology will allow farmers to increase their productivity by intensifying production so that they can feed more people on less land and earn higher incomes. Larger incomes will also help create the social environment within which other measures can effectively reduce population growth.

Intensified agriculture on good land will also relieve population pressures on more fragile lands. Increased farm incomes allow people to spend more on goods and services that are produced in labor-intensive ways in nonagricultural sectors and on labor-intensive agricultural commodities that are less harmful to the environment. As their incomes rise, farmers typically spend about 40 percent of their additional income on locally produced, labor-intensive, nonagricultural goods and services.[3] They spend another 20 percent on livestock and horticultural commodities. Therefore, in a

FIGURE 1. Average farm size in Bangladesh in 1960, 1977, 1983 and projected to 2006.



SOURCE: R. Ahmed, "A Structural Perspective of Farm and Non-Farm Households in Bangladesh," *Bangladesh Development Studies* 55 (June 1987):87–112.

country like Nepal, more land could be planted with perennial tree crops such as fruit orchards, which preserve the hillsides, and more land could be accorded to perennial grasses to feed more livestock. Thus, higher rural incomes are conducive to more environmentally sound land use.

Important environmental tradeoffs occur under the pressures of population growth and falling per capita incomes. For instance, to maintain their incomes, farmers must often clear more and more land. One way to overcome this kind of tradeoff is to increase fertilizer use on lowland areas, which boosts productivity and helps to prevent cultivation on hillsides. These efforts require cheap, reliable fertilizers and crop varieties that respond to increased fertilizer. Today, these fertilizers can be produced most cheaply from the vast quantities of gas that are going to waste in the Middle East and the Soviet Union. The question remains how those gas resources can best be mobilized to protect the even more easily exhaustible land resources.

The effects of poverty on the environment are endlessly complex. Thomas Reardon of the International Food Policy Research Institute points out that in the Sahel of Burkina Faso, with highly variable crop production, households have developed complex mechanisms to lessen extreme variations of income. For instance, in economically good times, livestock numbers rise well above the range carrying capacity of the Sahel. In these circumstances, foreign assistance increases income, livestock numbers, and therefore environmental degradation. Thus incomes rise but people's food security problems are not properly addressed. Providing food security requires greater integration with the outside world and effort by the international community. In contrast, on Burkina Faso's somewhat rainier Mossi plateau, poverty is more intense than in the Sahel, and higher incomes often lead to investment in bunds and other land-protecting devices. Even for such village-level cooperation, the investment structure needs to be reviewed and funds channeled effectively. Peter A. Oram in "Moving Toward Sustainability: Building the Agroecological Framework" treats the important issue of how to classify the agroecological conditions to facilitate those investment decisions (see page 14).

As the complex relationships between technology, input intensification, and environmental preservation are examined, the importance of commercialization and infrastructure to the environment becomes apparent. Land resources in developing countries are very diverse; optimal land use requires growing a wide variety of crops. However, marketing this variety of crops requires demand for those crops, which in turn requires higher incomes. To achieve higher incomes and the trade associated with diversity, low-cost transport is necessary. If people are to diversify their agricultural strategies enough to preserve the land, there must be broad demand for the products. Such demand cannot occur when incomes are at the minimal survival levels. For example, hill lands must generate income from perennial tree crops. The demand for these crops must come in part from local areas, but the income to buy the crops requires intensification of agriculture on other land. In part, the demand must also come from outside.

Increasing income and demand requires commercialization and development of the rural infrastructure. In Senegal, the introduction of cowpeas (legumes beneficial to the soil) to the rapidly degrading peanut basin is being delayed by lack of marketing infrastructure. Roads and communication systems also have a powerful impact on the environment. In Bangladesh, for example, in villages with good physical infrastructure (which generally means roads usable in all weather) only 12 percent of the population falls under the absolute poverty line, while 21 percent of the people are below the poverty line in villages without this infrastructure.[4] In villages with good infrastructure, employment per hectare of land is 4 percent higher; in nonagricultural sectors, employment is 30 percent higher; and wage rates are 12 percent higher than in villages without good infrastructure.[5] All those forces reduce the pressure to abuse the land for short-term survival.

A perennial problem for many developing countries is land tenure. The land often belongs to someone other than the people who are farming it. Since the farmers do not know how long they will be able to continue working on a parcel of land, they have little incentive to make long-term investments in it. In Africa, poorly defined land rights cause insecurity, and labor productivity is so low that farmers are preoccupied with wresting a minimum subsistence. Even with improved tenure conditions, only the research thrusts that E. T. York spells out in "Improving Sustainability with Agricultural Research" (see page 18) can raise agricultural productivities.

Poverty and Health

Much of the anxiety over environmental destruction in developed countries stems from health concerns. Pollution of cities, streams, and rivers cause serious illnesses. In developing countries, this concern is even greater because the state of health is so poor. For example, a lack of sanitation facilities creates serious health threats in densely populated

Deforestation has affected agricultural production and nutrition because of the greater time required to collect firewood. (Photo: Sean Sprague/Panos Pictures)

rural areas—a problem that rarely exists in developed countries. Without adequate disposal facilities, not only the streams but the land around small towns in developing countries is heavily polluted.

Although rising incomes lead to improved food intake, they do not necessarily improve health. For example, a study of women and children at different economic levels in southwestern Kenya found no significant differences in total illness (see Table 1 on page 28). However, a significant relationship exists between illness and the presence of general health and sanitation services in Kenya.[6] These problems are particularly severe in areas with dense rural populations and limited sanitation and health facilities. These areas also may have poorly drained alluvial soils, which add to the problems of population density and sanitation. In deforested regions, the quality of drinking water has dropped as water sources shift from fresh forest streams to increasingly contaminated rivers and ponds. Poor health cuts labor productivity and income in this "Catch 22" cycle.

Solving these problems requires tremendous investments of resources. However, solutions to environmental problems do not necessarily compete for resources with efforts to alleviate poverty and vice versa. However, many forms of investment benefit both endeavors. In Bangladesh, for example, the quality of the water supply and sanitary conditions are strongly influenced by improved rural infrastructure.[7] Also, health problems such as river blindness in Africa, tsetse fly infestation, and malaria all lend themselves to solution through modern biological research. Solving these problems would make it possible to populate more densely areas that are not environmentally fragile,

(continued on page 28)

Nepal's forests have been pushed so far back from rural populations that it takes, on average, 1.4 additional hours each day for women to collect firewood and fodder than it did just a decade ago.

Environmental Problems

(continued from page 13)

thus relieving pressure on the fragile areas.

Education's Role

Education affects the environment in three ways. First, some environmental destruction occurs simply because people do not understand the harm of what they are doing. Education can bring understanding of the environmental impacts of certain actions and lead to acceptance of complex technologies such as the biological control of insects and diseases. However, there is not much correlation between education and acceptance of a simple technology like high-yield wheat. Thus, educational levels in rural areas of developing countries must be raised to permit environmental improvements. This educational expansion must occur at all levels. At the secondary level, farmers must be taught to work with more complex technologies. At the college level, people need to be trained to teach this knowledge to farmers.

Second, education influences population growth. With all else equal, including income, rural people with more education tend to have somewhat smaller families. Perhaps with educated children who can get better jobs, parents need fewer children to support them in their old age.

Third, education increases income. In an increasingly complex world, education is necessary to understand the technological changes and the institutional interactions that can be used to raise farmers' incomes. So educational opportunities must grow to increase incomes.

Agriculture and Stability

Agriculture is innately and notoriously unstable, and the instability of production and prices is increasing. In bad times, instability drives poor people below the line of minimum subsistence. This drop cuts their ability to plan for the long term and leads them (and their animals) to assault the environment for short-run gains in ways they would never do if their incomes were stable above the subsistence level.

Areas with fragile environmental resources often have either low rainfall or rainfall that fluctuates around the critical level for arable agriculture. These areas in particular need to be returned to grassland or other perennial crops such as trees to counter the destruction that occurs, especially during periods of low rainfall. People must be provided with some means of support to carry them through these bad periods so they will not destroy the environment. Agricultural instability causes greater problems in areas of excessive poverty and environmental fragility, but the damage also carries into the middle classes.

Food scarcity wreaks devastating consequences on the poorest of a population rather than on the wealthiest. In India, a 10 percent reduction in food supplies reduces the consumption of the wealthiest 5 percent of the people by 8 percent, whereas the poorest 20 percent of the people are forced to reduce their consumption by 40 percent.[8]

Thus, ways must be found to stabilize the incomes of the very poor in the face of agricultural instability. Modern mechanisms do exist for just this purpose. Food aid can be useful. The International Monetary Fund, through its cereal facility, loans money to countries so that they can stabilize their food supply with imports during periods of extreme stress. Still, the recipient governments must have the facilities and institutions to utilize grain imports.

To reduce instability, unviable areas must, in the long run, lose population density through emigration to areas able to accept new technology and to realize rapid growth in nonagricultural employment. Those processes require infrastructure to facilitate specialization and trade.

A Shared Future

Unfortunately, income problems require solutions much more complex than just alleviating the grinding poverty of one-third to one-half of the population of the Third World. Quite simply, reversing the downward spiral of poverty and environmental destruction requires financial resources. Problems will be solved only through substantial expenditure on public goods, including investments in research, infrastructure, services, and education. But the tax base is thin and shallow in developing coun-

TABLE 1
PERCENTAGE OF TIME PRESCHOOLERS AND WOMEN IN SOUTHWESTERN KENYA ARE SICK WITH ANY ILLNESS AND WITH DIARRHEA, MEASURED BY PER CAPITA INCOME QUARTILE, FOR 1984–1985.

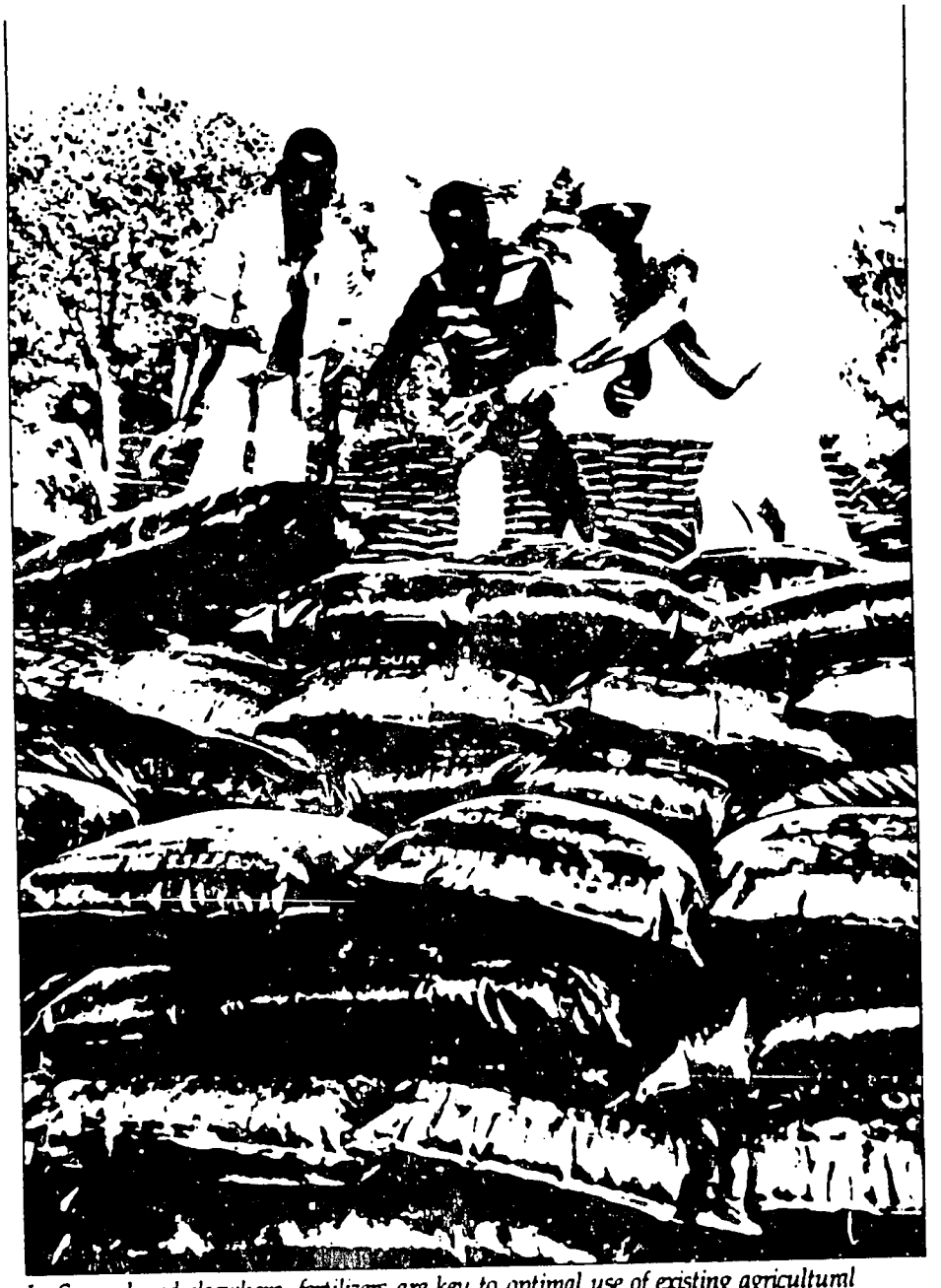
ILLNESS	POOREST QUARTILE	POORER THAN AVERAGE QUARTILE	RICHER THAN AVERAGE QUARTILE	RICHEST QUARTILE
	(percent)			
Preschoolers				
All illness[a]	27.5	26.0	29.5	26.5
Diarrhea[a]	4.9	6.4	6.2	4.6
Women				
All illness[a]	30.2	26.8	29.8	26.6
Diarrhea[b]	1.2	1.4	2.2	3.7

Note: The quartiles are based on total household income per capita.

[a]There was no significant difference across income quartiles.

[b]Women in the poorest and poorer than average quartiles reported significantly shorter duration of diarrhea at the 0.05 level than women did in the richest quartile.

SOURCE: Eileen Kennedy, International Food Policy Research Institute, "Survey 1984/85," South Nyanza, Kenya.



In Senegal and elsewhere, fertilizers are key to optimal use of existing agricultuml land. (Photo: Ray Witlin—World Bank)

Fertilizer use . . . boosts productivity and helps to prevent cultivation on hillsides.

tries. The combination of high proportions of populations living at subsistence levels, little administrative capacity, and inadequate commercialization shrinks the proportion of the gross national product spent in the public sector (to levels one-half to three-quarters of that spent in the United States, for example). Developing countries are constrained from generating resources because high taxation on those who live above the subsistence level and on the commercial sector discourages work and enterprise. Thus, a vital link in the poverty-environment nexus is to obtain adequate public resources for the physical and institutional infrastructure needed to raise incomes, reduce population growth, improve health, and increase education, as well as to undertake direct public action to protect and rehabilitate rural areas.

Given that people in poor countries often must sacrifice long-term environmental stability for short-run survival, wealthy countries must put aside the common belief that the poor can solve these problems on their own without enhanced resources and face up to the reality that substantial financial assistance in the short run is crucial to saving the environment from irreversible damage. However, if that assistance concurrently enhances progress toward self-reliant growth, it will be necessary only for a short while and can be beneficial to the donors themselves.

Developed countries must recognize that environmental protection and the growth of incomes of very poor people in developing countries will demand scientific and financial assistance to develop improved agricultural technologies. Investments in infrastructure and food aid will also help to dissolve poverty.

The leaders of developed countries need to understand how trade relationships can accelerate processes, allowing developing countries to import some agricultural commodities that they would otherwise be forced to produce on very fragile land resources, and to export commodities that are more suitable to those resources. Perennial crops, for example, could help pay for the imported commodities. Developed countries need to work toward an ecologically optimal global allocation of production systems. Most important, the rich nations need to consider the environmental problems of developing countries in a positive way, looking for solutions rather than criticizing their attempts to struggle with such complex problems.

ACKNOWLEDGMENT

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NOTES

1. See J. W. Mellor, *The New Economics of Growth* (Ithaca, N.Y.: Cornell University Press, 1976), for a description of the role of agriculture and employment growth in development.

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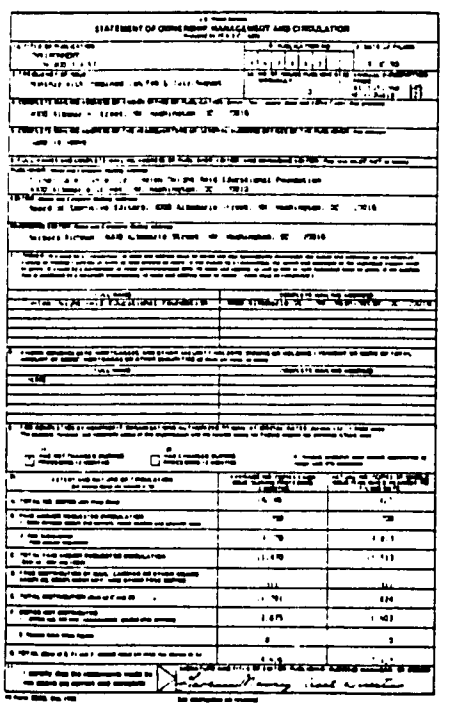

The Agroecological Framework

(continued from page 17)

ture. Agroecological characterization provides this framework.

Early global and regional attempts at agroecological zoning have shown that this approach can be valuable to agricultural planners. For example, Wladimir Köppen's 1936 definition of 13 rainfall/temperature classes in the tropics, each corresponding to a recognized vegetation zone, has helped both the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Centro Internacional de Agricultura Tropical (CIAT) identify the regional boundaries for their work on the agricultural problems of the semi-arid and humid tropics.[9] However, such broad specifications are not adequate for fine-tuning research priorities. In the last two decades, agroecological characterization has progressed. The United Nations Food and Agriculture Organization (FAO), working with other international agencies, notably the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Meteorological Organization (WMO), completed five regional agroclimatic studies between 1968 and 1978 and undertook extensive work on soil mapping and classification.

In 1976, FAO launched its pioneering Agroecological Zones (AEZ) project, which relates extensive physical resources data (on climate, soil, and landform) to crop growth requirements as a means of determining the best regions for producing particular commodities. Based on this project, agroecological zoning has been extended to assess the capacity of developing countries to sustain current and future food production with varying levels of technology.[10] The study indicates large food deficits where countries continue to depend on traditional, low-input technology and increasing self-sufficiency as more intensive methods are adopted (see Figure 1 on page 31). While some of the assumptions about resource and input use are questionable, the study shows how carrying capacity varies with changing levels of management and produces more exact estimates of Earth's carrying capacity than did previous estimates that ranged from 3 billion to 150 billion people.

The AEZ methodology developed by FAO has been adopted and modified by a number of national and international agencies. Other studies have also contributed new ideas. CIAT attacks the problem of characterization from the reverse end, describing actual land use first and then determining the environmental variables that differentiate land-use patterns between zones.[11] Although both approaches should ultimately reach the same endpoint, starting with a known situation has operational attractions.

The potential value of agroecological characterization as an operational tool for planning sustainable agricultural development as a framework for integrating the expertise of different disciplines is clear from its wide range of uses:

- Mapping the current distribution of ecozones and their suitability for specific crops and cultivars. Rice, the crop that feeds the largest number of people, is grown in at least five kinds of macroenvironments: irrigated, rainfed lowland paddy, rainfed upland, swamp, and deep flooded. Seventy-five percent of the world's rice is currently produced in the more fertile areas by only 25 percent of the world's rice farmers. Within major rice environments and especially in nonirrigated land, many local environmental variables affect choice of varieties and production techniques. The challenge is to fit improved production techniques to these local situations.

- Defining homologous zones for technology transfers and assessing the "spillover" benefits of research from one zone to another. These benefits can be considerable and have been largely ignored in past attempts at quantifying research returns.[12]

- Identifying constraints to land use, e.g., the distribution of tsetse fly in Africa. This carrier of trypanosomiasis in ruminant livestock and sleeping sickness in humans affects 34 African countries. In more than half of these countries, tsetse fly has infested at least 60 percent of the land. This debilitating disease re-

Moving toward sustainability

Building the Agroecological Framework

By Peter A. Oram

Drawing largely upon the principles of ecology and population dynamics, the concept of sustainable agriculture propounds that farming practices can and should be designed to maintain an optimal yield indefinitely. The particular biomass that produces this optimal yield defines the land's carrying capacity. Although the need for sustainability is a rather obvious conclusion to Malthusian theory, agronomists have only recently adopted it as an explicit goal of agricultural development.[1]

Nevertheless, sustainability has long been an important precept for resource management in animal husbandry and pisciculture. Through the millenia, husbandry practices have evolved, though not always successfully, with sustainability as a goal. Plato accurately and graphically described direct and indirect effects of deforestation of the mountains of Attica on the region's soil and water resources and the economy of Athens. Today ecologists are working to describe the causes and consequences of overstressing ecosystems, identify warning symptoms, and suggest ways to prevent deterioration.

As global concern focuses on sustainability, the complexity of interactions within and between nations and scientific disciplines becomes increasingly obvious. The causes and effects of deforestation, acid rain, eutrophication of water resources, ozone depletion, and greenhouse gases transcend economic, social, and geographic boundaries. Agriculture is both a contributor to the erosion of sustainability and a victim of other environmental abuses caused by industry, rapid population growth, and urbanization. Multifaceted problems affecting sustainability demand the attention of scientists from a great variety of disciplines. Conflicts of opinion have arisen over the definition of sustainability and the best way to achieve it. Persons trained in different disciplines often have very different concepts of sustainability and their goals do not necessarily coincide.[2] In particular, issues of short- versus long-term exploitation of natural resources and growth versus equity are controversial. Some ecologists

F. BOTTS—FAO

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and economists advocate a no-growth or steady-state approach on the grounds that continued growth will eventually lead to resource depletion on a catastrophic scale; technocratic optimists, on the other hand, assert that science will continue to maintain the growth of productivity into the future.

While the increasing complexity of sustaining human life without ruining the resource base makes it difficult to treat sectors such as agriculture as closed systems, the vast scope of sustainability makes component disaggregation essential for operational purposes. Within agriculture, it makes sense to distinguish the predominantly affluent, urbanized, industrial countries from the predominantly poor, agricultural, developing countries, because the former are largely

Some of the roughly 200,000 hectares of forested land denuded annually in Ethiopia have been planted with barley. Above, a seed collector gathers information about one farmer's crop.

FAO has estimated that of 92 million hectares of irrigated land in developing countries, 45 million require reclamation because of salinity and poor drainage.

In the lowland humid tropics in Asia, rice paddy production is the dominant form of land use. (Photo: FAO)

in temperate climates and the latter mostly in the tropics where crops, agricultural practices, and farming systems have evolved differently. Levels of infrastructure, education, and scientific capacity are generally lower in developing countries, and agriculture remains less mechanized and more vulnerable to the risks of uncertain climate. Natural resources largely determine the potential for modification of traditional practices. Human labor and animal power have yet to be supplanted by fossil fuels and agricultural chemicals that could increase productivity. Compared to the heavy dependence on those inputs by industrialized countries, Third World agriculture generates less chemical pollution, although the gap is slowly narrowing as industrialized agriculture reaches into the tropics.[3]

This does not mean that agriculture is more sustainable there; in many ways the reverse is now true. An increasing number of countries suffer from deforestation, desertification, and failure to sustain even low levels of subsistence production. Traditional farming systems that were designed to maintain relatively low population densities from their resource bases are failing to sustain the rapidly increasing human and animal populations with those same resources. Rural poverty inhibits the absorption of new knowledge that expands the resource base's capacity to support more people. Also, there is a lack of improved technology suited to the resources of the very poor and the more difficult ecological zones because researchers have failed to understand the conditions and constraints under which poor farmers operate; these researchers have also failed to build on the best of their traditional practices. Thus far, ecology has played only a minor role in increasing this understanding because most agricultural research institutions are exceedingly weak in environmental and social sciences.

Unable to increase productivity from their limited resources, the poor are driven to practices that amount to ecological suicide: shortening restorative bush fallows in shifting cultivation systems; extending cultivation to forested

areas that they need for fuelwood and forage; burning dung for fuel instead of using it to build soil fertility; planting annual crops on erosion-prone slopes; and grazing more animals than natural rangelands can support. Many areas are not suited to the introduction of green revolution, input-intensive technology, although it has provided a safety net for some populous countries with good soils and irrigable land, particularly in Asia. Even there, declining growth rates of productivity since the late 1970s have tempered early euphoria with doubts about sustainability.[4]

In Africa generally and in the wet tropics of Latin America, managing agriculture for sustained productivity on family farms is proving difficult at best.

Thus, the loss of momentum of green revolution technology in Asia, the failure under stress of traditional systems of land use, the depletion of sustaining natural resources, and the subsequent threat to the stability of agriculture everywhere pose tremendous problems.

Television has brought the difficulties of life in less developed countries to the attention of wealthier ones. Flooding in Bangladesh and Sudan, drought in Ethiopia and the Sahel, and hurricanes in the Caribbean highlight the perils of climatic extremes and the helplessness of humans to cope with them. Charity after the event is only palliative; alleviation of these disasters necessitates solutions or at least better understanding of their origins, frequencies, and ecological and social repercussions. If a greater frequency of such weather anomalies accompanies climatic warming, learning to cope with these extremes will become even more urgent.

Rethinking Approaches

Development agencies, governments, and agricultural scientists are concerned that new crop varieties with broad geographic adaptability and standardized packages of green revolution technology are not likely to have such widespread success in the future because the more favorable environments have largely been exploited. Also, the loss of genetic diversity increases risks. For example, a damaging epidemic of southern corn blight occurred in the United States when a large area was planted with a few hybrid varieties genetically susceptible to this disease. The Rice Tungro virus in Southeast Asia is another example. Ecologists have discovered that the wide adaptability of the prototypic semi-dwarf wheat and rice varieties was somewhat illusory; these varieties did indeed spread over a large geographic area, but only in scattered zones with very similar ecological characteristics.[5]

The international agricultural research centers now cover a wider spectrum of ecological conditions and commodities than they did in the past. Therefore agricultural technology must be more closely tailored to specific environments. Failure to understand population resource dynamics and the specific characteristics of local agricultural ecosystems (agroecological zones) has led to failures in development projects and research programs, which are often planned from the top down and do not adequately account for differences between national and local conditions and constraints. Indeed, experiments have shown that environmental differences and genotype-environment interactions influence the success or failure of crop and livestock breeding programs more than genetic differences alone.[6] Integrating information on environmental conditions and their variability in time and space helps scientists to set research priorities and to identify areas where new varieties and improved technologies can be best adapted.[7] Ecological characterization with improvements in weather instrumentation and recording will make it easier to track deviations in weather patterns and provide early warnings of possibly serious crop losses. This will contribute greatly to sustainability, defined by some as "the ability of a system to maintain its productivity when subjected to environmental stress or shock."[8]

Aids to Sustainability

In the future, ecology, climatology, geography, ecophysiology, soil science, and other resource-based disciplines must play greater roles in sustainable agricultural research and development. What has been lacking in the past is a conceptual framework to integrate these different disciplines and to enable them to interact effectively and contribute to the progress toward sustainable agricul-

(continued on page 30)

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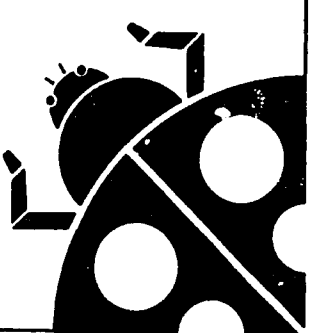

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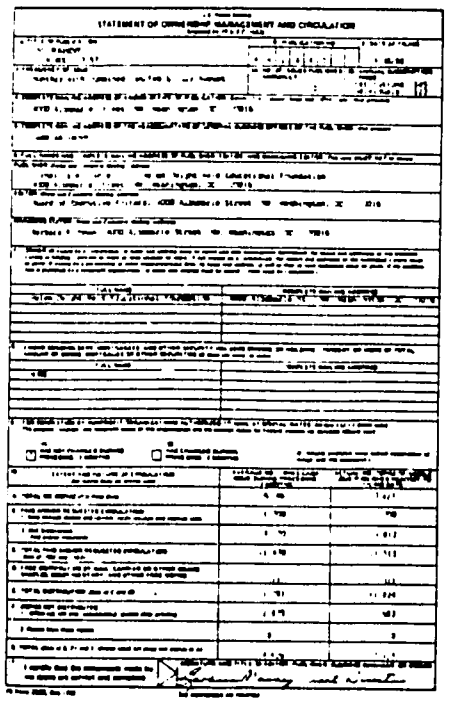

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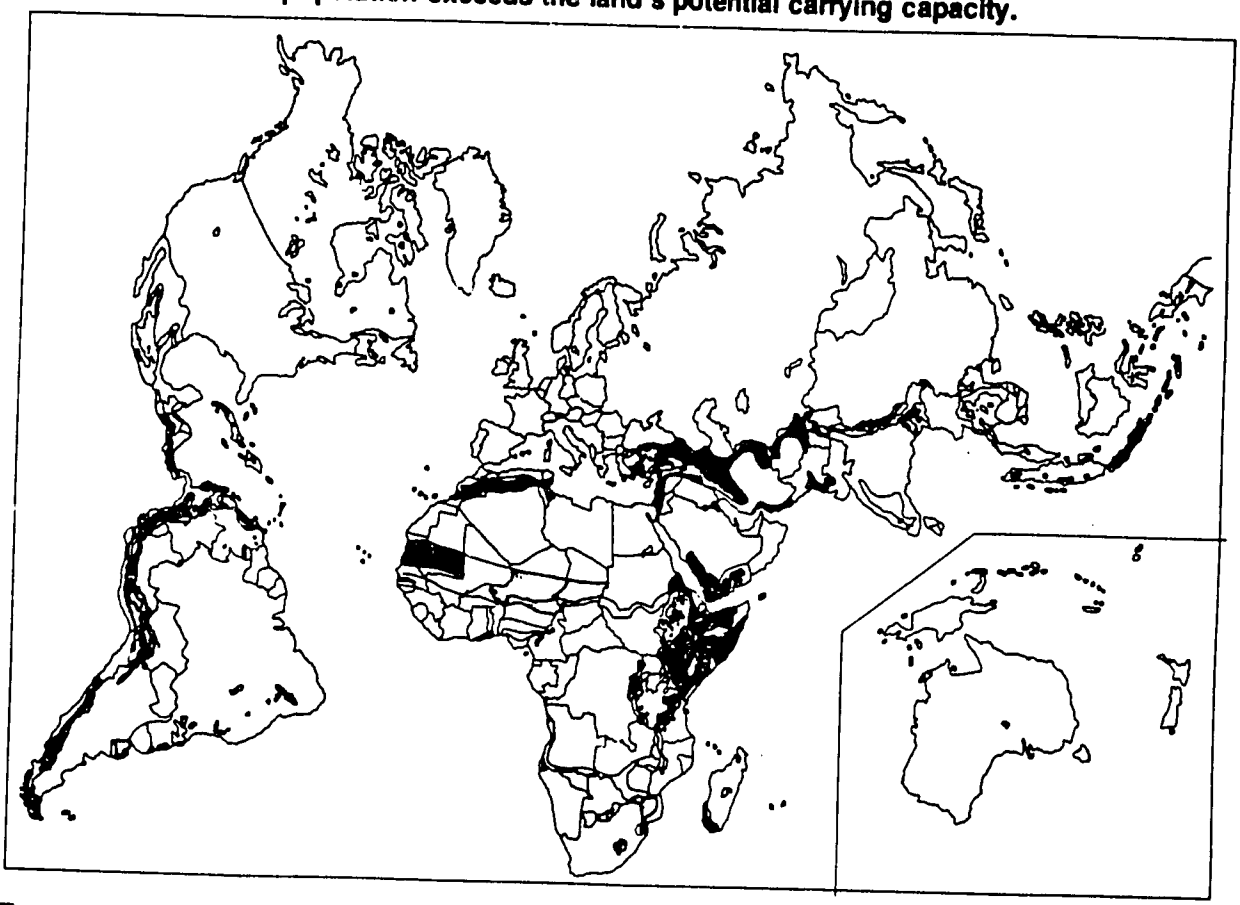
duces agricultural productivity by disabling farm workers and work animals. The fly infestation correlates strongly with environmental factors, and ecological characterization has improved accuracy in identifying areas of tsetse infestation by more than 20 percent compared to earlier "guesstimates."

- Evaluating production performance and targeting research.
- Determining optimum pasture management and carrying capacity.
- Modeling crop production and yield to environmental variability or climatic change. This work could be particularly valuable in assessing potential regional effects of global climatic warming and in safeguarding food supplies.
- Assisting in the design, data organization, and interpretation of the results of research networks and plant nurseries.
- Guiding the conservation and collection of genetic resources. Genetic resistance to pests and diseases has only been achieved in some cases by resorting to wild progenitors of cultivated plants. Knowledge of their ecological habitats can reduce the time plant collectors spend screening wild populations for sources of resistance.
- Assessing agricultural potentials of countries (including sociocultural factors and economic or demographic pressures that contribute to problems within agroecological zones) as a basis for regional planning, tailoring technology, and applying conservation policies.
- Reducing pesticide pollution and the costs of pest management programs by identifying environmental conditions favorable to specific pests or diseases and providing early warnings of pest outbreaks.

Characterization Techniques

As scientists realize the value of this approach to developing sustainable agriculture, the need for closer contacts and cooperation among various practitioners becomes obvious. Thus, in 1986, eight international and bilateral donors financed a workshop in Rome on behalf

FIGURE 1. Zones where population exceeds the land's potential carrying capacity.



■ Population exceeds carrying capacity even with high levels of green revolution inputs available

▨ Population exceeds carrying capacity with intermediate levels of inputs available

□ Population exceeds carrying capacity with low level, traditional inputs available

Note: In 1975, 38 percent of the total land area was carrying more people than could be fed with low inputs. Twenty-two percent of the total land area was carrying more people than could be fed even with high inputs.

SOURCE: Adapted from FAO, *Land, Food, and People*, based on the FAO/UNFPA/IIASA report "Potential Population Supporting Capacities of Land in the Developing World." (Rome: FAO, 1984), Map 1.

TABLE 1

PROPOSED CARRYING CAPACITIES FOR LIVESTOCK AND PEOPLE LIVING BY SUBSISTENCE PASTORALISM IN DIFFERENT ECOCLIMATIC ZONES IN KENYA

	ECOCLIMATIC ZONES				
	I	II	III	IV	V
Hectares required per unit of livestock	0.8	1.6	4.0	12.0	42.0
Units of livestock required to support one person	2.5	3.0	3.5	4.0	4.5
Hectares required per person	2.0	4.8	14.0	48.0	189.0
Maximum population density per square kilometer[a]	50	21	7	2	0.5

Note: Ecoclimatic zones I through V represent regions of Kenya with different lengths of growing (or rainy) seasons. From zone I (with the longest growing season in Kenya) to zone V (the most arid region in Kenya), the lengths of the growing seasons decrease.

[a]Assuming all land is both accessible and productive.

SOURCE: Adapted from D. J. Pratt, "Rangeland Development in Kenya," *Annals of the Arid Zone* 7 (1968): 177–208.

of the international agricultural research centers with technical support from FAO, WMO, and the International Soils Reference Center in the Netherlands. The workshop report provides comprehensive information on agroecological methodology and related problems in developing countries.[13]

In essence, proper agroecological characterization depends on the collection, organization, and analysis of climate, soil, and landform data and their influences on species' distribution, plant growth, and agricultural yield. To define precisely agroclimatic conditions, including estimates of climatic variability and risk, daily data should be recorded; particular attention should be paid to rainfall patterns because water availability constrains growth in the lowland tropics more than temperature does.

To evaluate agricultural potential, it is necessary to define values that correspond to changes in natural vegetation. A thorough evaluation requires a combination of such methodologies as Köppen's classification for broad characterization of sites, the FAO AEZ system based on major climates and lengths of growing periods for more specific definition, and the soil, water, and temperature regimes in the U.S. Department of Agriculture's (USDA) soil taxonomy for characterization of soil climates.[14]

The most critical measurements for characterizing a site are water balance, soil moisture-holding capacity, and length of the growing period. The balance between potential evapotranspiration and rainfall determines a water surplus or deficit; soil water storage values in the root zone must be measured or estimated; and periods when water supply is adequate to sustain crop growth must be calculated and mapped. Standard procedure is to record data at ten-day intervals, but for many purposes indices based on the ratios of mean annual rainfalls or temperatures through five years compared to mean annual evapotranspirations are adequate for rapid site characterization. Indices of rainfall intensity based on heavy downpours help ecologists to identify regions vulnerable to soil erosion. Other important soil data include nutrient status, acidity, salinity, and an excess of elements such as aluminum, selenium, and zinc, which can be toxic to crops or animals. Most areas are affected by one or more soil constraints, which usually correspond to certain climatic parameters. Thus many soils in the wet tropics are very acid, while salinity is more prevalent in the drier tropics, particularly irrigated areas. FAO has estimated that of 92 million hectares of irrigated land in developing countries, 45 million require reclamation because of salinity and poor drainage.[15]

Edaphic classification is often based on the FAO global soil maps or the USDA soil taxonomy, but other systems of soil classification for various purposes also exist. Most researchers and practitioners support a proposal by the International Society of Soil Science to develop a digitized, global soils and terrain database with standard maps and terminology of soils, landform, and terrain. This database will enable scientists using different systems of soil classification to interpret the data.

Botanical mapping can be especially useful for agroecological characterization where the soil and climate data are poor or where virgin flora predominate. In the highlands of East Africa, botanical mapping has helped determine the suitability of specific crops by drawing attention to wild indicator species whose presence denotes certain soil and climate types. Botanical mapping also may improve management of natural vegetation, for example, grazing practices (see Table 1 on this page). Aerial surveying eases the physical task, but careful verification is necessary to avoid being misled by human influence on vegetation.

Landform determines land use potential as well. In Bangladesh, where monsoon flooding affects most of the arable land, maps based solely on climate and soils are of limited value; topography is the critical factor (see Figure 2 on page 33). A few meters less elevation brings flooding of crops, animals, people, and loss of essential communications, as illustrated by the disastrous inundations in 1987 and 1988.

To be useful in the characterization of environments for agricultural purposes, data must be stored and recorded to allow retrieval for transfer, agroecological classification and mapping, adaptation of further research results, and diagnostic and predictive purposes, including regression analysis, simulation, and crop-weather modeling.

Database systems may incorporate geographical information. Computerized geographic information systems

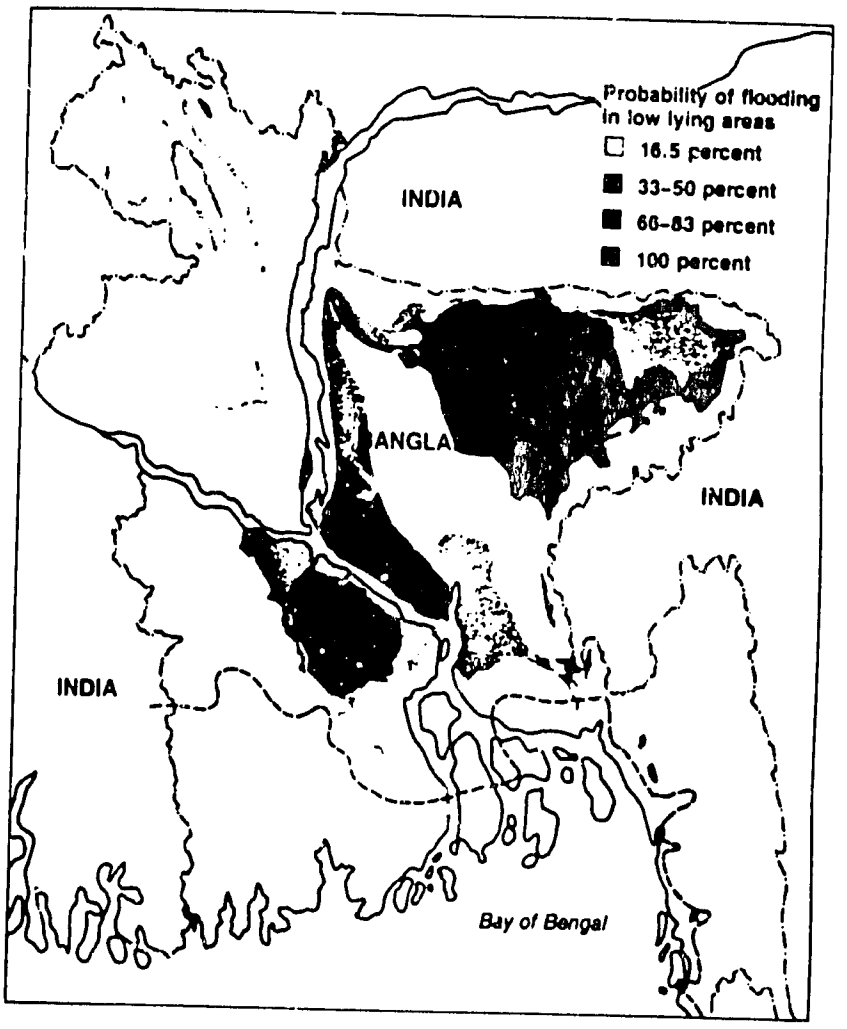
COMING SOON IN ENVIRONMENT
Ecological problems in the USSR

(GIS), although expensive, can encode, analyze, and display multiple data layers from different sources in tabular, graphic, or geographically coordinated mapping format. Less expensive, intermediate systems can still record critical data for agroecological characterization, provided that they are flexible and that there is a glossary of common attributes for data processing and exchange. These systems represent the essential structural framework for systematic data handling.[16]

Would maps based on agroecological characterization be made irrelevant by global climatic change? No, mostly because the climate is unlikely to change abruptly, but also because GIS databases provide a dynamic management tool that can be continually updated as new ecological data are added. Certainly, maps are not immutable and should be updated when conditions change. Indeed, the work described here will provide a sounder base for tracking regional changes in climate and for differentiating specific trends from general variability. By indicating parameters key to agricultural resource management, climatic models geared to practical needs may be developed. For example, small variations in temperature or rainfall are more crucial in certain seasons, ecological zones, or stages of crop growth than in others.

Agroecologists need a deeper understanding of global climatic systems, especially the circulation in the upper atmosphere and ocean currents, which affect the Sahelian rains and the Asian monsoon, for example. Despite progress in developing general circulation models, climate analysis and weather prediction are not yet precise enough. Closer links between climatologists and agroecologists will allow more effective collecting and recording of data for interpreting climate change and validating models.

FIGURE 2. Flood plains in Bangladesh from June through October.



Notes: Soil and climate maps are sometimes inadequate for determining agroecological zones. The high probability of floods in certain areas of Bangladesh illustrates the importance of taking topography into account in land-use planning. Salinity restricts land south of dotted line to one annual crop.
SOURCE: Adapted from E. B. Manalo, *Agroclimatic Survey in Bangladesh* (Dhaka: Bangladesh Rice Research Institute/International Rice Research Institute, 1977).

Problems Encountered

Despite significant advances made possible by remote sensing techniques, computer technology, and automatic climate and soil data recording instrumentation, numerous problems face the wider application of ecological data to effective management of natural resources for sustained agricultural production, including:

- Lack of a unified approach because different researchers have a wide range of objectives and expectations from the characterization of agricultural environments.
- Controversy over tools and techniques. Some practitioners think mapping invaluable, others consider it inessential because of the transitory nature of data and the fact that interzonal boundaries are rarely exact. While maps are useful for studying current environmental situations, they should not be regarded as the endpoint of agroecological characterization; GIS databases are also very useful for storing and retrieving updated and upgraded information.[17]
- Data inadequacies (missing data, mis-specification of data requirements, recording errors, confusion between estimated and exact data, differences in classification systems, and mapping scales, etc.) afflict interpretation and reconciliation efforts. Climate and soil data are particularly bad in remote areas

and developing countries where sustainability is often at greatest risk.

- Data on crop distribution, yield, land tenure, etc., are usually recorded by administrative units, which rarely coincide with ecological boundaries. Such information has to be reorganized and transposed to maps that relate it to agroecological zones.
- Lack of trained staff to maintain or use the more elaborate automatic recording systems, satellite imagery, computer hardware, and geographic databases.

Agroecology and Socioeconomics

The magnitude of the task of describing and understanding simply the physical parameters of the environment dissuaded the conferees at the Rome meeting from adding a socioeconomic dimension. Yet the reasons underlying farmers' choices of crops and technologies rest in socioeconomic conditions and constraints often unrelated to ecological situations.[18] After all, "innovations are sensitive to the economic environment just as much as to the agroclimatic and soils environment."[19] And so, farmers may not grow the most suitable crop, but will grow the least unsuitable within their constraints. In Africa, the FAO AEZ analysis shows that maize and soya occupy the same ecological zones, yet 20 million hectares of maize and only 300,000 hectares of soya are planted because maize is a familiar, readily disposable, staple food while soya is an unfamiliar crop that must be processed.

With abundant land and cheap labor, farmers do not readily adopt green revolution technology that increases yield per hectare because the inputs are expensive and require training. Only when overpopulation pressure pinches and new land cannot be brought into cultivation easily (as in Asia and, recently, the drier regions of eastern and southern Africa), is there incentive to shift to yield-increasing methods.[20]

However, in African countries with abundant tropical forests that should have the capacity to feed their own populations as well as those of other nations, this technological transition is not proving easy, and self-sufficiency has been falling. Farmers still cling to their traditional, shifting cultivation practices (even where rising population pressures dictate a change) because they lack resources and because, thus far, the new techniques cannot sustain continuous annual crops in the fragile soils of the forest zone. Targeting research to increase yields in zones with population pressures and to increase stress tolerance in crops for areas where land remains abundant is a sensible strategy (see Table 2 on this page).[21] Characterization may overcome these problems by matching particular agroecological approaches to certain ecological and socioeconomic constraints, but clearly both factors must be taken into account.

Several ongoing approaches to agroecological characterization already include socioeconomic parameters. These

TABLE 2
POTENTIAL FOOD DEFICITS AND SURPLUSES IN SUB-SAHARAN AFRICAN COUNTRIES IN THE YEAR 2000

ECOLOGICAL ZONE	AGROCLIMATIC POPULATION DENSITY[a]				
	LOW	TRANSITION TO MEDIUM	MEDIUM	TRANSITION TO HIGH	HIGH
Equatorial wet tropics	Congo* Central African Republic* Equatorial Guinea* Gabon* Sao Tome Zaire*				Mauritius†
Coastal wet tropics	Ivory Coast* Liberia* Madagascar* Guinea Bissau	Sierra Leone† Guinea			Comoros Islands†
Humid savanna	Angola* Cameroon* Southern Sudan*	Benin† Mozambique*	Togo† Ghana		Nigeria†
Seasonally-dry savanna	Zambia*		Gambia Zimbabwe†	Lesotho† Malawi†	Reunion† Namibia† Swaziland†
Semi-arid savanna (Sahel)	Chad	Northern Sudan*	Mali†	Botswana† Burkina Faso† Senegal†	Cape Verde† Mauritania† Niger† Somalia†
Tropics modified by altitude			Tanzania	Uganda†	Burundi† Ethiopia† Kenya† Rwanda†

[a]Agroclimatic population density is defined as projected total population divided by FAO's estimates of potential calorie production at the intermediate input level. Low density = less than 100 persons per million calories of potential production throughout 2000–2025; transition to medium = will reach 100 persons; medium density is between 100 and 250 persons; transition to high = will reach 250 persons; and high density = above 250 persons.

*Identified as potential food surplus producer at low input levels by FAO.
†Identified as potential (or actual) critical food deficit country at low input levels.

SOURCES: Adapted from H. Binswanger and P. Pingali, "Technical Priorities for Farming in Sub-Saharan Africa," *The World Bank Research Observer* 3, no. 1 (1988) and FAO, UNFPA, IIASA, *Potential Population Supporting Capacities of Lands in the Developing World* (Report of the Project on Land Resources for Populations of the Future, Rome, FAO, 1982).

In Benin, as in many developing countries, fire is often used to clear land for agriculture. (Photo: Julia Andrews)

include CIAT's studies of the agricultural socioeconomic environment for cassava in South America, the Commonwealth Scientific and Industrial Research Organization's (CSIRO) assessment of the agricultural resource potential in Papua New Guinea, the International Council for Research in Agroforestry's (ICRAF) farming systems with such dynamic aspects as roads that can engender changes in land-use patterns, and the Centro Internacional de Mejoramiento de Maiz y Trigo's (CIMMYT) "recommendation domains," which are areas with different socioeconomic conditions within homologous agroecological zones.

So, with luck, the recommendation of the Rome meeting will not deter other efforts to combine socioeconomic and agroecological information where it will be valuable to the analysis. Understanding social influences on agriculture and natural resource use, in particular those factors known to determine farmers' attitudes toward change and their ability to adopt new practices, is essential. Difficulties experienced with inducing technological change in developing countries include populations excessive to land carrying capacities, land tenure systems, and inadequate infrastructures such as roads and training facilities.

The Need for Training

The lack of trained workers causes crucial problems in accelerating the application of this interdisciplinary approach. Analysis of the disciplinary composition of national agricultural research cadres in developing countries shows that environmental and social sciences are often poorly represented.[22] Even the international agricultural research centers had only seven full-time staff members allocated to agroecological problems in 1986. The centers can draw on a global pool of trained scientists to fill gaps, but developing countries cannot easily do so. Moreover, the main responsibility for environmental characterization has to lie with national staff; international institutions can only be catalysts.

A training program that is internationally planned and funded needs to be launched; it ought to include short courses for established scientists at qualified institutions in developed countries

Unable to increase productivity from their limited resources, the poor are driven to practices that amount to ecological suicide.

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and expanded graduate and post-graduate training opportunities for less experienced staff at selected universities. The Consultative Group on International Agricultural Research centers should also strengthen their staffs in such disciplines as ecology, agroclimatology, crop geography, plant physiology, and soil science, both to enable the staffs to apply these techniques more effectively in their own research and to help local systems through better in-service training and collaborative studies. At the moment, this capacity is somewhat limited, but broader agreement on techniques, data requirements, and applications of results would simplify the task.

Agroecological characterization is clearly a valuable and flexible tool for assessing the nature and potential of the physical resources on which agriculture depends. Indeed, it has already benefited water resource allocation and commercial seed production strategies in developed countries. When linked to an understanding of the human factors that determine how the resource base is used (or misused), agroecological characterization sensitizes national research and development policies to the grassroot needs on which their acceptance and sustainability depend. Characterization demands a lot of equipment and trained staff, however, including environmental scientists, who are underrepresented in the national agricultural research systems that will do most of the work. Donor organizations must directly support the cooperative endeavor, both technically and financially, if they ever want to see a return on their investments of work, money, and hope.

NOTES

1. Thomas Malthus contended that populations tend to increase beyond the capacity of their resource bases to support them, with inevitably disastrous results unless population growth can be checked.

2. C. Tisdell, "Sustainable Development: Differing Perspectives of Ecologists and Economists, and Relevance to Less Developed Countries," *World Development* 16 no. 3(1988): 373.

3. M. Dover and L. M. Talbot, *To Feed the Earth: Agro-Ecology for Sustainable Development* (Washington, D.C.: World Resources Institute, 1987).

4. S. K. Sinha, N. H. Rao, and M. S. Swaminathan, "Food Security in the Changing Global Climate" (Paper presented at the international conference on The Changing Atmosphere: Implications for Global Security, Toronto, June 1988).

5. R. Brinkman, "Agro-Ecological Characterization, Classification, and Mapping: Different Approaches by the International Agricultural Research Centers," in A. H. Bunting, ed., *Agricultural Environments, Characterization, Classification, and Mapping* (Wallingford, England: Commonwealth Agricultural Bureaux International, 1987), 31.

6. D. Muiitze, R. S. Malhotra, and P. Goldsworthy, "Relating Production and Environment: The International Nursery Networks," in A. H. Bunting, ed., note 5 above, 85.

7. H. C. Harris and W. Goebel, "Objectives, Expectations, and Needs of the International Agricultural Research Centers," in A. H. Bunting, ed., note 5 above, 5.

8. R. G. Conway, *Agroecosystem Analysis*, ICCET Series E, no. 1 (London: Imperial College, 1983). See also *Agricultural Administration* 20 (1985).

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12. J. S. Davis, P. A. Oram, and J. G. Ryan, *Assessment of Agricultural Research Priorities: An International Perspective* (Canberra, Australia: Australian Centre for International Agricultural Research in collaboration with the International Food Policy Research Institute, 1987).

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19. H. Binswanger, "Evaluating Research System Performance and Targeting Research in Land-Abundant Areas of Sub-Saharan Africa," *World Development* 14 no. 4 (1986): 469.

20. P. A. Oram and S. Roy, "Accelerating Foodgrain Production in the Low-Income Food Deficit Countries—Progress, Potential, and Paradoxes" (Keynote paper prepared for the Second Review Meeting of the INPUTS Projects, East-West Center, Honolulu, Hawaii, May 1978) and H. Binswanger, note 19 above.

21. H. Binswanger, note 19 above.

22. P. A. Oram, "Research Objectives and Priorities: Constraints to the Development of Agricultural Research Institutes in Arab Countries" (Paper prepared for the First Meeting of the Council for Arab Agricultural Research, Kuwait, March 1988).

Agricultural Research

(continued from page 20)

research aims to breed for ecological flexibility and to achieve greater yield stability, reducing wide fluctuations in seasonal production that are so harmful to the small producer.

Pest Control

The International Center of Insect Physiology and Ecology (ICIPE) and the Asian Vegetable Research and Development Center (AVRDC) have emphasized the development of integrated pest management, tailored to meet the needs of small-scale, resource-poor farmers. Integrated pest management incorporates more sustainable methods of pest control, including host-plant resistance, intercropping, and biological control, to minimize the need for chemical pesticides.

Animal Health and Nutrition

Several research centers study aspects of animal health and nutrition. The International Laboratory for Research on Animal Diseases (ILRAD) devotes its work to the control of diseases in cattle, mainly theileriosis (a tick-transmitted disease caused by protozoan parasites) and trypanosomiasis (a disease primarily caused by protozoan parasites usually carried by the tsetse fly). Success could have enormous implications for livestock production in Africa and elsewhere. The International Livestock Center for Africa (ILCA) researches nutritional problems of cattle and small ruminants. Small ruminants also feature strongly in the programs of the International Center for Agricultural Research in the Dry Areas (ICARDA).

Soil and Water

The centers involved in crop productivity research devote considerable effort to improve soil and water management. Most researchers work on specific aspects of soil fertility, e.g., the determination of plant nutrient requirements under different soil conditions and cropping systems.

To better understand soil and water

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Improving sustainability with

Agricultural Research

By E. T. York, Jr.

During the last decade, industrialized nations have been plagued with significant surpluses of many agricultural commodities. Moreover, aggregate statistics for food production in developing nations look very positive. From 1950 to 1980, total food production in the Third World grew at a compound rate of 3 percent per annum. Per capita food production also increased at an annual compound rate of 0.6 percent.[1] Despite such improvement, there is growing concern in the global community that these gains cannot be easily sustained.

For example, little progress has been made in reversing the decline in per capita food production in Africa over the past two decades. There are also many indications that the rapid rate of growth in food production resulting from the green revolution in Asia during the late 1960s and 1970s cannot be maintained. Moreover, in both industrialized and developing nations, many natural resources on which agriculture depends have deteriorated. The failure to address such deterioration could make it increasingly difficult to maintain current levels of production, to say nothing of improving productivity to meet growing needs.

The next few decades present a greater challenge to the world's food systems than they may ever face again. The effort needed to increase production in pace with an unprecedented increase in demand, while retaining the essential ecological integrity of food systems, is colossal both in its magnitude and complexity. Given the obstacles to be overcome, most of them man-made, it can fail more easily than it can succeed.[2]

The foregoing statement from a 1987 report to the World Commission on Environment and Development provides a sobering appraisal of the challenge facing global food systems. Such an appraisal may be surprising to many, given the significant progress made in food production in recent years.

E. T. YORK, JR., is Chancellor Emeritus of the State University System of Florida, Distinguished Service Professor at the University of Florida, and a member of the Technical Advisory Committee of the Consultative Group on International Agricultural Research.

Globally, agriculture must produce enough food to meet the needs of 80 million to 100 million additional people annually. About 90 percent of this growth in population occurs in the developing world, where deficits in agricultural production are already critical in many regions. These circumstances are contributing to growing global concern about the need to develop and maintain sustainable agricultural systems.

The prospects for widening deficits between food production and demand in many developing countries underscore the need for enhanced research efforts to expand food output. The Consultative Group on International Agricultural Research (CGIAR) was organized in the early 1970s to support international agricultural research aimed at improving food production in the developing world. Recently, CGIAR modified its goal statement to place major emphasis upon research to achieve sustainable food production, and CGIAR's Technical Advisory Committee (TAC) has recently developed a comprehensive report on sustainability of agricultural systems.[3]

Goals of Sustainability

A dictionary definition of sustainability—"keeping an effort going continuously, the ability to last out and keep from falling"—suggests that agriculture would be sustainable if current levels of production could be maintained. However, sustainability should not be treated in a static sense, but rather as a dynamic concept that reflects changing needs.

Thus, to achieve sustainable agriculture, resources must be successfully managed to satisfy changing human needs, to conserve natural resources, and to maintain or enhance the quality of the environment. The goal of sustainable agriculture, therefore, should be to maintain agricultural production at levels necessary to meet the increasing needs and aspirations of an expanding world population without degrading the environment.[4]

A distinction should be made between sustainability and productivity. While greater productivity will be required to

In their plant breeding programs, the international agricultural research centers emphasize development of tolerances for various environmental stresses. Pictured far left is a screening test for manganese and aluminum toxicity in rice.

Efforts to achieve sustainability must take into account long-term implications and needs.

A scientist collects dried pods of Vigna nyangensis *spp. nov.* mithen *in Nyanza, Zimbabwe. (Photo: International Board for Plant Genetic Resources)*

achieve sustainability goals, that productivity must be achieved in such a manner as not to jeopardize the ability of agriculture to meet future needs. More explicitly, productivity goals often may be achieved through unsustainable, short-term approaches. Thus, efforts to achieve sustainability must take into account long-term implications and needs.

Determinants of Sustainability

The sustainability of agricultural production is determined by a complex interaction of biological, physical, and socioeconomic factors that constitute the basis of all production systems. Although diverse in character, agricultural production systems are inherently neither sustainable nor unsustainable. They respond to changes that either enhance or endanger sustainability depending on the nature of the change in relation to the prevailing environment and socioeconomic circumstances. If an agricultural system fails to respond to change, however, it is unlikely to be sustainable.

The determinants of sustainability might be classified into three primary groupings: biological, physical, and socioeconomic and legal. These determinants are discussed in some detail in the recently published report prepared by CGIAR's Technical Advisory Committee.[5] The TAC report addresses the following factors that affect sustainability: availability and use of plant and animal genetic resources; crop pests; animal health and nutrition; soil properties; water resources; air quality; hazardous chemicals; energy resources; economic policies; infrastructure and markets; inputs and credit; institutions for research, extension, and education; land tenure; and laws and regulations.

Research

Many circumstances that threaten sustainability may be effectively addressed through research. Already much research, particularly in industrialized nations, is directed toward the achievement of agricultural sustainability. International agricultural research centers, many of them affiliated with CGIAR, are engaged in extensive research with sustainability implications for developing nations. Clearly, however, many of the circumstances that preclude the achievement of sustainability cannot be solved through agricultural research alone. National governments and their development services will bear the brunt of the problem, and success in achieving sustainability will ultimately depend on their commitment. Nonetheless, continuing research is crucial for success. Research institutions, both national and international, should constantly review their programs to give greater emphasis and visibility to those aspects relating to sustainability.

The international agricultural research centers conduct much research related to sustainability.

Germplasm Conservation and Improvement

Given that a dynamic concept of sustainability implies increasing productivity to meet the needs of an expanding population, germplasm research at these centers has major implications for sustainability. For example, the conservation of genetic resources is designed to preserve sources of genetic diversity through exploration, collection, storage, and evaluation of living species. Genetic improvement research is designed to increase productivity while introducing and maintaining resistance to environmental stresses such as pests, drought, salinity, and soil toxicity. Such

(continued on page 36)

and expanded graduate and post-graduate training opportunities for less experienced staff at selected universities. The Consultative Group on International Agricultural Research centers should also strengthen their staffs in such disciplines as ecology, agroclimatology, crop geography, plant physiology, and soil science, both to enable the staffs to apply these techniques more effectively in their own research and to help local systems through better in-service training and collaborative studies. At the moment, this capacity is somewhat limited, but broader agreement on techniques, data requirements, and applications of results would simplify the task.

Agroecological characterization is clearly a valuable and flexible tool for assessing the nature and potential of the physical resources on which agriculture depends. Indeed, it has already benefited water resource allocation and commercial seed production strategies in developed countries. When linked to an understanding of the human factors that determine how the resource base is used (or misused), agroecological characterization sensitizes national research and development policies to the grassroot needs on which their acceptance and sustainability depend. Characterization demands a lot of equipment and trained staff, however, including environmental scientists, who are underrepresented in the national agricultural research systems that will do most of the work. Donor organizations must directly support the cooperative endeavor, both technically and financially, if they ever want to see a return on their investments of work, money, and hope.

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Agricultural Research

(continued from page 20)

research aims to breed for ecological flexibility and to achieve greater yield stability, reducing wide fluctuations in seasonal production that are so harmful to the small producer.

Pest Control

The International Center of Insect Physiology and Ecology (ICIPE) and the Asian Vegetable Research and Development Center (AVRDC) have emphasized the development of integrated pest management, tailored to meet the needs of small-scale, resource-poor farmers. Integrated pest management incorporates more sustainable methods of pest control, including host-plant resistance, intercropping, and biological control, to minimize the need for chemical pesticides.

Animal Health and Nutrition

Several research centers study aspects of animal health and nutrition. The International Laboratory for Research on Animal Diseases (ILRAD) devotes its work to the control of diseases in cattle, mainly theileriosis (a tick-transmitted disease caused by protozoan parasites) and trypanosomiasis (a disease primarily caused by protozoan parasites usually carried by the tsetse fly). Success could have enormous implications for livestock production in Africa and elsewhere. The International Livestock Center for Africa (ILCA) researches nutritional problems of cattle and small ruminants. Small ruminants also feature strongly in the programs of the International Center for Agricultural Research in the Dry Areas (ICARDA).

Soil and Water

The centers involved in crop productivity research devote considerable effort to improve soil and water management. Most researchers work on specific aspects of soil fertility, e.g., the determination of plant nutrient requirements under different soil conditions and cropping systems.

To better understand soil and water

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The International Institute of Tropical Agriculture has developed a variety of effective practices for controlling the kind of water erosion pictured above. (Photo: IITA)

Studies of growth linkages, the development of infrastructure, and the problems of populations in areas of low potential are all important aspects of research in support of options for development strategies.

management in rainfed agriculture, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) conducts research on a wide range of problems relating to soil and water conservation in the semi-arid tropics. The International Institute of Tropical Agriculture (IITA) has explored in depth the problems of the main soil types of the humid and sub-humid tropics, seeking ways to improve their fertility and reduce erosion.[6] ICARDA, which gives high priority to increasing water use efficiency, is investigating various components of production systems that reduce erosion and contribute to sustainability in Mediterranean environments.[7]

Many relevant projects focus on particular commodities. For instance, Centro Internacional de Agricultura Tropical (CIAT) is adapting methodologies and techniques of erosion control in its cassava program.[8] ILCA is investigating animal traction to develop low-cost, locally made implements for soil and water conservation in highland zones. The International Rice Research Institute (IRRI) is working to improve land management with better fallows, zero tillage, and erosion management of uplands.

The International Board for Soil Research and Management (IBSRAM) uses a network of collaborators to promote research for improved management of vertisols and acid tropical soils. The International Fertilizer Development Center (IFDC) is collaborating with numerous national and international programs to boost productivity and sustainability with fertilizers. The International Council for Research in Agroforestry (ICRAF) has conducted several studies on erosion control in systems of agroforestry. The International Irrigation Management Institute (IIMI), through its emphasis on irrigation management at all levels, seeks to improve soil and water management in irrigation systems.

Socioeconomics and Policy

Most of the International Food Policy Research Institute's (IFPRI) work relates directly or indirectly to the goal of achieving agricultural sustainability. For example, IFPRI is exploring the social and economic consequences of clearing tropical rain forest in Brazil for agricultural settlement. However, the institute may contribute most significantly to sustainability through its analysis of development strategies. Studies of growth linkages, the development of infrastructure, and the problems of populations in areas of low potential are all important aspects of research in support of options for development strategies. IFPRI is also studying the root causes of poverty, examining specifically the relationships between poverty and environmental degradation.

Centers with commodity mandates also contribute to greater understanding of sustainability through socioeconomic research. At ILRAD, for example, scientists are analyzing the potential economic, social, and environmental impacts of improved control of theileriosis and trypanosomiasis. Many of the centers become involved in the analysis of policy options in collaboration with national systems.

The International Service for National Agricultural Research (ISNAR) emphasizes environmental and sustainability issues in work to strengthen national research systems. The relation of these issues to policy is important in assisting countries to define program objectives. Sustainability also features in ISNAR's development of concepts and methodologies for training and research.

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Novel Production Systems

Many research centers contribute to research on the development of novel production systems. IITA has studied methods of soil mulching and mixed cropping for many years. They have also screened woody perennials for their potential use in agroforestry systems such as alley farming.[9,10] In collaboration with ILCA, the potential capacity of this system to sustain production of crops and small ruminants in the humid and sub-humid tropics has been clearly demonstrated, but its implementation on a large scale awaits further research on socioeconomic aspects.

In the semi-arid tropics, ICRISAT has made notable progress with new systems for managing small watersheds and vertisols[11] and with various systems of intercropping.[12] During the rainy seasons, vertisols are subject to heavy erosion, and production falls far below the optimal level. ICRISAT developed successful watershed technology to double-crop these soils. Traditionally, just one crop is seeded immediately after the rainy season. Double-cropping requires cultivating the land immediately after the first crop and dry-seeding the second crop just before the monsoon rains arrive. During seven years of tests at the ICRISAT center near Hyderabad, India, the annual value of the crops increased on average 4,000 rupees per hectare and farmers' profits multiplied two-and-one-half times. With this system, erosion is greatly reduced because the soils are covered by vegetation during the rains.

ICARDA has shown how production can be sustained in the dry regions of West Asia and North Africa through the application of relatively small amounts of phosphate to production systems that integrate cereals, livestock, and legumes.[13] This system has been extended by the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) to produce wheat in similar environments. CIAT's work on improving pasture and livestock production systems shows great promise and could be regarded as a novel production system. Centro Internacional de la Papa (CIP) has demon-

In alley farming, food crops are grown between rows of trees or shrubs. Pictured here, cowpeas grow between rows of legumes used for fuel, feed, and mulch. (Photo: IITA)

All agricultural research should be planned and conducted with a sustainability perspective.

strated the versatility of the potato, and IRRI has shown the adaptability of rice in a range of new production systems.

ICRAF promotes research on production systems that incorporate woody perennials, particularly the study of their potential to sustain crop and animal productivity. The council is taking the lead in clarifying terminology and developing methodology for research in agroforestry.[14] ICRAF suggests that, in intensified land use, trees can play both an ecological role (e.g., fertility maintenance and erosion control) and an economic role (e.g., increased income through sale of tree products).[15]

Centers involved in productivity research work with the national systems, the United Nations Food and Agriculture Organization, the World Meteorological Organization, and the International Society of Soil Science to accumulate and analyze data for agroclimatic characterization of environments.[16] Such knowledge is essential to define the broad domains for applying both existing and novel production systems.

Research Implications

The key questions raised by TAC in its recent analysis of this subject are not so much whether the centers are working to make agriculture more sustainable, but whether they should be doing more to make agriculture sustainable and whether they should orient their work differently. In this regard, the committee has made several observations and recommendations for consideration by the international agricultural research centers and the national agricultural research systems with which they work:

- ***A sustainability perspective.*** Instead of establishing and maintaining a discrete area of activity labeled "sustainability research," centers should ensure that sustainability is reflected in all aspects of productivity research. All agricultural research should, therefore, be planned and conducted with a sustainability perspective.

- ***Short-term vs. long-term objectives.*** The Brundtland Commission report[17] proposes that sustainable development must meet the needs of the present without compromising the ability to meet the needs of the future. To be consistent with this philosophy, research objectives should include the development of technologies designed to meet short-term requirements while maintaining the ability to meet long-term needs.

- ***Input levels.*** The use of commercial or industrial inputs, especially fertilizers and pesticides, raises many sustainability issues. Some believe that high levels of such inputs threaten sustainability; others suggest that, without greater use of such inputs, increased productivity and sustainability cannot be achieved.

Much public concern about sustainability in industrialized countries has been generated by the development of highly productive agricultural systems that require considerable commercial inputs. Without such systems, however, it would be impossible to meet the food needs of the increasing world population unless additional land that is less sustainable is brought into cultivation. However, this expansion would further degrade the surface of the earth and destroy natural ecosystems. Without more intensive agriculture, therefore, sustainability will be sacrificed. Yet even with it, sustainability is not ensured. There are indeed many disturbing developments such as the degradation of irrigation systems, the inappropriate use of fertilizer leading to contaminated aquifers, the burgeoning of noxious pests, and the subsequent dependency on pesticides. Obviously, research should aim

to develop techniques that might optimize the returns from the use of inputs while avoiding, to the extent possible, undesirable consequences.

• ***Poverty and sustainability.*** Who has benefited most from the generation and application of improved agricultural techniques through research? Socioeconomic studies have made it clear that increased production has lowered prices of staple foods and that the principal beneficiaries have been the poorest consumers.

Improved techniques, however, have led to the greatest increases in productivity in the well-endowed agricultural regions; farmers in less-endowed regions have not realized comparable increases in productivity. Also, they have often suffered from the falling commodity prices that are consequent to boosted productivity in the better regions. This has often had negative impacts on sustainability, since farmers in such less-endowed regions are often forced to sacrifice ecological stability for short-term needs. Such sacrifices often have led to conflict between the needs of these farmers and poor consumers.

Areas of low agricultural production potential are precisely those where agroecological and socioeconomic characterization of the environment are likely to be most helpful. Moreover, both equity and sustainability considerations will be served if researchers emphasize the development of techniques applicable to less-endowed regions. In "The Intertwining of Environmental Problems and Poverty" on page 8, John Mellor treats the issue of poverty and sustainability in greater detail.

• ***Improved production systems.*** Although the productivity of traditional farming systems may become inadequate to meet growing needs, certain principles on which they are based have permitted those systems to persist for generations. Research has already explored the strengths and limitations of many traditional systems. There are dangers both in disregarding the principles of traditional systems and in assuming that, because they are appropriate to some circumstances, the systems are appropriate to others. Research institutions must continue to investigate more intensive systems that could evolve from sound traditional systems.

• ***Biotechnology.*** To achieve sustainable production, research workers, scientific leaders, and policymakers must remain alert to the implications of evolving knowledge in the biological sciences. New techniques emerging from these disciplines already offer important opportunities. Research institutions should monitor advances and continually assess the cost-effectiveness of incorporating new capabilities in biotechnology into their research programs.

• ***Policy research.*** As stated earlier, economic, social, political, and institutional problems threaten sustainability. Although these problems do not have technological solutions, they lend themselves to policy research aimed at discovering those options most likely to create circumstances that are favorable to sustainability. The magnitude and complexity of these problems warrant greater emphasis on policy research.

Priority Attention

Finally, agricultural sustainability has major implications for the further development of the Third World and for global security. The international agricultural research centers, the donor community, and the governments of developing countries have crucial roles to play in giving high priority to sustainability when formulating future plans and allocating resources.

The common challenge is to remove the technical, economic, social, institutional, and political impediments to sustainable agricultural production. Such efforts offer opportunities for unprecedented contributions to the global community by solving problems that threaten the future welfare of humanity.

Wild•er•ness

(noun, state of mind)

For information about saving America's wilderness, please write to: Wilderness Conservation, Sierra Club, 730 Polk Street, San Francisco, CA 94109.

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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

SUSTAINABLE AGRICULTURAL PRODUCTION: IMPLICATIONS FOR INTERNATIONAL AGRICULTURAL RESEARCH

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

March 1988

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SUMMARY

From its inception, a major goal of the CGIAR 1/ has been to increase food production in developing countries. Much of the work it supports has also been concerned with sustaining production for the needs of future generations.

In its study of CGIAR prorities and future strategies, TAC recommended that the word "sustainable" be included in the System's goal statement and that greater emphasis be placed on sustainable production systems in future work of the Centres. In this paper, TAC reviews the circumstances threatening sustainability, analyzes ways in which international research could be more effective, and makes recommendations for the future work of the Centres.

TAC's Concept of Sustainability

A dictionary definition of sustainability refers to "keeping an effort going continuously, the ability to last out and keep from falling". Such a definition suggests that agricultural systems would be sustainable if production could be maintained at current levels. This would be a static concept of sustainability. But sustainability should be treated as a dynamic concept, allowing for the changing needs of a steadily increasing global population. In the static sense, many traditional agricultural production systems were sustainable for centuries in terms of their ability to maintain a continuing, stable level of production. However, the needs and growing aspirations of increasing numbers of people have forced changes in production practices that have imposed excessive demands on natural resources.

Within this context, sustainable agriculture should involve the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources.

Trends in Agricultural Production

Characterized in this way, sustainability should be considered in the light of past and current trends in agricultural production.

Aggregate statistics look very positive in terms of food production in developing countries in the 30-year period from 1950 to 1980. During this period, food production in the Third World grew at a compound rate of 3% annually. Per caput food production in the developing world also improved, growing at a compound rate of 0.6%, even though populations grew rapidly during the same period.

1/ A List of Acronyms is given in Annex II.

Despite this remarkable progress in expanding food production, the needs for further improvement continue to mount. Food deficits remain critical in Africa, where per caput food production has dropped by almost 20% in the last quarter-century. Furthermore, despite the overall increase in per caput food production in the developing world, it is estimated that half the population cannot afford a diet that meets the minimum energy needs for a healthy, active life. Consequently, increased incomes are needed as well as increased production.

Difficulties in Maintaining Progress in Food Production

For the foreseeable future, there is much evidence to suggest that it will be difficult, but by no means impossible, to maintain the rate of progress in food production in developing countries, which has been realized during the past 20-30 years. It is doubtful, for example, whether those regions that have benefitted from the green revolution in rice and wheat production can continue to enjoy the same rates of gain in productivity that have occurred in recent decades. Furthermore, it will be very difficult to extend the green revolution in rice and wheat to the other half of rice and wheat producers in the developing world whom it has not yet reached.

In addition to the difficulty of sustaining the rates of gain in food production through the green revolution, many other limitations will make the realization of sustainable production extremely difficult unless remedies can be found and implemented.

Population Growth

On a global basis, agriculture must produce enough to feed some 80-100 million additional people each year. The enormity of this problem is compounded by the fact that about 90% of this increase in population is occurring in the developing world.

Expansion in the numbers of people increases the demand for cropland while simultaneously expanding the need to take land out of production to accommodate other requirements. Furthermore, expanded production in response to rising demand increases the pressures on those natural resources that are vital to sustain production, often with serious environmental consequences.

Limited Availability of Land

Globally, opportunities to expand the area of productive agricultural land vary with ecological, socio-economic and demographic circumstances. Consequently, in many countries, the growing demand for agricultural products must be met primarily by intensification, rather than by extending production into new areas.

The Determinants of Sustainability

Production Systems

Sustainability is determined by the complex interactions of the biological, physical and socio-economic factors that constitute the basis of all production systems. A comprehensive approach is therefore required to improve existing systems and to develop novel ones that are more sustainable. In particular, methodologies must be developed for studying, in quantitative terms, the spatial and temporal relationships of the components of complex systems, such as those involving agroforestry, their productive capacity, and the opportunities they present for the control of pests and diseases.

Biological Determinants

It is essential for future sustainability that work on the conservation of genetic resources should be continued. The preservation of obsolete crop varieties and animal breeds is vital for the success of future breeding programmes. National authorities should be encouraged to give greater attention to the conservation *in situ* of wild species of both plants and animals.

If the needs for agricultural products of rapidly increasing populations are to be met, both yields per unit area and per unit time must be substantially increased. Such intensified production favours the build-up of pests which, unless adequately controlled, seriously limit productivity. Although there is wide variation, it is estimated that pests account for field losses of some 35% of the potential production of major food crops, with the greatest losses occurring in the developing countries.

The long-term control of pests is also threatened by break-down in the effectiveness of pesticides and host-plant resistance because of mutation of the pests. The research required to maintain the levels of control already achieved is important for the achievement of sustainability.

The sustainability of animal production depends partly on finding improved methods of controlling diseases and parasites, and partly on improving nutrition. To enhance productivity and avoid over-grazing, balanced production systems involving both crops and livestock are required.

Physical Determinants

Soils. No single resource is more important to achieving a sustainable agriculture than the soil which contains essential nutrients, stores the water for plant growth, and provides the medium in which plants grow. Soil erosion is already serious in some parts of the world, while in many others it has increased to the point where losses exceed the formation of new soils through weathering. When this occurs,

the soil is, in effect, being mined, converting renewable resources to non-renewable ones. Loss of topsoil through erosion causes loss of fertility and deterioration of physical properties, resulting in a decline in productivity.

Population pressures are contributing to other difficulties in maintaining soil productivity. As fuelwood supplies are diminished, expanding populations in many areas have become increasingly dependent on crop residues and animal manures for fuel, thereby reducing their use in replenishing nutrients and organic matter.

Water. Globally, agriculture is the principal user of accumulated reserves of water. From historic times, irrigation has been used to help farmers to secure a reliable and timely supply of water for their crops. During the 1950s and 1960s, irrigated areas expanded at the rate of about 4% annually. By the early 1980s, the rate of growth had declined to less than 1%.

Non-sustainable use of water, involving both the use of fossil water as well as the overdrafting of rechargeable aquifers, is occurring in a number of agricultural areas throughout the world. Irrigation water is often used inefficiently, with much more water transported and applied than crops require. Furthermore, poor irrigation practices result in severe problems of land degradation through water-logging, salinization or both.

For those vast areas in developing countries that depend on rainfall for their agriculture, efficient use is just as important as for irrigation water. Inappropriate soil and water management under rainfed agriculture is one of the primary causes of land degradation.

Atmosphere. Many human activities release harmful gaseous elements into the air, some of which give rise to acid-contaminated rainfall. Others damage the ozone layer exposing the earth to greater ultra-violet radiation. The combustion of fossil fuels and wood increases the concentration of carbon dioxide, giving rise to a warming trend and predicted changes in rainfall distribution, the melting of polar ice and thermal expansion of the sea. The detailed effects of these changes are difficult to predict, but at least some of them adversely affect the sustainability of agricultural production, either locally or generally.

Hazardous Chemicals. Industry and its products cause a wide variety of chemicals to be released into the environment, many of which can be harmful. The large array of chemicals used by modern agriculture are also potentially hazardous, because they can be misused, or they may contribute to the accumulation of toxic substances in the soil, such as the cadmium contained in some deposits of rock phosphate. Natural problems of soil toxicity are also widespread in certain soil types and salinization is a hazard in many irrigation schemes.

Energy. Traditional cropping systems such as shifting cultivation are sustainable only because they exploit for arable cropping only a fraction of the land used for maintaining its fertility. The energy efficiency is considerably less than unity. Although high-

yielding production systems use considerably more energy, their efficiency of use is potentially much greater. By meeting the increased needs for agricultural products by growing more per unit area rather than by expanding the area of production, the use of one unrenewable resource (oil) is substituted for another (soil). For the foreseeable future, it can be argued that the cause of sustainability would be better served by saving soil at the expense of oil, rather than by conserving oil and degrading soil.

Socio-economic and Legal Determinants

The achievement of sustainability requires vigorous agricultural development which is often hampered by urban-biased development strategies. Consequently, agriculture is deprived of the financial and administrative resources, as well as the political support, that its central place in the economy would justify. Farmers are forced into using methods that give immediate returns, the environment becomes degraded, and the investments needed to conserve natural resources become unattractive.

In many developing countries, a weak infrastructure is a major constraint to the delivery of inputs and transport of farm commodities to market. Extending infrastructure helps to remove these constraints and allows further intensification of production in favourable areas, thus helping to reduce the pressure for increased production in the more fragile environments.

In many circumstances, the achievement of sustainability will require the use of purchased inputs such as seed, fertilizers, pesticides, implements and machinery. High prices and the lack of credit, as well as a poor infrastructure, often make them difficult to obtain.

The development of effective agricultural research, extension, and education programmes is vital to the achievement of sustainability. Despite the high financial returns such investment yields, there is widespread evidence that they are underfunded in most developing countries. This often results in the inadequate development of human resources vitally needed to achieve sustainability objectives.

Systems of land tenure that discourage producers from conserving natural resources and investing in the future productivity of the land may also limit agricultural development and the achievement of sustainability. Moreover, many countries have inadequate laws and regulations to control the use of land and to protect forests and rangelands from indiscriminate exploitation.

Contributions by the IARCs to Research Related to Sustainability

TAC requested all the IARCs to provide information on their current research related to sustainability. The information is summarized in Annex 1. Chapter 3 gives examples of the wide-ranging research currently being undertaken on the various determinants of sustainability.

Recommended Strategies for Research Related to Sustainability within the CGIAR System

If sustainability in agricultural production is to become a reality, not only must the constraints that threaten it be alleviated, but major efforts must be made to increase productivity. TAC considers the challenge of finding timely and workable solutions to these problems as one which should receive the highest priority from all organizations that can make a contribution.

Many of the circumstances that limit the achievement of sustainability, however, cannot be solved by the CGIAR or through agricultural research alone. It is national governments and their development services that must bear the brunt of the problems and on whose commitment progress in achieving sustainability depends. Nonetheless, continuing research is crucial for success and international research institutions, as well as national agricultural research systems, must continually examine their programmes to give greater emphasis and visibility to those aspects that relate to sustainability.

Although the resouces of the CGIAR are small relative to total global expenditure on agricultural research by the public sector, the Centres can have a disproportionate impact because of their ability to influence the nature of research at other institutions. Furthermore, donors and other components of the CGIAR System can help to focus attention on sustainability, and encourage governments and relevant institutions to accord it high priority.

Much of the work being undertaken by the Centres already relates, to a greater or lesser extent, to problems affecting sustainability. The questions that arise, therefore, are not so much whether the Centres are working to make agriculture more sustainable, but whether they should be doing more, whether there should be a different emphasis in the work and whether major restructuring of the approach is necessary.

Research with a Sustainability Perspective

TAC does not view research related to sustainability as a separate or discrete activity. Rather, concern for sustainability should be reflected in the way in which the research is approached. TAC therefore recommends that research at the Centres designed to generate agricultural innovations should be planned and conducted with a sustainability perspective. TAC further suggests that in formulating or revising their strategic plans, Centres should include proposals for maintaining a sustainability perspective throughout their programmes.

Balance in Research

Although productivity research includes many aspects of resource management, the strengths of the various components of the multidisciplinary approach must be kept under review to ensure an

appropriate balance. Plant breeding, for example, can continue to contribute much to sustainability, but must not dominate Centre programmes to the extent that other approaches are neglected.

TAC recommends that Centres with commodity mandates review the balance of activities in their productivity research. Sustainability concerns may make it desirable, if not essential, for some Centres to give increased attention to research on problems of resource management.

Centres should not be restricted from penetrating deeply into aspects of the natural or socio-economic environments that are important for, but not specific to, sustainable production of their mandated commodities. Accordingly, TAC does not see a need for major restructuring within the CGIAR System, but changes in emphasis will be required, as well as stronger institutional collaboration.

Short-term and Long-term Objectives

If the goal of sustainable agriculture is to meet the changing needs of people, research must clearly cater for both short-term and long-term needs. Nevertheless, Centres must be guided by the principle that stability of the environment should not be consciously sacrificed for short-term gains. The aim should be to devise technologies that can meet short-term requirements while, at the same time, maintaining or enhancing the ability to meet long-term needs.

Levels of Inputs

TAC considers that the Centres should give greater emphasis to research designed to optimize productivity from the use of low levels of purchased inputs, consistent with the requirements of sustainability. The aim should be to promote a gradual evolution towards greater productivity from balanced systems, which may require progressively higher levels of purchased inputs to ensure that the requirements of sustainability are met. At all levels, the aim should be to use inputs as effectively as possible.

New varieties bred to make more effective use of scarce resources can aggravate the problems of soil mining unless nutrients are recycled as manure or plant residues, or replenished through the use of fertilizer. There are large differences, however, in the demands for nutrients made by different crops and different production systems. Cassava production systems, for example, are sustainable with very low external inputs provided they receive sound management.

Centres should review the emphasis given to low-input farming in their research programmes, and increase it where appropriate. They should also review their approaches to research on low-input farming to ensure that the sustainability perspective is adequately taken into account.

Public concern about sustainability in the industrialized countries arises partly from the use of high levels of inputs. Without

high-yielding production systems, however, it would be impossible to meet the food demands of the increasing world population unless more, but less suitable, land were brought into cultivation, further destroying natural ecosystems in the process.

TAC considers that the use of high levels of industrial inputs can make important contributions to sustainability and recommends that high-input production systems and related policy issues be included in research programmes of the CGIAR Centres. TAC suggests, however, a selective approach to research related to sustainability in these systems to avoid duplicating research being done in the industrialized countries.

Sustainability and Equity

TAC reaffirms its earlier recommendation that the Centres give greater emphasis to the development of techniques that are especially applicable in less-endowed regions. In addition, TAC stresses that assessment of these techniques with respect to sustainability requires a thorough analysis of evolving agricultural policies in the domains of their application.

Improved Production Systems

There are dangers both in disregarding the principles of traditional production systems and in assuming that, because they are appropriate in some circumstances, they will remain appropriate in others.

TAC encourages Centres to continue to investigate aspects of more intensive production systems based on sound ecological principles and the conservation of resources. Whenever appropriate, this work should include aspects of agroforestry.

Advances in Biotechnology

Centres must constantly assess, in relation to other needs and opportunities, how new techniques emerging from advances in the biological sciences might contribute to their work on sustainability and productivity.

TAC considers that Centres involved in productivity research should have the capability to monitor advances in biotechnology and, when appropriate, develop the in-house capacity to use techniques that would assist their programmes in a cost-effective manner.

Policy Research

Policy research has a particularly valuable role to play in the CGIAR System through its intimate interaction with technological research. Although many problems of sustainability do not have

technological solutions, they lend themselves to policy research aimed at discovering those options most likely to favour sustainability.

In its study of priorities and future strategies, TAC recommended a significant increase in policy research. TAC reaffirms this recommendation.

Relations with National Agricultural Research Systems

Centres could be very effective in encouraging national agricultural research systems to give greater attention and accord higher priority to considerations of sustainability, as well as in helping to strengthen their capacity to do so.

TAC recommends that Centres give high priority to strengthening the capacity of national agricultural research systems to incorporate a sustainability perspective into their research approach.

Training

TAC further recommends that Centres give high priority to the incorporation of a sustainability perspective in training programmes, making adjustments, where necessary, to meet the needs of national agricultural research systems in this respect and taking steps to harmonize their approaches.

The Role of Developing Countries

Whatever help the Centres provide to national systems in research and training, success in achieving sustainability will ultimately depend on the commitment of the developing countries themselves.

Collaboration with Institutions Outside the CGIAR System

In view of the contributions the Centres can make to the solution of large-scale and long-term problems of sustainability, the need for effective collaboration is greater now than ever before, not only with national systems, but also among the Centres themselves, as well as with institutions outside the CGIAR System.

TAC recommends that Centres continue to explore the potential for collaboration with other research institutions, including those in the private sector, particularly with a view to strengthening their research related to sustainability.

Research Needs and Resource Implications

While the Centres and the national agricultural research systems already make important contributions to the solution of problems

related to sustainability, the total current effort is unlikely to be adequate.

In view of the serious problems limiting the achievement of sustainability and the urgency for additional research to assist in their solution, TAC recommends that Centres review the priority accorded to sustainability in their budget allocations and increase it where appropriate.

TAC considers that, because much of the required additional work relates to the protection of the environment and the conservation of natural resources, it might well be possible to widen the avenues for donor support for this vital new thrust, compared with support for productivity research *per se*. TAC will support the Centres in attempts to attract funding for well-conceived new projects related to sustainability.

While many of the circumstances that limit sustainability cannot be alleviated through work supported by the CGIAR, members of the Group can bring their influence to bear in creating a greater sense of urgency amongst all concerned. TAC suggests that the issue of agricultural sustainability has major implications for the further development of the Third World and, indeed, for future global security.

TAC considers that the international donor community, as well as the governments of developing countries, have crucial roles to play in emphasizing the need to consider sustainability in allocating future resources and orientating future thrusts.

Conclusion

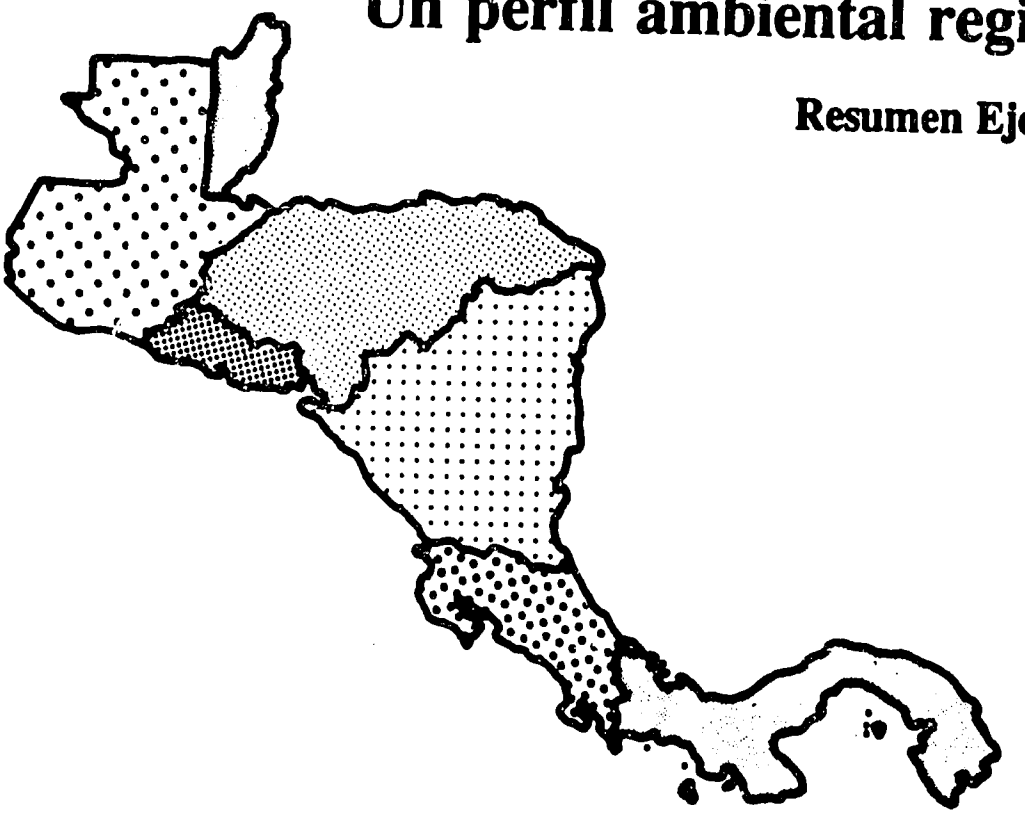
TAC has characterized sustainability in terms of the dynamics of population growth and resource conservation. The common challenge facing all concerned is to find ways of removing the impediments to sustainable agricultural production, whether the causes are technical, economic, social, institutional, political, or some combination of all.

A significant part of this challenge rests with the International Agricultural Research Centres. Accepting it offers them opportunities for making unprecedented contributions to the global community, as they help to find solutions to serious problems that significantly affect the future of humanity.

RECURSOS NATURALES Y DESARROLLO ECONOMICO EN AMERICA CENTRAL

Un perfil ambiental regional

Resumen Ejecutivo



RECURSOS NATURALES Y DESARROLLO ECONOMICO EN AMERICA CENTRAL

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Resumen Ejecutivo
Agosto, 1986

Por

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En nombre del Instituto Internacional
para el Ambiente y el Desarrollo / Earthscan

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INTRODUCCION

Centroamérica es a todas luces una Región que sufre profundos cambios. La mayoría de los análisis más recientes del área han enfocado la dinámica de la situación político-militar. Unos pocos, como el Informe de la "Comisión Kissinger", han intentado ir más allá de este análisis limitado para enfocar el desarrollo económico a mediano y largo plazo en la Región.

Muchos planes de desarrollo para la Región enfatizan la importancia crítica de la producción agrícola y sus posibilidades de expansión, especialmente para las exportaciones que permitirán obtener las divisas que desesperadamente se necesitan. La mayoría de la población de América Central ya depende de la agricultura para su subsistencia. Estas cifras están aumentando por el rápido crecimiento de la población en esta Región, a una tasa del 2,9% por año. La inversión industrial en la Región no se ha incrementado significativamente en los últimos años y es improbable que haya aumentos fuertes en el número de empleos industriales en el futuro predecible.

Los diversos planes de desarrollo agrícola asumen que deben hacerse inversiones cuantiosas para mejorar la infraestructura física de la Región. Años de negligencia y destrucción han dejado los caminos, instalaciones y puertos de América Central en pobres condiciones como para responder al auge agrícola. Ninguno de estos planes incluye medidas para restaurar y rehabilitar la infraestructura natural de la Región, en especial sus bosques, suelos y cuencas que constituyen el nervio vital de la agricultura.

De hecho, toda la evidencia indica que el ambiente natural de la Región ha estado deteriorándose rápidamente. Gran parte de las mejores tierras de la Región, se encuentran bajo severa erosión de suelo. En El Salvador, más del 50% de toda la tierra arable está peligrosamente erosionada. Gran parte de las nuevas tierras que están siendo habilitadas para fines agrícolas se encuentran en laderas empinadas y por lo tanto sujetas a erosión, o se ubican en las áreas húmedas y forestadas de la vertiente del Caribe. En estas tierras bajas de la vertiente del Caribe, gran parte de los suelos son inadecuados para una agricultura sostenida.

Hoy, quedan menos del 40% de los bosques de antaño de Centroamérica, habiéndose perdido dos terceras partes desde 1950. Las tasas de deforestación se han incrementado en cada década, desde la década de 1950, y tanto como alrededor del 3% de los bosques remanentes continúan desapareciendo cada año. A esta tasa, Costa Rica, justificadamente orgullosa de sus esfuerzos por conservar su rica herencia biológica, podría tener para el año 2000 muy pocos bosques primarios con valor comercial, fuera de sus parques nacionales. Los ecosistemas marinos también están bajo fuerte presión. En la última década, la captura de las dos especies comerciales más importantes, langostas y cambute (conchas), han descendido a 41% y 27% respectivamente de su producción anterior. Esto es debido principalmente a la espada de doble filo de la severa sobreexplotación de estas especies cercanas a la costa y a la creciente destrucción de manglares que constituyen valiosos hábitat reproductivos.

Estas tendencias son similares en todas las Repúblicas Centroamericanas, sin considerar su orientación política pasada o actual. Costa Rica, con sus 40 años de tradición democrática, está perdiendo su cobertura forestal a la misma tasa que Guatemala, dominada hasta recientemente por oligarquías militares, o aun su vecina Nicaragua, con su régimen revolucionario.

Esto no quiere decir que los problemas de América Central no demanden principalmente soluciones políticas. Más bien implica que cualquier plan que surja de estas soluciones fallará en el área rural a menos que contenga medidas ambiciosas para replantar los bosques, proteger las cuencas críticas, rehabilitar las tierras degradadas y ayudar a los desesperados pequeños agricultores para que puedan ganarse una vida decente con prácticas agrícolas sostenidas.

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El presente estudio fue preparado por el Instituto Internacional para el Ambiente y el Desarrollo (IIED) bajo los auspicios de su acuerdo cooperativo con la Agencia Internacional para el Desarrollo de Estados Unidos (AID). Desde 1979, AID ha estado preparando una serie de perfiles ambientales por países para ayudar a la Agencia y a los Gobiernos anfitriones a incorporar el planeamiento y manejo ambiental en el proceso de desarrollo. Este volumen utiliza aquellos perfiles como un punto de partida, pero también va más allá con información previamente compilada para documentar el rápido y extensivo deterioro de los recursos naturales renovables de toda la Región. Este es el primer vistazo regional del problema. La versión completa será publicada en inglés por "Transaction Books", New Brunswick, N.J., EE.UU. en junio de 1987.

La preparación de cualquier análisis multi-país requiere intensa colaboración con un amplio rango de individuos e instituciones. Tanto la recolección y revisión de este cuerpo de información masiva y dispersa requirió la participación de numerosos colegas de amplio prestigio. Para asegurar que la información contenida dentro de este informe fuera correcta y tan al día como posible, IIED organizó y reunió a un comité de revisión técnica en América Central. Estamos agradecidos con sus miembros por su tiempo y sus valiosos consejos como grupo e individuos.

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David Runnals
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AMERICA CENTRAL - UNA REGION EN CRISIS

Los recursos naturales básicos de América Central, su tierra, bosques, recursos de agua, áreas costeras y pesquerías están mal utilizados y esto compromete la prosperidad económica futura de 25 millones de personas de la Región.

En toda Centroamérica, la abrumadora evidencia es que las presiones de la creciente población y las economías en expansión están causando que la gente y los gobiernos sobreexploten los recursos naturales a su disposición, a fin de satisfacer necesidades diarias inmediatas; incrementar las oportunidades de empleo, incrementar los actuales ingresos, y evitar decisiones políticas difíciles como la redistribución de las tierras productivas. Como consecuencia, las tasas de reducción de bosques, de suelos productivos, pesquerías y otros recursos vitales, exceden en mucho a las tasas de renovación. Asimismo, algunos problemas derivados como erosión del suelo, sedimentación de represas hidroeléctricas y de puertos costeros, así como la contaminación de las aguas, han alcanzado proporciones críticas en muchas partes de la Región.

Esta explotación de tipo "minera" del ambiente, puede que facilite los esfuerzos de subsistencia a corto plazo tanto de los gobiernos como de la gente, pero en última instancia, contribuye en realidad, a la creciente disminución de la producción de alimentos, con bajas en el ingreso per cápita y al bienestar físico que se verifica en muchas partes de América Central durante la década de 1980. La creciente evidencia sugiere que todas las naciones de la Región están experimentando pérdidas financieras directas y han sacrificado ya importantes oportunidades en el futuro económico como resultado del manejo descuidado de recursos naturales renovables vitales.

Para salir adelante con estos problemas y aliviar el sufrimiento humano generalizado, los gobiernos de la Región, así como también otras naciones y organizaciones internacionales de asistencia que financian programas de desarrollo en América Central, deben tomar medidas para ayudar a los países de la Región a ejecutar prácticas adecuadas de manejo de recursos naturales. Deben dedicar más atención a las consecuencias ambientales de muchos de los programas de desarrollo en la Región. A menos que los programas de desarrollo incluyan enfoques regionales a los problemas de la Región, llegarán a ser contraproducentes a largo plazo.

En el centro de la crisis se destacan dos factores sobresalientes:

- La población de la Región ha aumentado rápidamente.

  En 1920, había alrededor de cinco millones de personas en los siete países de Centroamérica. En 1960, había 12.5 millones. En 1985, la población era de 25 millones, un incremento del 400% desde 1920. La población de América Central ha crecido a una tasa más alta que en cualquier otra Región del mundo en las últimas décadas, y ahora está creciendo a una tasa de 2.9% al año, más alta que en toda América Latina e igual a la de Africa. Si ésta tasa se mantiene, la población de la Región se doblará nuevamente en 24 años. En Nicaragua, Honduras y Guatemala, donde se encuentra más del 60% de la población regional, la tasa de crecimiento anual de la población es actualmente de alrededor de 3.5%.

- Esta población en rápido crecimiento hace demandas excesivas para la base de recursos naturales renovables que además sufre de mal manejo y sobreexplotación.

  Los problemas de rápido crecimiento de población son agravados por otros dos factores que sólo ayudan a incrementar las tensiones puestas sobre la frágil base de recursos naturales de la Región.

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Primero, las oportunidades para ganarse la vida en los sectores manufactureros o de servicios están limitadas severamente por la grave situación económica que predomina en todos estos países. Segundo, una serie de tradiciones arraigadas, tanto políticas como económicas, que limitan el acceso a la gran mayoría de la población a las tierras agrícolas más fértiles.

En toda América Central, estos factores se han combinado para dejar a la masa de población rural, cada vez con más población, en la difícil posición de compartir los limitados recursos de la Región, lo cual produce una disminución en las cantidades de alimentos básicos requeridos; asimismo en los últimos años, especialmente en las áreas rurales, se ha sufrido una disminución de los niveles de vida, cuando estos son medidos por índices de ingreso per cápita y de calidad de vida.

En muchos casos, el único recurso para gran parte de la población rural de Centroamérica en los últimos años, ha sido el de intensificar la explotación de las tierras y de los otros recursos naturales adyacentes. Esto ha tenido consecuencias devastadoras para el ambiente en toda la Región. Muchas cuencas hidrográficas muy empinadas y quebradas han sido deforestadas con fuego, para ampliar el área de cultivos y ganadería o por otras prácticas descuidadas en el uso de la tierra, causando erosión masiva, incrementando las inundaciones y corrientes de barro durante la estación lluviosa, y contribuyendo a reducir los caudales durante la estación seca del año. Una erosión severa de tierras también se está presentando en tierras menos quebradas, principalmente debido a la extensa deforestación, al sobrepastoreo y la compactación del suelo por la ganadería así como por el agotamiento de las tierras limpiadas con fines agrícolas. Cabe señalar que irónicamente gran parte de la madera que está siendo cortada en Centroamérica está siendo quemada o abandonada en el sitio en vez de ser cosechada, aumentando sobremanera el desperdicio de recursos potencialmente valiosos.

Recursos Naturales y Tendencias Socioeconómicas

La crisis ambiental de América Central está ligada estrechamente a un amplio espectro de problemas socioeconómicos que atañen a los siete países de la Región: Belice, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua y Panamá. Entre estos factores tenemos los siguientes:

- Las economías de la Región están arruinadas tanto por la disminución del ingreso como por el aumento de la deuda internacional. La productividad agrícola es baja, la producción de alimentos básicos per cápita se ha detenido o ha disminuido en toda la Región mientras los ingresos por exportación no han aumentado lo suficientemente rápido para permitir aumentar la importación de alimentos. Las cosechas de langostas y otros valiosos moluscos han disminuido en los últimos años en muchas áreas costeras de la Región.

- Prosigue la alta migración desde áreas rurales, especialmente desde las áreas densamente pobladas de las laderas de tierras altas, hacia áreas urbanas de la Región. La mayoría de los Gobiernos están tratando de desarrollar las áreas frágiles de la vertiente del Caribe como una válvula de escape para desviar parte de estos migrantes, pero en muchos casos la producción agrícola de estas nuevas tierras "conquistadas" ha sido decepcionante y no sostenida. Aunque gran parte de la electricidad de la Región es actualmente generada por hidroenergía, este recurso permanece subutilizado. La capacidad hidroenergética que existe está seriamente amenazada por el deterioro de las cuencas hidrográficas y la consecuente sedimentación en represas y lechos fluviales.

- La salud y los indicadores de calidad de vida de los países de América Central también presentan un cuadro deprimente. Por ejemplo, las tasas de mortalidad infantil (0 - 1 año) y de niños

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pequeños (1 - 4 años) aún es alta en gran parte de la Región. En contraste con el resto del hemisferio, las enfermedades transmisibles, tales como la diarrea, las enfermedades respiratorias, la polio y la tuberculosis son las principales causas de muerte, excepto en las áreas urbanas de Costa Rica y Panamá. El resurgimiento de la malaria es un problema particularmente serio para Centroamérica, especialmente por tratarse de la aparición de especies de zancudos portadores de la malaria que han resultado ser resistentes a los insecticidas. El uso generalizado y en altas dosis de plaguicidas, muchos de los cuales ya no se usan en los Estados Unidos, también amenaza la calidad ambiental y la vida humana.

Todos estos problemas socio-económicos actualmente se combinan en América Central para hacer las condiciones de vida diarias cada vez más deprimentes para un número creciente de personas. El Informe de la Comisión Nacional Bipartita para América Central ("Comisión Kissinger") concluyó en 1984 que alrededor de la mitad de la población urbana y hasta tres cuartas partes de la población rural en El Salvador, Guatemala, Honduras y Nicaragua, podrían no estar satisfaciendo sus necesidades básicas en términos de alimentación, vivienda, salud y educación. Aunque la población se encuentra relativamente un poco mejor en Belice, Costa Rica y Panamá, también allí y particularmente los habitantes de las áreas rurales, han experimentado marcados descensos en sus niveles de vida en los últimos años.

Patrones Despilfarradores del Desarrollo Económico

Ni la crisis ambiental ni la crisis económica que hoy día amenazan socavar los esfuerzos para mejorar el bienestar de la población de América Central eran inevitables. A pesar de los problemas causados por eventos internacionales como, por ejemplo, las condiciones comerciales más desfavorables, el aumento de los precios del petróleo en la década de 1970 en más de cuatro veces y el incremento acelerado de las tasas de interés sobre la deuda externa, todos los países de Centroamérica tienen una gran capacidad de autoabastecerse. De hecho, en términos globales, Centroamérica es extraordinariamente rica en recursos naturales. Sus suelos volcánicos están entre los más fértiles del mundo, también posee abundantes existencias de madera y de agua dulce, asimismo sus aguas costeras producen langostas, camarones y otros numerosos recursos marinos.

¿POR QUE ENTONCES LA CRISIS?

Cuando se piensa acerca de las economías de América Central, varios factores críticos deben tomarse en cuenta:

- Gran parte de la población centroamericana depende directamente de la base de recursos naturales para su subsistencia. De hecho, alrededor de una cuarta parte del total de la producción económica interna en cada uno de los siete países proviene de la agricultura, la forestería, la pesca y actividades relacionadas. Esta dependencia no se reducirá de manera importante en el futuro predecible, ya que las industrias manufactureras y el sector servicios en la Región no podrán proporcionar suficientes empleos para la creciente población.

- Por razones sociales, económicas y políticas de larga historia, una pequeña minoría en cada país centroamericano (excepto en Nicaragua), controla la mayor parte de la riqueza y de las tierras arables. Gran parte de las mejores tierras adecuadas para producir alimentos básicos, o están ocupadas por grandes propiedades subutilizadas, o son usadas para la crianza de ganado o cultivos de exportación tales como algodón. Este sector agrícola comercial proporciona importante empleo durante la estación de cosecha, sin embargo, en muchas áreas este empleo decae durante otras estaciones.

- Una mayoría abrumadora de la fuerza laboral en la agricultura de América Central, los agricultores con pequeñas propiedades y campesinos sin tierra, está siendo relegada a tierras de ladera,

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marginales o frágiles. Estos agricultores de subsistencia producen gran parte de los alimentos para consumo doméstico, pero los rendimientos de sus cultivos son muy bajos en comparación a los niveles de Estados Unidos. Muy pocos programas gubernamentales para aumentar los rendimientos o ingresos se han centrado en estos agricultores. Muchos de los Gobiernos de la Región continúan fomentando la migración hacia áreas de frontera agrícola en las áreas escasamente pobladas de la vertiente del Caribe, frecuentemente con la ayuda de fondos externos. Mientras, algunas de estas fronteras agrícolas pueden ameritar desarrollo, gran parte de tales tierras no sostendrán la productividad agrícola tradicional, basada en prácticas de deforestación masiva (sistema de milpa) o con prácticas tradicionales de cultivos anuales como es costumbre entre los pequeños agricultores. Así, la solución a las sobrepobladas áreas urbanas de América Central y a la creciente existencia marginal de los agricultores pobres no se encontrará en el traslado de estas masas hacia las áreas de frontera agrícola de América Central. Sin embargo, la apertura de nuevas fronteras agrícolas continúa, y a medida que avanza, se están destruyendo permanentemente algunos de los bosques tropicales primarios donde se encuentra la mayor diversidad biológica natural del planeta.

Dentro de este contexto se pueden identificar los pasos necesarios para crear un progreso económico duradero en Centroamérica. Primero, el desarrollo agrícola es de importancia fundamental. Segundo, aunque la producción continuada de cultivos de exportación es necesaria para apoyar economías deprimidas y generar ingresos de divisas, es imperioso poner más atención al mejoramiento de la productividad en el sector agrícola de subsistencia. Tercero, aunque las áreas no desarrolladas de la vertiente del Caribe pueden tener un potencial importante, el desarrollo descuidado de estas tierras probablemente agrave los problemas actuales tanto económicos como ambientales de la Región.

En resumen, la combinación de desarrollo cuidadoso y el manejo eficiente de los recursos naturales de la Región constituye una de las claves vitales para el futuro progreso económico de Centroamérica. Irónicamente, sin embargo, los registros de los últimos años indican que casi toda la expansión económica generada por la agricultura e industrias relacionadas, ha sido como resultado de la explotación acelerada de estos recursos más que por el manejo de ellos. A lo largo de todo el Istmo, estos sistemas de recursos naturales están siendo explotados como si fuesen minerales, derrochados, mal manejados, gradualmente degradados y reducidos en cantidad y calidad.

Consideremos algunos de los indicadores que conducen a esta conclusión:

- De acuerdo con un informe previo hecho para la "Comisión Kissinger", se estima que casi la mitad de las fincas de toda la Región están usadas deficientemente o mantienen grandes cantidades de tierra en barbecho permanente.

- La productividad por hectárea de tierra es baja en casi todos los cultivos; en particular los cultivos alimenticios rinden alrededor de una tercera parte de los niveles alcanzados en Estados Unidos.

- Se estima que actualmente alrededor de dos terceras partes de las mejores tierras agrícolas en Centroamérica están siendo utilizadas para ganadería extensiva, con un retorno económico muy por debajo del que podría obtenerse con cultivos para exportación o alimenticios.

- Las operaciones de las fincas ganaderas usan muchas más tierras que las necesarias y son altamente deficientes en producción, en parte, porque en su mayoría los pastos de la Región son dejados en su estado natural en vez de ser mejorados y manejados.

- Existen enormes despilfarros de madera y solo una pequeña porción de la madera cortada anualmente en la Región se usa comercialmente.

- Las tasas de reforestación son muy bajas en toda la Región, alcanzando alrededor del 7% de la corta anual de bosques.

- Se hace muy poco procesamiento de la madera en bruto, sin considerar el amplio espectro de usos industriales disponibles; esto implica que la región es un exportador neto de madera con bajo valor agregado y un importador neto de muchos productos de alto valor agregado de madera, pulpa y productos de papel.

- La sobreexplotación pesquera es endémica en los arrecifes de coral, cayos, áreas ricas en pastos marinos y otras áreas cercanas a la costa en toda la Región, a tal punto que la escasez de especies con alto valor, como por ejemplo, langostas, cambute y camarones, se ha transformado en muchas áreas en uno de los principales problemas.

- Al mismo tiempo, el desarrollo de la industria pesquera en la plataforma continental y de alta mar en gran parte de Centroamérica, continúa atrasada por la falta no solo de capital y personal experimentado, sino también por la falta de actividad empresarial.

- Existe un derroche a gran escala de pescados, ya sean comestibles o dañados en el proceso de captura, pero potencialmente útiles para procesar, especialmente cuando son extraídos en conjunto con las faenas de pesca de camarones y otras especies marinas de alto valor.

Estos y otros numerosos indicadores de deficiencia económica en las industrias basadas en recursos naturales de Centroamérica son las principales barreras para el futuro desarrollo económico de la Región. Ellos también son factores causales principales de la masiva degradación de los suelos, bosques y recursos de agua de la Región. A menos que estos problemas tanto de deficiencia económica como de deterioro ambiental sean manejados simultáneamente en la década venidera, muy poco progreso se puede esperar para mejorar el nivel de desarrollo social y económico en América Central.

CONSECUENCIAS AMBIENTALES DEL MAL USO Y MAL MANEJO DE LA BASE DE RECURSOS NATURALES DE AMERICA CENTRAL

Consideramos ahora algunas de las consecuencias ecológicas destructivas que están relacionadas con el mal uso y mal manejo de la base de recursos naturales de América Central.

Pérdida de Bosques

El cambio ecológico más importante que está ocurriendo en toda Centroamérica como resultado de presiones por el crecimiento de la población y económicas es la rápida y continua transformación de los bosques a otros usos de la tierra. Actualmente solo alrededor del 40% del área de los siete países permanece con bosque. Esto no es inusual en comparación a otras regiones del mundo. Lo que es insólito, sin embargo, es la velocidad a la que el paisaje centroamericano está siendo transformado. Por ejemplo, se ha estimado que dos tercios de todos los bosques cortados desde que Centroamérica fue colonizada, han sido deforestados desde 1950. Las tales tasas de corta de bosques se han incrementado en cada década desde 1950. En 1970, 49% de Centroamérica estaba bajo bosque natural denso y bosque natural abierto. En 1980, esta cifra se redujo al 41% – una pérdida en una década de 8% de la cobertura boscosa de la Región.

La deforestación, por supuesto, tiene su lado positivo. Puede y ha proporcionado tierra para cultivos y pastizales. Pero la deforestación en América Central ha sido económicamente derrochadora. Gran parte de la madera que ha sido cortada está siendo quemada o abandonada para que se pudra en los campos. La cosecha comercial de madera contribuye significativamente a la economía de solo un país en la Región, Honduras.

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Pero aún para este país existe una estimación que señala que cada año se quema o se deja pudrir madera con un valor comercial de US$320 millones. Por otra parte, muchos especialistas ahora concuerdan que la mayoría de las tierras con el mejor potencial agrícola y que antaño estaban cubiertas de bosques ya han sido ocupadas. Gran parte de los bosques remanentes en Centroamérica se ubican sobre suelos que son de calidad baja y sujetos a un rápido deterioro.

La deforestación también puede eliminar especies de plantas que pueden algún día probar ser valiosas para productos farmacéuticos, para hibridación de plantas económicas e incorporar características valiosas o para plaguicidas. Alrededor de una cuarta parte de las medicinas actualmente producidas en forma comercial en Estados Unidos han sido derivadas en su totalidad o en parte de plantas tropicales. La recolección, clasificación, investigación para usos potenciales y comercialización de plantas tropicales aún es una actividad incipiente. Hay indicaciones que al menos el 15% de unas 1.500 especies arbóreas evaluadas críticamente en Costa Rica pueden ser potencialmente útiles en el tratamiento del cáncer.

Belice es el único país de la Región que no está experimentando una gran destrucción de bosques; la pérdida es de menos del 1% por año de la cobertura de sus bosques remanentes. La razón principal es que Belice tiene una pequeña población (sólo 150.000 habitantes) y la demanda por tierras para ganadería y agricultura en el interior no ha sido lo suficientemente fuerte como para estimular el ataque sobre los bosques como ha ocurrido en los otros países de América Central. Belice, así, tiene la oportunidad de evaluar cuidadosamente sus recursos forestales y proteger aquellos bosques menos adecuados para la agricultura antes de que las presiones de población también desencadenen una deforestación desordenada.

Degradación de Tierras

La degradación de tierras está alcanzando proporciones de crisis en cada país de Centroamérica, excepto en Belice. Las razones son: deforestación extensiva, expansión de la actividad ganadera, agricultura en laderas y áreas montañosas y falta de conservación adecuada de suelos y prácticas de manejo de tierras.

El problema es más serio en las áreas que drenan al Pacífico donde vive la mayor parte de la población. Allí alrededor del 40% de todas las tierras sufren tasas de erosión lo suficientemente altas para socavar la productividad de la tierra. El Salvador es el país más críticamene afectado. En 1984, más del 50% de ese país estaba sujeto a una seria erosión del suelo o estaba significativamente degradado por las fuerzas combinadas de deforestación, ganadería y otras prácticas agrícolas perjudiciales realizadas por campesinos y recolectores de leña. Si bien otros países de la Región podrían percibir, generalmente en forma errónea, que pueden permitirse compensar la pérdida de tierra productiva en la vertiente del Pacífico de la Región, trasladándose a tierras en la vertiente del Caribe esto no se aplica a El Salvador que sólo tiene costa en el Pacífico. En la vertiente del Caribe, la degradación es más obvia en las áreas de frontera agrícola, recientemente deforestadas para cultivo, ganadería y colonización. Gran parte de estas tierras son abandonadas después de sólo algunos ciclos de cultivo.

La degradación de tierras y la erosión de suelo conduce, por supuesto, a incrementar las cantidades de sedimentos que fluyen hacia las corrientes de agua dulce, los ríos, los lagos, las bahías costeras y los estuarios. En Guatemala, por ejemplo, se estimó que el acarreo anual de suelo en áreas aún cubiertas con vegetación varía entre 20 y 300 toneladas métricas por km^2. En áreas deforestadas el acarreo anual de suelo se eleva entre 700 y 1.100 toneladas métricas por km^2.

Esta carga de sedimentos conlleva consecuencias desastrosas aguas abajo. Examínese solamente la generación de energía hidroeléctrica, que se ha incrementado más de cinco veces en los últimos 20 años en América Central.

Un estudio reciente en el nuevo proyecto hidroeléctrico en Pueblo Viejo Quixal, Guatemala, encontró que los sedimentos se estaban acumulando considerablemente más rápido que lo estimado originalmente en el sitio de la represa y en la cuenca alta. Si esto no se corrige, la vida proyectada del plan será drásticamente reducida y su capacidad generadora disminuirá. El costo de las medidas remediales que permitirían a la represa producir al ritmo de sus tasas originalmente proyectadas será de, por lo menos, US$100 millones si continúan las actuales tasas de sedimentación.

También en El Salvador la alta sedimentación, en los últimos años, ha reducido el potencial de generación del proyecto Cinco de Noviembre y ha incrementado el costo de mantención del equipo generador de energía. La sedimentación de represas ya está creando problemas en nuevos proyectos hidroeléctricos en ese país.

En Honduras, los proyectos hidroeléctricos actualmente en construcción, a un costo de casi US$1.000 millones, obtendrán su agua de cuencas hidrográficas con altas tasas de sedimentación. Pero poco se ha hecho para reducir la amenaza de sedimentación en esos proyectos.

En Costa Rica, que obtiene 99% de su energía eléctrica de proyectos hidroeléctricos, virtualmente todas las cuencas que surten a cada una de las principales plantas, están deteriorándose. En una de estas plantas, la pérdida de ingresos debido a sedimentación se estima entre US$133 – 274 millones.

El problema se extiende mucho más allá de los límites de los países individuales, ya que muchas cuencas abarcan más de un país. El Río Lempa es un buen ejemplo. Con sus nacientes en la parte centro-sur de Guatemala y el oeste de Honduras, escurre hacia El Salvador. Drena 49% del territorio de El Salvador y proporciona el 93% de la capacidad generadora hidroeléctrica de este país. Cerca de 8.000 km^2 de los 18.000 km^2 de la cuenca del Lempa están fuera del control de El Salvador, ya sea en Guatemala u Honduras. Por lo tanto, gran parte de los sedimentos que están perjudicando las plantas hidroeléctricas de El Salvador provienen de Guatemala y Honduras.

La sedimentación también ha causado otros problemas. En Panamá, la rápida deforestación ha duplicado la sedimentación en el lago que abastece agua para operar el Canal de Panamá, el pilar de la economía panameña. En Honduras, una rápida acumulación de sedimentos está reduciendo la capacidad de la represa que proporciona agua para la capital, Tegucigalpa. En Guatemala, la sedimentación redujo la capacidad de carga del río Motagua en alrededor del 50% entre 1960 y 1980. Esto perjudica a un extenso programa de riego patrocinado por el Gobierno, y ha incrementado las inundaciones causando millones de dólares en daños y reduciendo la distancia navegable del río.

Destrucción de Recursos Costeros

Debido a su localización especial, por ser una estrecha masa de tierra separando a los dos océanos más grandes del mundo en un clima tropical, América Central ha sido dotada con algunos de los recursos costeros más abundantes, hermosos y productivos de la tierra. Sus arrecifes de coral, manglares y estuarios proporcionan hábitat para moluscos y peces de gran valor comercial.

Pero estos recursos también están ahora amenazados. Un problema es la pesca excesiva principalmente en aguas cercanas a la costa. En Belice, la captura de conchas marinas ("Queen conch" o cambute) ha decaído en un 75% en los últimos años desde su auge en 1972. La captura de peces en gran parte de las áreas costeras de América Central aumentó en las décadas de 1960 y de 1970. Pero desde entonces se ha mantenido relativamente estancada o ha disminuido. En Honduras, la población de cambute ha disminuido tan dramáticamente que la cosecha para uso comercial o consumo local prácticamente ha cesado. La captura de langostas y camarones ha decaído desde 1978, cuando llegaron a un máximo de 5.000 toneladas métricas. Los gobiernos de la Región han tratado de detener la sobrecaptura limitando las estaciones de captura para varias especies, limitando el número de licencias de botes, limitando las cosechas y controlando la pesca ilícita.

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Otro problema es la continuación de la destrucción extensiva y la degradación de hábitat costeros vitales. No importa cuán efectivos sean los intentos para controlar la sobrecaptura, el futuro abastecimiento de pescado en la Región se reducirá, a menos que se detenga la destrucción y degradación del hábitat. Se está tardando mucho para reconocer este problema y ningún Gobierno en la Región ha hecho esfuerzos importantes para preservar, proteger y manejar sabiamente los recursos costeros.

Los bosques de manglar son las áreas por excelencia de reproducción para muchas especies de peces, camarones y langostas. No obstante los bosques han sido cortados para ser utilizados o removidos para dar paso a desarrollos costeros, o dañados por contaminación provocada por el hombre a un ritmo creciente en los últimos años.

En Guatemala, Honduras y El Salvador, los manglares son ampliamente cosechados para leña y para hacer carbón. Algunas áreas han sido completamente destruidas, otras degradadas. La escorrentía proveniente de zonas agrícolas también afecta los manglares en El Salvador, Honduras y Guatemala ya que las aguas de escorrentía transportan sedimentos y residuos de plaguicidas hacia las aguas estuarinas de los manglares.

En Costa Rica, los manglares han sido destruidos para proporcionar corteza para la industria de la curtiembre (recientemente prohibido), así como para la producción de sal y para el desarrollo costero. En Panamá, los manglares han sido drenados, deforestados y rellenados para expansión urbana, actividades de maricultura y desarrollo para turismo.

Se ha estimado que 1 km^2 de estuario con manglar puede producir un rendimiento comercial de US$95.000 por año en producción de pescado y moluscos. Así, agregado al daño ecológico causado por la destrucción de manglares, los países centroamericanos han sufrido también importantes pérdidas económicas debido a la destrucción del manglar. Belice es el único país en la Región, donde los manglares no están siendo significativamente degradados o eliminados.

Plaguicidas

En América Central, el uso indiscriminado de plaguicidas, muchos de ellos no permitidos o restringidos en Estados Unidos, como por ejemplo DDT, DBCP, Leptofos y BHC, origina una de las contaminaciones ambientales más insidiosas y que causa problemas mayores en la salud humana. Muchos de estos plaguicidas son extremadamente peligrosos; algunos son tóxicos a los humanos, otros pueden causar cáncer o esterilidad. Los niveles usados, especialmente en las áreas de cultivo de algodón en la costa del Pacífico, exceden de lejos las dosis recomendadas. Esto por supuesto, tiene un importante costo económico, ya que en algunas áreas los plaguicidas actualmente representan casi el 50% de los costos de producción.

El problema de los plaguicidas es múltiple. Los trabajadores agrícolas en el campo usan poca o ninguna ropa protectora. Algunos no pueden leer o no entienden las etiquetas de advertencia. Algunos lavan los equipos usados en las aplicaciones en los canales de riego o en los ríos. Dado que gran parte de las viviendas de los trabajadores no poseen servicio de agua, los trabajadores y sus familias a menudo se bañan en ríos contaminados con plaguicidas. La fumigación aérea derrochadora y sin cuidado agrava el problema; en algunos países los pilotos fumigadores son pagados en función del volumen de plaguicida empleado.

El fuerte uso de plaguicidas a través de los años en América Central ha destruido algunos insectos predadores naturales y ha originado algunos insectos resistentes a los plaguicidas. Esto ha sido resultado del incremento de las aplicaciones de plaguicidas, ya que en algunas áreas se ha pasado de las recomendaciones de un promedio de 8 aplicaciones por año, a más de 40.

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El amplio uso y abuso de los plaguicidas ha provocado muchos envenenamientos y muertes. En un período reciente de cinco años, alrededor de 19.000 envenenamientos con plaguicidas fueron médicamente certificados, 17.000 de ellos sólo en Guatemala y El Salvador. Pero el registro mantenido es bajo y se piensa, en general, que el verdadero número de víctimas es considerablemente mayor. La Agencia Internacional para el Desarrollo de Estados Unidos ha informado que existen alrededor de 1.800 envenenamientos con plaguicidas por cada 600.000 habitantes en América Central cada año, en comparación a 1 persona por cada 600.000 habitantes en Estados Unidos.

En algunas áreas de la vertiente del Pacífico se aplican 80 kgs de plaguicidas por cada hectárea de algodón, una de las dosis más altas del mundo. Solo El Salvador en un año reciente, usó no menos del 20% de la producción mundial de parathion. Los residuos de DDT en los tejidos humanos, en áreas donde se cultiva el algodón, han alcanzado valores de siete veces más que en los tejidos de residentes urbanos. También se han encontrado niveles muy altos en muestras de carne y leche; de hecho en algunas muestras de leche se han encontrado residuos 90 veces más altos que el nivel tolerado en Estados Unidos.

El problema de los plaguicidas en América Central ha contribuido y a la vez ha magnificado la reaparición de la malaria en algunas áreas. En 1982, 3.000 casos de malaria fueron tratados en Belice en comparación a los 1.600 del año 1980 y 2.075 en 1981. Esto ha hecho necesario continuar el uso de DDT en y alrededores de muchos caseríos y pueblos. El DDT es ampliamente usado también en Guatemala, Nicaragua, El Salvador y Honduras.

La población de América Central no es la única que está siendo amenazada por el enorme y devastador empleo de plaguicidas en su Región. Alrededor del 70% de toda la producción agrícola de Centroamérica es exportada, en gran parte a Estados Unidos. El uso de plaguicidas es de mayor magnitud en las grandes plantaciones, en las fincas y haciendas que producen los cultivos claves de exportación como son el algodón, el café, la carne, los bananos, los cítricos y la caña de azúcar. Mientras los inspectores de Estados Unidos han bloqueado con creciente regularidad en los últimos años la entrada de carne y cultivos de Centroamérica debido a la contaminación por plaguicidas, probablemente algunos de los productos contaminados escapen a la detección. Así, algunos consumidores de Estados Unidos también pueden estar expuestos a alimentos de Centroamérica con altos niveles de plaguicidas.

Los plaguicidas también ponen en peligro la abundante vida silvestre de América Central. Aunque no se han hecho estudios detallados, un informe reciente de Nature Conservancy, señaló que el fuerte uso de plaguicidas en Centroamérica puede afectar adversamente a algunas aves de Norteamérica que pasan el invierno en esta Región. Dice el informe: "Sería irónico si las aves migratorias de Norteamérica estuvieran sufriendo los efectos de altas dosis de plaguicidas en sus áreas de permanencia temporal, justo en el momento en que están recuperándose de tales prácticas en sus áreas de reproducción".

Contaminación Ambiental

Más allá de la desenfrenada contaminación con plaguicidas, el problema ambiental más serio en Centroamérica es la contaminación del agua. Gran parte de las áreas urbanas tienen alguna forma de sistema de recolección centralizada de aguas servidas, ya sean alcantarillas, canales o zanjas abiertas, tanto para aguas de escorrentía de lluvias como aguas negras de viviendas. Pero solo existen actualmente, poco menos de una docena de sistemas de tratamiento de aguas negras en toda Centroamérica. Por lo tanto, gran parte de las aguas servidas son descargadas sin tratamiento, directamente a los ríos, los lagos o las aguas costeras. Esto genera importantes problemas de salud para las poblaciones humanas ubicadas aguas abajo, ya que los ríos y corrientes de agua son aún ampliamente usadas para lavar ropa y para bañarse; así, como se explicó antes, la enteritis y las enfermedades diarreicas son las principales causas de muerte en Belice, Guatemala, Honduras y Nicaragua.

MANEJO AMBIENTAL EN AMERICA CENTRAL

Cada país centroamericano tiene al menos una agencia gubernamental o departamento directamente relacionado con los problemas ambientales y recursos naturales. En realidad, sin embargo, el control de aspectos relacionados con recursos naturales frecuentemente está dividido en una amplia variedad de ministerios y departamentos. Como resultado se han generado conflictos de intereses, duplicación de esfuerzos, burocracia excesiva y deficiencia en general. En muchos países, la protección de los recursos naturales es vista erróneamente como un aspecto secundario y separado de la producción económica. La política agrícola generalmente se antepone a la política ambiental. De esta manera persiste el conflicto entre el uso de la tierra para la agricultura y la protección de recursos. Aún más, pareciera haber poca comprensión de la necesidad para el desarrollo económico que pueda ser sostenido en el largo plazo por medio de un manejo adecuado de la base de recursos naturales.

Uno de los obstáculos más importantes en la protección de los recursos naturales en toda América Central es la falta de personal y/o su poca capacitación. Agregado a la falta de instituciones de capacitación dentro de Centroamérica, los salarios públicos son notoriamente bajos. Al contratarse al personal más efectivo, éste pronto se traslada a puestos de más alto nivel donde gana mejores sueldos. Asimismo parte del mejor personal en recursos naturales se va a otros países o trabaja para organizaciones internacionales.

En general casi todos los países en la Región tienen legislación ambiental y de recursos naturales, sin embargo, la implementación es otro asunto. Hay muy poco apoyo político o financiero para aplicar tales leyes. Así, algunos observadores han notado que la mayor parte de las leyes ambientales de América Central no tienen más valor que el papel en que están escritas.

Consideraciones Regionales e Internacionales

Tanto las causas como los efectos de muchos de los peores problemas de los recursos naturales en América Central, alcanzan más allá de las fronteras individuales de cada país. La destrucción de recursos naturales a nivel local de un país puede afectar a países vecinos. Por el contrario, la capacidad de un país por controlar sus problemas de recursos naturales más urgentes puede verse entorpecida por el hecho que las cuencas, los ecosistemas naturales o los recursos biológicos migratorios, son compartidos con otros países de la Región, los que tienen menos deseos o menos capacidad administrativa para resolver tales problemas.

Esto aumenta el desafío tanto a los Gobiernos individuales como a las organizaciones internacionales de asistencia para el desarrollo para revertir el deterioro de la base de recursos naturales de la Región. Las leyes de un país para controlar la desordenada destrucción de sus recursos costeros y de vida silvestre pueden no tener significado si continúa, en países vecinos, la demanda legal o ilegal, de madera, de corteza de mangle o de especies exóticas en peligro de extinción. Los esfuerzos por preservar la capacidad generadora de energía de los principales proyectos hidroeléctricos, o asegurar la disponibilidad de recursos marinos valiosos a largo plazo, tales como langostas y camarones, serán exitosos solo si estos se llevan a cabo en todos los países que comparten cuencas altas y hábitat marinos críticos tales como manglares y arrecifes de coral.

CONCLUSIONES

El crecimiento económico y una distribución equitativa de los frutos de ese crecimiento, son obviamente las prioridades principales para América Central. Pero los costos para alcanzar estas metas serán altos. Se ha estimado que para 1999 se necesitarán unos US$24.000 millones en ayuda externa, de acuerdo al Informe de la "Comisión Kissinger" y solamente para regresar al nivel del producto interno bruto per cápita de 1980.

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Aunque los esfuerzos de desarrollo económico para América Central deben poner énfasis en la industrialización y el incremento en la producción manufacturera, gran parte del crecimiento económico de la Región seguirá proviniendo del incremento de productos tradicionales de exportación (café, bananos, algodón, azúcar y carne). Aún así, las limitaciones del mercado internacional para absorber estos productos, asociado con la evidente ineficiencia de dedicar las mejores tierras agrícolas a ganadería bovina, hace imperativo que todos los países de la Región centren sus esfuerzos de desarrollo en dos metas:

1. Diversificación de la base agrícola comercial.

2. Mayor productividad de, y mayor énfasis en la producción de cultivos alimenticios para consumo interno.

Aún así, no deberán esperarse incrementos importantes en la producción agrícola si no se implementan programas nuevos enfocados en el mantenimiento, la protección y la rehabilitación de la base de recursos naturales de la Región. Las presiones que existen actualmente sobre la base de recursos naturales pueden ya estar casi llegando a sus límites. El uso de plaguicidas en cultivos de exportación ha llegado cerca del punto donde los costos adicionales y los peligros a la salud humana, no están compensados por correspondientes incrementos en rendimientos. Muchas de las áreas que han sido deforestadas para cultivo y pastoreo están siendo abandonadas después de solo unos pocos años, debido al mal manejo del suelo y de la tierra. Al aumentar las presiones económicas por alimentar, vestir y dar vivienda a las rápidamente crecientes poblaciones, tales señales de agotamiento y presiones sobre la base de recursos naturales podrían aumentar en el futuro.

Cabe resaltar que mientras el desarrollo agrícola en la Región, continúa estancado, y mientras que el bienestar humano para posiblemente la mayoría de la población continúa en descenso, la productividad potencial futura derivada de la base edáfica y de los bosques remanentes de la Región está siendo lentamente socavada y las corrientes de agua de la Región se están llenando con sedimentos y contaminantes. Aún más, algunos de los problemas más importantes y debilitadores de la salud que enfrenta la Región podrían ser notablemente reducidos si se mejora el manejo ambiental, como por ejemplo al proporcionar agua potable, controlando vectores y poniendo más énfasis en la producción agrícola de alimentos básicos.

Aún las perspectivas de industrialización están en peligro debido al deterioro de los recursos naturales. Gran parte de la electricidad en la Región es generada por plantas hidroeléctricas. La Región tiene limitada energía renovable y poco petróleo y cabe recalcar que gran parte de la deuda externa es debida al alto costo de las importaciones de petróleo. Pero el actual deterioro de cuencas hidrográficas ya está reduciendo el producto energético derivado de las represas hidroeléctricas de la Región, debido a la erosión del suelo y subsecuente sedimentación de los embalses.

Esto no quiere decir que el problema no tenga solución. En el futuro, los proyectos de desarrollo económico tanto públicos como privados deben ir mano a mano con medidas que reviertan el deterioro del ambiente y la base de recursos naturales de la Región. A menos que esto se haga, cabe esperar que importantes recursos públicos y privados, continuarán siendo malgastados y la pobreza seguirá siendo el patrón de vida para un gran número de la población centroamericana.

Por otra parte, a pesar de la seriedad de los problemas ambientales en Centroamérica, los programas de manejo de recursos naturales en la Región pueden solamente ser exitosos si ellos están ligados estrechamente con otros importantes programas de desarrollo económico, dado que un paso fundamental hacia el mejoramiento del manejo ambiental debe ser la disposición de alternativas económicas que ayuden a reducir la presión sobre la base de recursos que ejercen las poblaciones que crecen aceleradamente. Ningún gobierno

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en la Región puede esperar alcanzar objetivos primordiales de manejo de recursos naturales si los resultados solo obligaran a nuevas olas de población rural a emigrar hacia las ya sobrepobladas áreas urbanas, donde las oportunidades de empleo son escasas.

Por lo tanto, los esfuerzos de ayuda al desarrollo en América Central deben no solo enfatizar la mutua interdependencia entre metas de conservación y de desarrollo a largo plazo, sino seguirlas en la práctica, de manera concertada. En particular, el Gobierno de Estados Unidos, otros donantes bilaterales, el Banco Mundial, el Banco Interamericano de Desarrollo y otras importantes agencias multilaterales deben tomar acciones concertadas y enérgicas para evitar en Centroamérica un desastre económico y ecológico de proporciones gigantescas en el futuro.

UN PROGRAMA PARA EL DESARROLLO AGRICOLA ORIENTADO HACIA LA CONSERVACION

El desarrollo agrícola, como subrayó el Informe de la "Comisión Kissinger", es el aspecto clave más crítico para mejorar el bienestar económico y social en América Central. Aun cuando la meta de mejorar el manejo de los sistemas de recursos naturales no fue establecido explícitamente en ninguna parte del Informe de la "Comisión Kissinger", es obvio que la implementación de muchas de las recomendaciones señaladas por ese informe para estimular el desarrollo agrícola deberían también conducir a un mejor manejo de los recursos. Por ejemplo, la Comisión hizo recomendaciones para que los Estados Unidos den asistencia para:

1. Fomentar la eliminación de las peores desigualdades relativas a la mala distribución de las tierras.

2. Estimular el uso más eficiente de tierras ociosas pero potencialmente productivas.

3. Mejorar los procedimientos legales para garantizar a los pequeños propietarios la obtención de títulos seguros para sus tierras.

4. Concentrar los esfuerzos en el desarrollo agrícola en mejorar la eficiencia productiva de pequeños productores de alimentos básicos.

5. Aumentar el acceso de pequeños productores agrícolas a los programas de crédito rural.

En la medida que la asistencia para el desarrollo que los Estados Unidos pueda proporcionar a los países de la Región les ayude a alcanzar estas metas, es probable que algunos de los peores problemas de recursos naturales serán aliviados en este proceso.

Además, deberán fomentarse las siguientes iniciativas positivas de desarrollo en el sector agrícola, descritas más abajo. Todos los pasos recomendados en este programa y que se describirán en detalle en el texto completo de este informe, pueden ser introducidos bajo las actuales condiciones político-económicas en gran parte de la áreas rurales de la Región. De hecho, hay sobradas razones para confiar en los programas y técnicas que ya han probado ser efectivas bajo las condiciones imperantes en la Región. Más importante, este programa integrado para incrementar el desarrollo rural podría tener el efecto simultáneo de crear empleo rural, disminuir la migración de población hacia áreas urbanas, reducir la dependencia en las importaciones

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de insumos agrícolas esenciales, y mejorar notablemente la situación del manejo de los recursos naturales. Los componentes claves de este programa integrado implican que se preste mucha más atención a:

1. Programas de trabajo público en el área rural.
2. Desarrollo de industrias locales para producir alimentos para ganado.
3. Aumento en la producción de carne para el uso interno.
4. Industrias procesadoras para productos de consumo interno.
5. Diversificación agrícola .
6. Campaña para mejorar los rendimientos de los cultivos en el sector de subsistencia.
7. Mejorar los servicios de extensión agrícola para pequeños propietarios.
8. Introducción de cultivos asociados y sistemas agroforestales.
9. Programas integrados de manejo de plagas.
10. Mayor uso de técnicas en la agricultura que faciliten la fijación de nitrógeno.

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POLITICAS AMBIENTALES PARA PROYECTOS DE DESARROLLO

Las principales agencias internacionales de asistencia para el desarrollo que operan en Centroamérica podrían tomar una serie de medidas para asegurar que los proyectos que ellos patrocinan no contribuyan a un mayor deterioro ambiental. Todos los proyectos de desarrollo basados en recursos naturales de la Región deberían incluir, como un componente integral de la propuesta inicial del proyecto, un plan de acción para asegurar el menor deterioro de los recursos naturales que serán afectados. Esto es más que prudente ya que últimamente los retornos productivos a largo plazo de estas inversiones van a depender del manejo continuo de estos sistemas de recursos naturales. En particular, se deberían establecer las siguientes políticas:

1. Manejo de bosques naturales y programas de reforestación para todos los proyectos de explotación de madera, utilización de madera y procesamiento de madera.

2. Manejo de las cuencas altas para el abastecimiento de agua y proyectos hidroeléctricos.

3. Manejo integrado de plagas en conjunto con todos los proyectos de agricultura comercial.

4. Protección de manglares, arrecifes de coral y otros hábitat marinos junto con todos los proyectos pesqueros de desarrollo de la pesca.

5. Análisis del impacto ambiental y estudios alternativos de trazado para los principales proyectos de construcción de caminos y carreteras.

6. Estudios de capacidad del uso de la tierra para sitios potenciales de desarrollo en las fronteras agrícolas de la vertiente del Caribe de América Central.

MEJORAMIENTO DEL MANEJO AMBIENTAL REGIONAL

Ningún gobierno en la Región Centroamericana, actualmente, tiene disponible una base de información adecuada con la cual se tomen importantes decisiones en la planificación del desarrollo acerca del uso de sus recursos naturales más esenciales. Por lo demás, todos los países carecen de suficientes especialistas entrenados en ciencias ambientales y manejo de recursos naturales para diseñar e implementar programas de protección necesarios a los recursos naturales. Así, los donantes internacionales deberían también apoyar los esfuerzos y las capacidades de las organizaciones regionales y de los gobiernos nacionales por medio del mejoramiento de la información sobre recursos naturales y levantando el nivel de los recursos humanos destinados a manejar los recursos naturales. Estos deberían incluir programas que se enfoquen en:

1. Una mejor información sobre la capacidad del uso de la tierra y sobre el uso de la tierra.

2. Promulgación de metas para el uso y desarrollo regional de la tierra.

3. Directrices para el manejo de ecosistemas especiales.

4. Mayor atención a la interdependencia entre programas de conservación y de desarrollo.

5. Mayores programas de manejo de cuencas y conservación de suelos para beneficio de pequeños agricultores, especialmente en áreas con tierras potencialmente frágiles, como por ejemplo laderas muy quebradas, zonas con altas precipitaciones, etc.

6. Introducción de un programa regional para monitorear y reducir la contaminación de las aguas de fuentes industriales y aguas servidas de alcantarillas.

7. Mayor apoyo para el desarrollo y protección de los recursos marinos y costeros.

8. Inicio de un programa coordinado para evaluar críticamente los recursos genéticos de la región, valores económicos de áreas críticas, de áreas y vida silvestre y proporcionar apoyo regional para protección de áreas y vida silvestre.

9. Fomentar un programa regional para preservar, proteger y registrar los ricos y diversos recursos culturales de América Central.

10. Creación de un fondo regional de becas para capacitación en ciencias ambientales y manejo de recursos naturales.

POST DATA

Un tratamiento comprensivo de los temas destacados en este resumen está disponible en el texto completo del documento "Natural Resources and Economic Development in Central America" que será publicado por Transaction Books, New Brunswick, New Jersey, en junio de 1987. La versión traducida al español será publicada en Costa Rica por el Centro Agronómico Tropical de Investigación y Enseñanza, CATIE, y distribuida por el Programa de Areas Silvestres a partir de junio de 1987.

También se encuentran disponibles en IIED los perfiles ambientales individuales de cada uno de los siete países de América Central preparados inicialmente bajo los auspicios de la AID.

En conjunto estos documentos representan una "primera" e integrada compilación de información ambiental acerca de una región geográfica del mundo en desarrollo. Los documentos ofrecen a los planificadores y a los encargados del desarrollo, información esencial acerca de los sistemas ecológicos, económicos y sociales de la Región. Además de proporcionar valiosa información sobre los países individuales del área, estos documentos revelan la naturaleza regional de muchos de los problemas.

Estos materiales pueden también ser considerados como apéndices al informe inicial de la "Comisión Kissinger", sobre problemas sociales, económicos, políticos y militares de América Central. Ellos claramente demuestran la relación entre los problemas ambientales y muchos de los problemas sociales y económicos que afectan la Región.

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ANEXO

LOS PERFILES AMBIENTALES

El propósito de los Perfiles Ambientales es proporcionar un cuadro comprensivo del ambiente y de los recursos naturales de un país, incluyendo un análisis del uso actual, manejo y conservación de los recursos naturales como por ejemplo suelo, agua, árboles, bosques y pastizales que son de vital importancia para sostener el desarrollo económico y el bienestar social. La planificación del desarrollo ecológicamente formulada debe estar basada en una evaluación clara del potencial de recursos naturales de un país. Frecuentemente, la información necesaria para tal evaluación se encuentra ampliamente dispersa y no fácilmente accesible. El proceso de perfilar puede servir para recolectar, integrar y publicar esta información de manera que sea útil a científicos, planificadores y tomadores de decisiones.

Los perfiles aquí señalados son estudios basados en un país, que incluyen considerable información sobre recursos naturales y problemas ambientales, así como también aspectos institucionales, políticos y legales de la conservación ambiental y el manejo de recursos. Estos perfiles generalmente concluyen con una serie de estrategias recomendadas o acciones requeridas que se asocian con materias ambientales. En muchos casos éstos han sido publicados con ilustraciones, mapas y otros gráficos.

Los perfiles proporcionan una descripción de referencia de la extensión y condición de los recursos naturales de un país, que puede proporcionar una base para evaluar las tendencias en el uso de los recursos y las áreas de cambios ambientales significativos en el futuro. Además promueven el reconocimiento del ambiente como un sistema interactuante e interdependiente de componentes naturales, agrícolas, industriales, urbanos y otros componentes con numerosas oportunidades que presentan complementareidad y conflicto. Los perfiles pueden servir también como una guía vital para los vacíos existentes en nuestro conocimiento del ambiente y de los recursos naturales, conocimiento que debe ser completo si se pretende que ocurra un desarrollo sostenido.

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Minimum Conflict:

Guidelines for Planning the Use of American Humid Tropic Environments

GENERAL SECRETARIAT
ORGANIZATION OF AMERICAN STATES
Washington, D.C. 1987

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EXECUTIVE SUMMARY

The "environmental movement" and the international development community commonly have been at odds over the use of the world's humid tropical lands and their resources. This book is about the obstacles to and consequences of exploiting one such area in the rainforest of Peru and presents guidelines drawn from that experience which should help minimize the conflict inherent in any development activity. It is based on the view that environmentalism represents neither a sector nor a special interest; rather it is a way of looking at the activities of development to assure that their costs and benefits are equitably distributed. It also understands that our world is made up of an infinite number of environments, not one, and that therefore the question of *whose* environment becomes the paramount one in any discussion of what is to become of a land, a country, a river, an enterprise, a people.

Underlying the meaning and ultimate effect of this study are the premises that development in its social, economic and cultural dimensions is the process of improving human life quality and that this process involves manipulation of the complex, interrelated natural and man-made structure and function of human environments.

Economic pressures on developing countries in Africa, Asia and South America make it imperative that they eschew overdependence on imported goods and services and try to feed and house their people using the nation's own resources. It is natural that such countries should look to their rainforests as areas of unlimited potential for food, fiber, energy, mineral wealth and land to be occupied. But once there they are faced with the enormous complexity of the forest ecosystems and the minimal available information about the relationships among the earth, air, water, flora and fauna. They are reminded also that though sparsely settled, the humid tropics are seldom "empty."

This study has defined "environmentally sound development" as a process having the improvement of human life quality as its objective. It is a process of active manipulation of ecosystem structure and function in order to appropriate the goods and services offered by the ecosystem in question—a process that almost always changes the mix between natural and economic goods and services. That is, cities rely almost exclusively on economic goods and services, while in frontier areas like the rainforest of Peru natural goods and services play a relatively greater role. Environmentally sound development minimizes the conflict inherent in the shift towards economic goods and services and the increase in human activity; it maximizes mutual support between the required activities and distributes their costs and benefits throughout the affected populations.

In order to enable planners in the humid tropics to carry out their mission, understand the region, foresee possible conflicts among competing sectors and linked ecosystems, and forestall these conflicts by informed planning and adjustment, the OAS, UNEP and the Government of Peru initiated a detailed study of a single region of the Peruvian humid tropics in which development had been underway. This document provides an exhaustive treatment of the region and a method of conflict identification and resolution in the early stages of development planning. Each chapter has a single subject (water, agriculture, wildlife, etc.) but a multiple purpose. Experts in each field were asked first to

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describe the present state of the resources and sectoral activity in the region, discuss the goods and services upon which sectoral activity was, or could be based; and then identify and suggest solutions to any conflicts that exist or might arise between that sector and others with which it must interact.

The first part of this book (Chapters One through Three) discusses the context of the study, the conceptual bases supporting the sectoral analyses and the legal basis for human activity in the study area. Chapters Four through Seven identify the vast and complicated natural resources and processes of the Central Selva, looking at its major ecosystems with particular emphasis on soils, vegetation, water resources and wildlife. Chapter Eight gives the history of human occupation of the Central Selva, and the remaining chapters recount the activities of human beings there: farming, ranching, forestry, fishing, mining, road building and the search for alternative sources of energy from the forest —the activities, in other words, by which man changes the ecosystems which surround and support him. Chapter 16 presents guidelines, recommendations and observations for planning development in the American humid tropics.

The contents of this report are designed to assist policy makers and practitioners of development who participate in planning the use of humid tropic environments. Since the report is based on sectoral analyses written by representatives of the more relevant and important development sectors, those who undertake sectoral planning will find something here for them. Further, the concepts and conclusions should provide a basis for discussions within the organizations and interest groups that have come to be called "environmental," and should find ready use as reference material in courses or training centers dealing with environmental management.

Perhaps the most important parts of this report, however, are the sections which suggest to planners how to go about gathering information in information scarce areas, identifying the potential conflicts, and working together to minimize the impact of these conflicts while the planning stage is still going on. This will, of course, greatly facilitate the actual implementation of the development project, and, through understanding of each sector's needs, mitigate the "negative environmental impact" such projects inevitably generate.

Planners are told first to develop a regional model, and are offered a system for regional modelling based on the Central Selva experience. Next, an inventory of goods and services is necessary: this report offers a list of the more widely used natural goods and services in a tropical forest, but cautions that planners must make up their own lists based on interviews with the people who live, use, or have an interest in the ecosystems under study. Finally, a companion inventory of natural hazards will help planners predict how earthquakes, flooding, erosion and other natural events and processes might threaten the project at hand.

Among the guidelines to identify and remove potential conflicts during the planning stage are:

— use an environmental management advisor;

— coordinate to reduce potential conflicts (exchange ideas and information with other members of the planning team);

- review the regional conceptual model;
- analyze goods and services (and assign them to individual sectors);
- use an activity matrix to see how activities in one sector will influence, positively or negatively, activities in another; and
- distinguish between real and apparent conflicts.

Specific guidelines for the sectors are given, as well as directions for agriculture, forestry and livestock management. The report also deals with the thorny problems of spontaneous migration and how to honor cultural traditions and long-established patterns of land use.

Throughout this report the writers have used a common vocabulary, purged, as far as possible, of emotional words and phrases indicating the superiority of one sectoral interest over another. "Environment" itself was used only where it could be said to describe a specific environment; the word "ecology" did not replace "environment" or "ecosystem." "Delicate" and "fragile" are not allowed to describe ecosystems, because more often than not their common usage is to justify the position of a sector or interest group and says little of value about ecosystem structure and function.

The methods presented here do not discuss economic valuation of goods and services despite its being an important contribution towards better development decisions. Rather, the methods recognize that much of what has value from frontier areas has not been and may never be quantitatively valued. Important conflicts arising from changes in the mix of goods and services created by development activities, however, will occur, and it is the early identification and resolution of these conflicts that this document treats.

Chapter 2

CONCEPTS OF ENVIRONMENTAL MANAGEMENT

Underlying the meaning and ultimate effect of this study are two unarguable premises: development in its social, economic and cultural dimensions is the process of improving human life quality; and the process of development involves manipulation of the complex, interrelated natural and man-made components and processes of human environments. In this chapter we shall develop concepts based on these premises, which will lead to an understandable and workable definition of "environmentally sound development"; we will do this by an examination of the terms: "human quality of life"; "human environments"; "systems goods, services and hazards"; and, "environmental management."

HUMAN QUALITY OF LIFE

Quality of life discussions have usually centered on the subject of "basic human needs" (Streeton and Burki, 1978; McHale and McHale, 1977) and the moral choices to be made among those needs in development activities (Goulet, 1971).

Human life quality depends on the physical and psychological health or welfare of an individual or a society. Health and welfare in turn, depend on the degree to which a person's or a society's respective environments satisfy their needs.

Needs vary substantially by culture, age, sex, season, climate, education and income. Some must be satisfied before others are felt. It is often difficult to distinguish between "needs" and "wants" and lack of information and understanding often undo efforts to improve one's quality of life. If the allotment of resources required to satisfy any of their perceived needs is not sufficient or, though sufficient is placed in jeopardy, that society will believe that its quality of life is threatened and will fight to save or restore it.

HUMAN ENVIRONMENT

The Encyclopedia of Environmental Sciences defines Environment as "the aggregate of all external conditions and influences affecting life and development of an organism" (Platt, 1971) but a definition of the "human environment" must go further. A human environment is more than external, for internal and external are relative concepts and an individual is a significant component of his own environment. This study therefore regards the human environment as "*the aggregate of all conditions and influences affecting the behaviour and development of humans as individuals and as societies*". "Conditions and influences" vary over time and space and, though often shared, are perceived and experienced differently by each individual or society (Saarinen, 1969).

Each environment is a system which overlaps, influences, and is influenced by other systems. They resemble ecosystems (or are at least significant parts of ecosystems) in that they are units of space where biotic and physical components and processes interact to develop patterns of energy and material flow and cycling. In human environments these components and processes —called structure and function by scientists (Odum, 1962)—are not restricted to those that are from "nature." Indeed, they include those that are social, economic and political (Smith, 1972) or cultural (Boyden, 1976). By extension, they include machines, institutions, language, and art, as well as nutrient cycling, photosynthesis, respiration and food chains, since all are conduits for the flow and storage of energy (Odum and Odum, 1976).

A reductionist approach to environmental complexity, though useful in a great many ways, cannot resolve environment/development conflicts. We do participate in a world where everything *is* related to everything else. Though some of the components and processes involved are more important than others, there is no easy way for any one person or interest group to decide for the others which are the important ones (Dasgupta, 1976).

Thus, considering the many levels of organization, our world is made up of a large number of environments —not one. One of those environments, of course, is the "biosphere," but that is only *one more* environment and not *the* environment. The global environment is important. However, there are countless other environments that are just as problematic, more easily understood, and treatable and very much nearer at hand than the global environment. Because there are numerous environments, the phrase "protect the environment" is not a useful term unless we know whose environment is to be protected.

The question "whose environment" is always relevant. Because sectoral activities use, improve, or conserve what comes to us from an environment, decisions based on these sectoral interests are the cause of what have been called "environmental problems." These problems are created by efforts to improve quality of life in one environment at the expense of reduced quality of life in another. "The environment," therefore, is not a special set of unique interests to be treated separately from "development."

NATURAL RESOURCES AND THE CONCEPT OF GOODS, SERVICES AND HAZARDS

Nature is the original patrimony of humanity and is the source of goods and services as well as of the space in which society develops and evolves.

The concept of goods, services and hazards opens and extends the concept of natural resources and links the concepts of environmental quality and life quality, since a quality environment is one that provides the necessary goods and services to satisfy life quality needs and which mitigates the severity of an encounter with a hazardous event.[1]

When the natural characteristics of ecosystem structure and function are of interest to any one, they are classified as natural goods and services. Natural goods are generally equivalent to natural resources except that they have been further defined and identified by specific sectors as being useful for development. Thus, within the natural resource "forest," the natural goods may be woody fiber for lumber, pulpwood, or posts; medicinal plants; edible fruits, and chemical substances among others. Natural services are derived from the natural characteristics of ecosystem structure and function and include the flow of energy and materials; nutrient storage, distribution and cycling; provision of wildlife habitat; germplasm storage and evolution; biomass production; and flood control.

The term "goods and services" historically carries an economic connotation. Economic goods and services are, of course, the results of labour and the expenditure of capital to refine and convert natural resources to useful products, and to design and provide activities of public utility such as health, security, communication and goverment services.

Several years ago, the concept of "natural goods and services" was introduced. These have been defined as those goods and services that are provided by natural environments (Gosselink *et al*, 1973; Ehrenfeld, 1976; Lugo and Brinson, 1979) and, in economic literature, include, but are not confined to, "amenity resources."

In many ways, no *fundamental* distinction can be made between natural and economic goods and services. Both types are derived from the structure and processes of ecosystems. Both types support human life quality. Individual examples of each kind have value dependent upon their utility and scarcity. Price and market participation do not make a difference despite the fact that early efforts to place a market price on natural systems—and the goods and services they provide—met with stiff resistance on the part of some economists (Shabman and Batie, 1978). There is now little, if any, debate as to whether natural goods and services have value nor whether the concept fits economic theory.

Indeed, the major difference between them seems to be that economic goods and services have been thoroughly discussed and studied while natural goods and services have not. To correct this inequity, today economists are beginning to grapple with ways to place a value on non-priced natural goods and services (Krutilla and Fisher, 1975; Hufschmidt *et al*, 1983).[2] Those which remain non-priced but no less valuable will have their identifiable constituencies who will demand due process in development planning in much the same way as the value of work in the household and the real worth of protection by police and firemen are receiving increasing attention because housewives and police officers demand it.

Natural goods and services have a value according to the following categories:

1. They may have economic, social or cultural value and are therefore considered to be important to current development activities. The economic elements (those that are priced and participate in the monetary market) are well understood. The barter system is less understood but no less important in many development contexts--particularly in frontier areas such as the Central Selva. Though not necessarily quantifiable, the social and cultural components can also be valuable in other ways. Human culture and life styles contribute to the diversity and richness of a population. Both recent immigrants and native peoples use an area's natural goods and services as food, folk remedies, instruments in religious ceremonies, and to provide historical perspective. Though not ordinarily considered in development planning, the social and cultural components may carry an importance far beyond anything known by an outsider.
2. They may have a scientific value and are therefore of importance to future development. Natural goods and services of this type are of interest to those who search for new technologies and new information for development purposes. Much of the effort to protect endangered species, representative ecosystems, germplasm reserves, and wildlands for research and monitoring fall into this category.

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1. *Environmental quality in some writings refers to "ambient environmental quality" i.e. the "state of air, water, land, and human artifacts" (Hufschmidt et al, 1983, p.2). However, as used here, it is the relative capability of an environment to satisfy the needs and wants of an individual or society.*

2. *It is not the purpose of this study to provide methods of economic valuation. Rather it is to help lay an acceptable conceptual foundation for "environmentally sound development." Analysis of the market pricing system and other methods of economic analysis are and will continue to be, formidable tools in development planning and decision making. Our purpose here is to define where and in what context those decisions will have to be made. As we will see in the following sections, that context is often one of competing and reinforcing sectoral activities.*

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3. They may control ecosystem functioning and are therefore important to a sustainable flow of a good or service. Thus, activities which lead to the conservation, protection and use of those natural goods and services required to maintain ecosystem atributes of value are also important development activities. Included are the natural goods and services of erosion and flood control, climate regulation, and chemical buffering. Their conservation or protection are legitimate and valuable *development* activities.

In addition to providing natural goods and services, human environments also present a gamut of natural hazards which have a great influence on how successful development efforts may be. These phenomena are also the result of ecosystem structure and function. Earthquakes and hurricanes are a part of energy and material flow in the global ecosystem. Though they are hazards to development they may be responsible for a significant number of natural goods and services. For example, hurricanes which distribute large amounts of energy built up in tropical latitudes to the temperate latitudes are also responsible for the survival of valuable mangrove systems (Lugo, 1978); natural flooding and ocean currents are responsible for massive flows and cycling of nutrients (Hartline, 1980); lightning fixes unusable nitrogen to useful forms; bees sting but they have a value beyond calculation in the pollination of flowering plants and in food production for human beings (Pimentel *et al*, 1980).

Indeed, *the process of development is made up of those activities that lead to the use, improvement, or conservation of goods and services in order to maintain and improve life quality.* "Negative environmental impact," on the other hand, is the opposite of development. That is, it is *the destruction, impoverishment, misuse or non-use of goods and services whether the result of human activity or of natural hazardous events.*

ENVIRONMENTAL MANAGEMENT

The objective of environmental management is improved human life quality. It involves the mobilization of resources and the use of government to administer the use of both natural and economic goods and services. It is based on the principles of ecology. It uses systems analysis and conflict resolution to distribute the costs and benefits of development activities throughout the affected populations and seeks to protect the activities of development from natural hazards. Conflict identification is one of the more important tasks in environmental management planning and the resolution of conflicts is a fundamental part of what makes up "environmentally sound development."

In the complex and interdependent world that we have been given, environmental management is required because the activities of development in one sector affect in both positive and negative ways the quality of life in others. Indeed, if one asks of any "environmental impact" the questions "who caused it?" and "who felt it?," sector/sector relationships are identified. For example, a hydroelectric dam which reduces nutrient levels in the water and thus destroys downstream fisheries is sector 410 causing problems for sector 130 of the UN List of Economic Activities (UN, 1969). By the same token, cutting down trees to produce grazing land for cattle may cause sedimentation in a reservoir, and is a problem between sectors 111 and 420. And, if a hotel sends its wastes out to sea only to have them return to its beaches, a conflict is caused within sector 632. It needs to be said in addition that such "problems" are, in reality, conflicts between two activities. That is to say, the problem is not only caused by promoting ranching over fisheries since a decision in favor of fisheries will cause a problem for ranching as well. It is the *conflict* that requires solution.

Such a concept of "environmental impact" may be seen to have left out "the environment;" a very large black box exists between cause and effect if one is only interested in those sectoral activities which cause a problem and those which receive the problem. There are two basic reasons, however, why this is not a major concern here. First, the guidelines to be produced are guidelines for planning development at the earliest possible stage of the process. Time, funding, and expertise at this level do not allow in-depth study of that black box. Second, the guidelines are for planners in the humid tropics—a biome known for its lack of available information. That is, the black box covering the humid tropics is a very large one and efforts to reduce its size in any significant way—though certainly necessary and welcomed by planners— should not be undertaken by planners. The needs of development planning should help orient research in information-scarce areas. But, in the context of specific development planning projects, neither science nor planning will be advanced much by expenditures of large amounts of planning time and funds for research.

Conflicts between natural hazards and development activities also exist and result from a confrontation between hazardous natural events and human activity. So-called "natural disasters" occur because we have not paid sufficient attention to natural hazardous phenomena. Indeed, the term "natural disaster" is misleading for this reason: it places the blame on nature when, in fact, the blame belongs to those who decided that projects be implemented under circumstances that jeopardize the very objectives that the development activities were designed to meet.

The techniques of conflict resolution are well known and are comparatively successful given man's continued existence on earth for several thousands of years under very complex conditions. If they had not worked there would be no life as we know it today. Conflicts make up the matrix in which we live; it is a world of

uncertainties compounded by a shortage of technical information, a large variety of values, interests and judgements, and overlapping environments.

Most writers on the subject of conflict resolution, however, say that conflict can be positive as well as negative (Boulding and Kahn, 1962; Coser, 1956; Deutsch, 1973). For example, conflict tends to maintain valid group boundaries and needed group structure and provides incentives for the formation of alliances to combat an exploitive elite.

Planning, especially intersectoral planning, has a tremendous advantage over efforts in real life to resolve conflicts because, in many ways, planning is a game; and, to play the game one must cooperate. Within this context, individuals on a planning team have a shared commitment to rules and procedures which can be controlled. The various parties (sector specialists) operate with a similar rationale, can be easily encouraged to focus on criteria rather than on positions and, each can insist that evaluation criteria be objective. The result is an opportunity to invent options for conflict resolution that provide for mutual gain.

Many activities designed to use, improve, conserve, and protect goods and services for development purposes support other development activities. Development projects requiring the conservation of ecosystems for purposes of wildlife management also conserve the soil stabilization function of vegetation and, as a result, downstream reservoirs receive less sediment. Development policies that restrict construction in areas of natural flooding create recreation possibilities and green space near urban areas and lessen dependence on expensive flood control structures. Enlightened systems engineering turns industrial wastes into residuals that provide raw material for other development projects (Bower, 1977).

ENVIRONMENTALLY SOUND DEVELOPMENT

Discussions that treat environment and development revolve around the point of "environmentally sound development." Despite this, the term has seldom been defined and it is left to the reader to gather from the discussion just what it might be. In large part, such discussions seem to suggest that development is "environmentally sound" if it is "sustainable," if it does not "disturb the ecological balance," if it "causes no environmental degradation," if it does not "surpass the carrying capacity of the natural system," and if it "avoids the loss of long term natural productivity." Even the most cursory analysis, however, will show that such criteria are untenable; no development project—including conservation—can meet all of these restrictions.

First, there is a problem of meeting the objectives of development. Development objectives that do not treat life quality—even if "environmentally sound"—make no sense because no one will benefit. Second, there is a problem of level of aggregation. Which natural system are we talking about? The construction of any man-made structure will disturb, even erase, natural systems at a certain level. Third is a question of decision. Is long-term natural productivity essential when a choice must be made between wood fiber and protein? Fourth, there is a question of adequacy. Is the carrying capacity of a natural system relevant when it can be significantly increased through the application of even the simplest technology? Fifth, there are problems of clarity and specificity. Environmental "degradation" and "ecological balance" mean different things to different people. Is a project "environmentally sound," for example if "balance" is maintained but a species is lost, or added, because of that project?

To evade such problems this study has defined "environmentally sound development" as a process having the improvement of human life quality as its objective. It is a process of active manipulation of ecosystem structure and function in order to appropriate the goods and services offered by the ecosystem in question. It minimizes the conflict inherent in the appropriation of those goods and services, it maximizes mutual support between the required activities and distributes their costs and benefits throughout the affected populations. The chapters which follow are based on this understanding of environmentally sound development.

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Chapter 9

AGRICULTURE

Because farming is the principal means of support of most of the people living in the Central Selva, and because feeding its growing population has become a matter of critical concern for Peru as a whole, questions of land use for agriculture go to the very heart of the problems encountered by those who would transform the humid tropics. It is not enough to cut and burn trees, plant seeds, and expect to have a harvest. Agriculture in the Central Selva as elsewhere in the humid tropics requires a process of integrated and coordinated activities at the farm level and their interaction with regional and national economies and with other development sectors.

NATURAL GOODS AND SERVICES

Soil

Peruvian Amazonia has a limited supply of soils that are well-suited for continual agricultural production. According to ONERN (1981) only 6 percent of the soils in the Selva, or 4.6 million hectares out of a total of 75.7 million, are suitable for annual and permanent cultivation; while 7.5 percent (5.7 million ha), are potential pastures. More than 84 percent (63.5 million ha) of the total land area is classified as being best suited for forest exploitation and protection. Unfortunately, little information is available concerning human settlement patterns on these lands, the amount of land being abandoned or left fallow because of soil and pasture deterioration, and on the underutilization of these soils through extensive livestock grazing.

The best soils are found on terraces near rivers and most of these areas are already planted in annual crops (corn, manioc, beans, and vegetables) and permanent crops (citrus fruits, bananas, papaya, and avocado). Some cleared forest lands yield harvests once or twice a year through the traditional system of cultivation, which takes place until crop yields diminish from the lack of soil nutrients and competition from weeds and pests. Once the lands become infertile, they are abandoned and new farmland is cleared from the forest. This system of "shifting agriculture" is practiced by native communities and also by the majority of colonists in Peruvian Amazonia.

Farmers with access to capital have established perennial crops, such as citrus, coffee, cacao, and other tree fruits, which maintain soils on slopes by providing continuous plant cover. Although permanent agricultural production such as this requires extensive management and investment in fertilizer and pesticides, its yields are higher than those of shifting agriculture. Permanent agriculture is not only an efficient use of land, it also helps stabilize rural populations by producing continual employment, and food that can be consumed domestically or sold in regional markets.

When good agricultural soils are scarce, and the existing soil resources underutilized and badly managed, soil erosion and reduced agricultural production inevitably occur. For example, grazing livestock on fertile alluvial soils is a low-intensive land use when compared with cultivation of high value crops. Equally inefficient is the system of planting annual crops on steeply sloping land, which will produce diminishing yields, eventual abandonment of the site, and a search for new lands to clear. But conflicts over the use of such lands are not easily resolved, being related to regional socioeconomic factors that are influenced by land tenancy patterns, market conditions, and access to roads.

Many of the soils in the humid tropics have little agricultural potential because they are highly acid and contain toxic quantities of aluminum and low levels of phosphorus, potassium, and organic matter (Sanchez, *et al*, 1982). What nutrients they do have are obtained through burning of vegetation and decomposition of organic matter. The nutrients are used up when fast-growing annual crops are planted and when pastures are established in recently-burned areas (Figure 9-1).

The mechanisms governing nutrient cycling in humid tropical forests are located in the upper soil levels and in the biomass. When organic material in the soil decomposes, its nutrients are absorbed and recirculated through the natural vegetation (Table 9-1). Under continuous vegetative cover or with systems of permanent cultivation, few nutrients are lost. But if the vegetation suffers continuous disturbance, as in annual cropping, nutrient levels are reduced by leaching, soil erosion and the harvest itself, making the addition of fertilizers necessary.

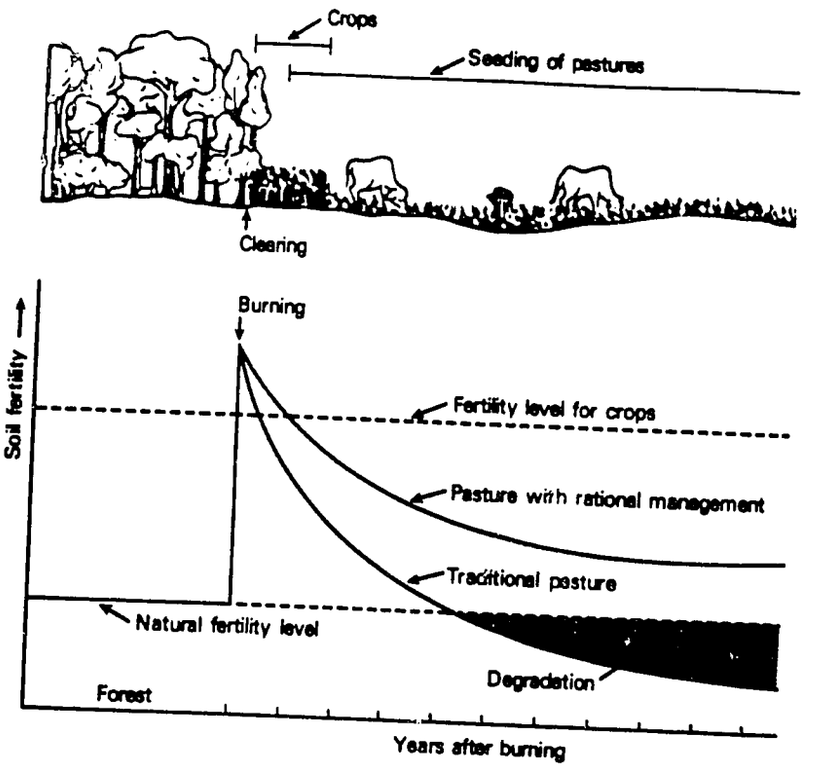
If production is to be maintained in the humid tropics, therefore, crop rotation and new cropping systems will be required. Examples of these systems are those that use nitrogen fixing legumes to help sustain production, including annual crops such as beans and peanuts in association with rice, corn and manioc, tree legumes (*Inga sp.*) in coffee and cacao plantations; and forage legumes (*Calopugnium sp.*) with natural pasture (*Paspalum natatum*).

Water

Water excess is often as detrimental to plant growth as is water scarcity. Water excess results in reduced

FIGURE 9-1

TENDENCIES IN SOIL FERTILITY UPON CONVERSION FROM FOREST TO PASTURE



Source: Toledo-Serrão (1982)

oxygen levels in the root zone and water deficiency creates problems for plant metabolism, poor nutrient circulation, high temperatures, and dehydration. Both sets of conditions reduce growth and potential yields. In the humid tropics, only crops with a high market value (unhusked rice, bananas for export, oil from African palm) are mechanically irrigated and drained. For the rest, the most successful cultivation systems are adapted to water regimens dictated by climatic and soil factors.

For example, natural marshes serve as buffer zones for adjacent agricultural lands, regulating water levels and absorbing rising waters. In these flood plains the sediments that are annually deposited along the banks of the large rivers are excellent for growing such short-cycle plants as rice, corn, beans, or jute (Table 9-2). When annual crops are grown on these fertile soils, they can be planted and harvested between normal flooding cycles.

Lesser Forest Products

Although lesser forest products are not actually agricultural products, the forest ecosystems adjacent to many cultivated fields provide various natural supplements to rural economies. Thus, native fruits, resins, natural pigments, medicinal plants, and natural palm and reed fibers are collected in great amounts and are

Table 9-1

NUTRIENT CYCLES IN TROPICAL AGRICULTURAL AND FORESTRY SYSTEMS

Function	Temperate Forests	Amazonian Forests	Implications for Tropical Forest and Agricultural Lands
Location of nutrients, cycle mechanisms	In the soil	In biomass covering the soil	When the biomass decomposes or when it is continually exploited, yields diminish.
Nutrient cycle index[a]	Not available	High (0.7)	Few nutrients are lost when there is continuous plant cover as exists in forests or in permanent cultivations.
Cation exchange	High	Low	The majority of soils in the humid tropics cannot support sustained production without fertilization. Soils with high CEC experience less severe nutrient loss because of leaching and a better response to fertilization.
Nutrient cycle duration	The processes are slow because of limited humidity and/or temperature	Successional plants rapidly absorb nutrients after forests are cleared	If soils remain continually covered with fruit or wood-producing trees, few nutrients will be lost.
Length of seed dormancy period	Long	Short	Natural reforestation depends on seed sources close-by, since seeds will not be transported over long distances.

a. This index compares the quantity of "recycled" nutrients with the total quantity circulating through the system. A high cycle index (around 1.0) means that all of the nutrients in the system are "recycled" and are not lost.
b. A low CEC means that there exist few negative changes in the soil capable of retaining nutrient cations such as calcium, potassium, and magnesium.
Source: Jordan, C.F. (1982).

sometimes processed during times of little agricultural activity. Historically, Peruvian Amazonia has supplied international markets with products such as rubber, barbasco, zarzaparillo, and rosewood. The demand for these products varies according to cost increases due to increasing distances between forests and shipping ports. Demand may also vary because of competition from other parts of the world where transport costs are less and communication is more efficient. The social value of these products is difficult to estimate since native communities and colonists that gather and process them are dispersed throughout a large area for which commercial data are not available.

AGRICULTURE TODAY

In 1980 the total amount of cultivated land and pasture in the agrarian districts of San Ramon and Satipo was estimated to be 70,426 hectares, with an agricultural

production value of 15,276,63 thousand soles (Table 9-3). This figure represents a 25 percent increase over 1973, as a result of road construction in the Perene Valley. Moreover, preliminary sectoral comparisons between the Central Selva and the rest of Peru give an idea of the Central Selva's importance in the national economy (Table 9-4), but tell nothing about the area's production potential nor about predicting the reductions in yield and land use efficiency if agroecosystems are improperly managed.

Table 9-2

SUGGESTED ANNUAL CROPS TO BE PLANTED ON FLOODPLAINS

Common Name	Scientific Name
Cereals	
Corn	*Zea maiz*
Rice	*Oryza sativa*
Legumes	
Beans	*Phaseolus sp.*
Soybeans	*Glycine max*
Chick-peas	*Cicer arietinum*
Peanuts	*Arachis hypogaea*
Fibers	
Ramie	*Boehmaria nivea*
Jute	*Corchorus capsularis*
Urena	*Urena sp.*
Tubers	
Manioc	*Manihot esculenta*

Almost all farms, regardless of size, are labor-intensive. Such a practice is probably the most appropriate technology for these hilly areas with a high percentage of permanent cultivation. In 1976 fertilizers were used more in Chanchamayo (62 kg/ha) than in Satipo (35 kg/ha) and Oxapampa (33 kg/ha), primarily because the citrus plantations are older and more numerous (Table 9-5). This indicates not necessarily "progress," but rather a vigorous fertilizer industry, dating from the 1950s (Recharte, 1982).

Today coffee is the principal income crop: the Central Selva produces 25 percent of the coffee of Peru. Coffee production has remained stable in recent years despite fluctuating market prices. Yields vary from 400 to 600 kg/ha, although they could increase with better management. Diseases affecting coffee plantations, such as *broca* (*Hypothenemus hampei*) and *roya amarilla* (*Hemileia vastatrix*), can be caused by large extension or excessive density of the crop; intensive cultivation can also be counterproductive to obtaining high yield Coffee is planted on all types of land, and little erosion soil loss occurs because the coffee trees simulate nat ral forest conditions, providing shade and fixing nitroge

Citrus fruits—oranges, tangerines, and grapefruit are the second most important crop in the area. Yield vary from eight to 13 metric tons per hectare. In spite relatively intensive management, fertilization and di ease control, losses from pests have forced farmers t replant in affected areas. Fresh fruit is sent to markets Lima, while surpluses produced during periods of abun dance are locally distributed.

Other important fruits, in terms of area planted include avocados, papaya, and pineapple. Avocad production is limited because of the pest *Phytophthora* which attacks the roots and flourishes in poor drainag conditions. Papaya is grown to provide income whil citrus trees are being established. In the last two year however, the total area planted has diminished becaus the pests have shortened productive tree life to less tha two years. Chemical control is expensive and ineffe tive, and genetic resistance to pests has yet to be deve oped. Some farmers replant papaya plantations eve one or two years as a practical solution to the pe problem.

Recently, small-scale plantations of a crop call *carambola* (*Averroha carambola*) has been plant near Satipo. This fruit is unknown outside of Peru, but it being well-received in Lima markets and its futu appears promising. Bananas, breadfruit, passion fru and chirimoya are usually produced for local and inte national markets.

A major fruit-processing plant near La Merced en bles local farmers to sell their fruits, and connects th regional agricultural economy to national and intern tional markets (for example, passion fruit juice concen trate is shipped in quantity to Europe). Productio increased from 2,029 tons in 1976 to 7,836 tons in 198 Its capacity has been estimated to be 9,000 tons a yea Farmers also benefit from several small citrus fruit pack ing plants in the Chanchamayo area which wash an pack the fruit before sending it to Lima. The presence o these establishments has encouraged the developmen of permanent fruit plantations by both large and sma farmers. Because fruit trees are one of the few species in the humid tropics that can be cultivated on slopes, has been possible to grow them relatively near the fresh produce markets and Lima processing centers.

Central Selva Land Use

Present land use patterns reflect soil and climate limitations, available capital, proximity to markets, transport facilities, tenancy patterns, and regional cultural traditions. Four general types of land use and human settlement patterns are found in four development axes in the Central Selva (Table 9-6).

Table 9-3

ESTIMATED AGRICULTURAL PRODUCTION IN THE SAN RAMON AND SATIPO AREAS IN 1980

Permanent Crops	Area (ha)	Production (ton)	Yield (Ton/ha)	Price at the Farm[a] (soles/kg)	Gross Value of Production[a] (thousand of soles)
Coffee	38,100	18,570	0.49	544	10,109,460
Citrus Fruits	4,697	44,345	9.4	22	968,760
Cacao	201	40	0.2	385	15,400
Avocado	1,355	7,569	5.6	38	288,430
Other Fruits	140	335	2.4	40	13,360
Mango	25	140	5.6	30	4,200
Annatto	139	48	0.35	167	8,000
Sugar Cane	87	792	9.1	10	7,920
Passion Fruit	175	875	5.0	35	30,625
Cocona	69	345	0.2	25	8,625
Others	48	93	1.9	20	1,850
Totals	45,046				11,456,630
Annual Crops					
Corn	4,003	9,152	2.3	39	357,970
Bananas	4,374	25,549	5.8	14	352,340
Manioc	1,295	15,819	12.2	22	348,018
Rice	490	578	1.8	62	36,120
Tobacco	278	2,803	0.1	30	84,090
Beans	258	243	0.9	135	32,860
Papaya	1,705	27,940	16.4	20	544,960
Soybeans	91	112	1.2	108	12,200
Taro	82	333	4.1	10	3,330
Pineapple	1,577	25,123	15.9	15	380,170
Tubers	72	577	8.0	58	33,620
Ginger	84	478	5.7	35	16,730
Vegetables	4	41	10.3	20	820
Totals	14,313				2,203,228
Grasses					
Elephant Grass	5,888	362,280	61.5	2.5	903,840
Molasa Grass	1,695	101,700	60.0	3	305,100
Jaragua	1,888	113,280	60.0	2.5	283,200
Kudzu	27	810	30.0	2.5	2,025
Others	1,361	40,830	30.0	3	122,490
Totals	10,859				1,616,655
TOTAL	70,218				15,276,513

a. In sales of 1980.
Source: MAA, Peru (1982).

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Table 9-4

ECONOMIC COMPARISON BETWEEN THE CENTRAL SELVA[a] PERUVIAN AMAZONIA, AND THE ENTIRE COUNTRY OF PERU

	Selva Central	Peruvian Amazonia	All of Peru
Cultivated area (hectares)[b]	70,426	666,724	2,470,718
Estimated Value of Agricultural Production[c] (thousands of soles)	15,276,513		39,883,600
Estimated value of forest production[d] (thousands of soles)	3,927,091	35,777,387	38,311,153
Estimated value of lesser forest products	26,768	2,087,918	2,511,570

a. Data for the Central Selva only include the San Ramon and Satipo agrarian districts.
b. MAA, 1980.
c. MAA, 1982 (annual and permanent crops, grasses, and forests).
d. Lesser forest products include resins, fibers, pigments, medicinal plants, oils, and native fruits.

Table 9-5

CENTRAL SELVA FERTILIZER CONSUMPTION IN 1976

Region	Area Planted (ha)	Fertilizers (ton)			Average Fertilizer Application
		N	P_2O_5	K_2O	
Chanchamayo	33,225	695	497	881	62
Satipo	20,743	245	239	234	35
Oxapampa	12,981	151	141	140	33

Source: Rechanie, 1982

Development in the *San Ramon-La Merced axis in the Chanchamayo Valley* was based historically on large coffee plantations and on one sugar refinery. During the 1969 agrarian reform, however, a large portion of these lands was abandoned or expropriated. Today, while still producing some coffee, they are principally planted in fruit trees. The few alluvial terraces with the most fertile soils support large plantations of citrus fruits, avocados, papayas, and other tree fruits that are often harvested on hillsides. Pineapples, another commercial crop, are generally planted on poor sloping soils. Corn, beans, peanuts, and manioc, as well as bananas and other tree fruits, are also planted on small plots for subsistence purposes.

At present, there are few conflicts over the use of forest lands for farming, since most of the valuable timber has already been extracted and the harvest of secondary native trees and shade trees for firewood and charcoal is not detrimental to agricultural interests. The 30 percent of the land planted in pineapple, annual crops, and pasture is removed from agricultural production when exhausted and can be either reforested or left as permanent protected areas to prevent erosion and sedimentation and to ensure continued water supplies.

Table 9-6

AGRICULTURAL ACTIVITIES AND THEIR POTENTIAL SECTORAL CONFLICTS IN THE CENTRAL SELVA

Development Axis	Land Resource Base	Availability of Agricultural Lands	Agricultural Activities	Conflicts with Other Sectors
Chanchamayo Valley (San Ramon-La Merced)	Alluvial Terraces gently sloping to hilly.	Poor	Fruit production, coffee distribution, shipping.	Sloping terrain should be reforested or managed as protected watersheds.
Villa Rica-Oxapampa	Steep to hilly terrain.	Moderate	Coffee, livestock, permanent cultivation, limited forest exploitation.	Intensive horticulture needs to be carried out on fertile soils, where grazing is the predominant land use.
Pichanaki-Satipo	Undulating topography, hilly to level terrain.	Moderate	Small farms, shifting agriculture, coffee, livestock, forest exploitation.	Intensive agriculture can threaten downstream ecosystems. Regenerating natural forests rarely have time to produce harvestable sizes of timber-producing trees because peasants cut them down first.
The Ene, Tambo, Pichis, and Palcazu river valleys	Seasonally-flooded soils.	Moderate to high	Scattered colonies and native settlements that practice shifting agriculture, extensive livestock enterprise in the Palcazu valley, small-scale livestock production elsewhere.	A large percentage of the alluvial floodplains are, at some time, occupied by permanent cultivation and extensive livestock operations.

Since fruit grown in the Chanchamayo Valley is sold in Lima, it is difficult to imagine how alternative land uses such as grazing or cultivation of annual crops would compete economically with present practices.

The Villa Rica-Oxapampa region has rolling land with scattered terraces well-suited for agriculture, especially coffee and livestock. Although coffee prices fluctuate widely, the favorable growing conditions and efficient management by the descendants of German and Peruvian colonists produce high yields. Coffee and livestock operations demand much capital investment, but they are successful and well-established because neither coffee nor livestock compete much with similar land resources. On the other hand, the use of flat land near Oxapampa for grazing can compete with papaya production, while level ground planted in pasture is controlled by stockmen who have developed their own markets for livestock and milk products.

The construction of roads from La Merced to Pichanaki and Satipo has been a principal factor in determining land use patterns in the *Pichanaki-Satipo development axis*. Since the topography is gently undulating, the area offers promising agricultural potential when compared with that of the Chanchamayo Valley or the narrow valleys in the Villa Rica-Oxapampa region. A few medium-sized farms on level terrain raise livestock, fruit trees, and coffee, although semi-permanent agriculture, including shifting agriculture, is much more prevalent. Shifting cultivation meets its constant need for new land by timber harvest, although when more land is planted in permanent crops, the need for clearing forest should diminish and conflicts related to forest exploitation should be resolved. But a long-term problem may arise from the increasing use of pesticides as lands are converted to semi-permanent agriculture.

The Central Selva river valley regions (The Ene, Tambo, Pichis, and Palcazu rivers) are wild areas characterized by subsistence agriculture and small-scale animal production for domestic use. Native communities of Campas and Amueshas and some colonists live here, often without legal title to their property. The fertile soils of the alluvial floodplain make this area well suited

for cultivation of certain permanent and annual crops. The land is more commonly cleared for grazing, however, because of the strong market for livestock products. A private airline owned by the larger producers has several airstrips in the Palcazu and Pichis valleys to transport fresh beef to San Ramon.

Proposed road construction in the region can alter market preferences in favor of other products and land uses. Since sparsely populated land still exists in the Ene and Tambo valleys, conflicts related to forest and livestock production, and to protected land, can be resolved through land use planning. Soils of these valleys are poor and, in some areas, dry, and not suited to either sustained yield forestry or agriculture.

Expansion of Arable Lands

If Peru hopes to keep pace with population growth in the next few decades, it must increase its agricultural production by at least 2.6 percent annually. The country can do this by intensifying production on existing agricultural lands, expanding the amount of land under cultivation, and using land to produce food for internal consumption rather than for export. Considerable differences in production potential characterize the three principal regions in Peru. The non-coastal areas are less productive because of climate and soil limitations, inadequate transportation and commercial infrastructure, and lack of appropriate technology (this comparison, however, is based only on agricultural suitability and not on land tenancy, actual use, and availability). For example, one hectare of cultivated land on the coast roughly equals the production of 2.3 mountain hectares and 1.8 forest hectares (Table 9-7). These conversions show that land suitable for agriculture is concentrated along the coast (41.7%) and in the mountains (33.5%), with a smaller percentage being found in the forest (24.8%). Although the total area of cultivated land varies little, there has been a tendency to cultivate new lands in the forest, because of the ease of doing so and because of the long periods of drought in the mountains.

For example, in the 1960s, the Marginal Highway was begun in response to social pressure for broad agrarian reform and to provide access to lands in Peruvian Amazonia. The highway led to spontaneous migration to scattered areas, and the limited agricultural potential of such land produced questionable economic success for the migrants, conflicts with local communities, and destruction of forest resources. In the 1970s attempts were made to expand the agricultural frontier by installing irrigation in coastal areas. Very few of these large-scale irrigation projects (Chira, Piura, Tinajones, and Majes-Siguas) can be considered successful, however, because of the high costs per hectare, the long-term financial commitment required, and deficiencies in project management. Indeed, one reason to expand the agricultural frontier in Peruvian Amazonia is that the cost of irrigating new coastal areas is extremely high—more than US$7,500 per hectare (Table 9-8) compared to the US$4,000 per hectare cost of developing forest lands (Table 9-9). These costs include access roads, credit, and commercial infrastructure.

Most likely, mountain lands could be used more intensively with irrigation and the use of technologies that take advantage of natural pastures and more stable soils. The result would be higher agricultural productivity that could feed more people and reduce migration to the coast and forest. An alternative strategy to incorporate additional areas into cultivation would be to rejuvenate the 153,000 hectares on selected coastal sites, improve

Table 9-7

GEOGRAPHIC DISTRIBUTION OF AGRICULTURAL LAND USE

Region	Ha.	%	Conversion to the Equivalent of Cultivated Coastal Hectares Under Irrigation	%
Coast	632,095	25.6	631,336	41.7
Mountains	1,171,899	47.4	505,909	33.5
Forests	666,724	27.0	375,832	24.8
Total of Cultivated Land	2,470,178[a]	100.0	1,513,077	100.0

a. An estimated 1.1 million hectares are left fallow each year.
Source: MAA, 1982.

the irrigation of mountain lands, and utilize suitable lands in the high forest.

AGRICULTURAL DEVELOPMENT LIMITATIONS IN THE CENTRAL SELVA

Limitations to agricultural development in the Central Selva come from various sources. Those related to the physical environment include the following:

- Long rainy seasons create weed growth in pastures, flooded lands, and conditions favoring the breeding of insects and other pests.
- The short-dry periods make pasture maintenance through burning of shrubs and weeds more difficult, increase the demand for seasonal labor, and affect the harvest, drying, and storage of some crops such as soybeans and peanuts.
- Low soil fertility and the high percentage of hilly terrain are not favorable to productive agriculture.

Other limitations are related to agronomy, commercial conditions, and to the availability of agricultural services:

- Most crops encounter problems with pests and weeds. Any new technologies employed to increase crop yields will also incur additional production costs.
- Agricultural extension services and the agrarian banks need to be more efficient in transferring technology to farmers.
- Marketing lesser forest products is a problem because of the rapid decomposition of tropical fruits, the lack of reliable supplies, competition with established tropical products harvested near markets and processing plants, and the shortage of marketing services, such as current price information for the growers.

And finally, limitations related to the lack of appropriate technology abound. Efforts have been made to transfer agricultural practices used in temperate regions to the country, rather than to apply techniques approp-

Table 9-8

ESTIMATED COSTS INCURRED BY COASTAL LANDS

Project	Lands Irrigated (ha)	Estimated Cost of Irrigation (US$ million)	Cost/ha of Lands Irrigated (US$)
Chaco-Viru	31,400	294.7	9,385
Olmos	80,717	563.0	6,975
Total	112,117	857.7	7,650

Source: Adler, 1980.

Table 9-9

STRATEGIES FOR EXPANDING ARABLE LANDS IN PERU

Region	Ha	Equivalent Cost of Coastal Irrigation (Ha)	Total Project Estimated Cost (US$ million)	Cost/Ha	Necessary Activities
Coast[a]	70,000	35,000	150	1,500	Recuperation of lands in affected saline areas.
Mountains[b]	25,000	8,500	21.3	850	Improved irrigation.
High Forest[c]	261,400	109,800	462	4,207	Access roads, credit, crop storage

a. Recuperation of lands affected by salinity.
b. IBRD.
c. The high forest includes three special projects: Alto Maya, Alto Huallaga, and Pichis-Palcazu.
Source: Adler, 1980.

riate to the small farms typical of the mountains and forest. Sufficient evidence proves that land management practices successful in temperate regions do not work in the humid tropics (Nelson, 1973).

SECTORAL PROBLEMS AND CONFLICTS

To give planners a quick orientation to the present situation in the Central Selva, some of the region's problems are briefly described below. Table 9-10 presents a summary of these conflicts.

1. The best agricultural lands are already occupied.
2. Poorly-planned roads provide access to lands unsuitable for agriculture.
3. The underutilization of agricultural lands has resulted in low production.
4. The intensified use of suitable agricultural lands will require greater investments in fertilizers and pesticides to maintain sustained production. If such investments are poorly managed, downstream ecosystems can become contaminated.
5. As more lands are abandoned and more pastures deteriorate, weeds become abundant and forests that act as barriers to the spread of pests disappear.

Table 9-10

ENVIRONMENTAL MANAGEMENT: CONFLICTS IN THE HUMID TROPICS

Agricultural Activity	Conflicts Within the Agriculture Sector	Conflicts with Other Sectors	Solutions
Utilization of fertilizers and pesticides for more intensive agriculture.	Loss of predator-prey equilibria; disease and insect resistance to pesticides require increasingly-expensive control.	*Fish/Wildlife* - Direct and indirect effects because of increasing levels of biocides in the water. *Water* - Potential contamination of drinking water. *Livestock* - Potential contamination of meat and milk products. *Forests* - Reduces the need to clean forests for agriculture.	Investigation of integrated pest management techniques. Establishing regulations controlling pesticide use with training, extension services, and enforcement. Evaluation of crop mixtures and agroforestry systems to increase production and to minimize problems with weeds and plagues. Pesticides need to be properly used for both economic and health reasons.
Increasing cultivation on marginal areas because of spontaneous cultivation.	Continued subsistence production levels and standards of living because of low yield.	*Fish/Wildlife* - Habitat loss because of forest destruction. *Water* - Accelerated sedimentation, increased water volumes in rivers, water quality is adversely affected by rapid runoff and reduced infiltration. *Forests* - Additional losses due to clearing. *Social Problems* - Rapid marginalization of small farmers near new settlements and limited development potential of occupied areas.	Encouragement of intensified agriculture on the best soils, evaluation of sustained agricultural production systems adapted to the humid tropics. Emphasizing the rehabilitation of abandoned fallow lands and of degraded pastures before new forest land is cleared.
Underutilization of land resources (planting of fertile soils in grass instead of more intensive uses).	Loss of profits obtainable from more intensive uses, need for utilizing marginal lands for intensive cultivation of annual or high-value crops.	*Fish/Wildlife* - Indirect loss due to continued clearing of forests. *Water* - Indirect conflicts due to continued agricultural activity on marginal soils in watershed highlands. *Forests* - Utilization of forest lands for agricultural use; loss of forest resources.	Evaluation of land use, considering climatic, soil and economic limitations, land tenancy, market conditions, and cultural characteristics.

6. Urbanization and extensive livestock production utilize land suitable for agriculture.
7. Traditional agricultural systems increase resources, but are not sufficiently flexible to accommodate growing human populations. The short amount of time that lands are left fallow do not allow sufficient time for the soils to recover enough fertility for sustained agricultural production.
8. Native communities, which traditionally have practiced extensive use of the land, are now competing for their own land with colonists. The indigenous Campas and Amueshas intend to complete the process of obtaining land titles and to extend their domain to accommodate their growing populations. At the same time, national policy is to encourage emigration from overpopulated Andean communities. Conflicts between native communities, colonists, and Andean emigrants will increase when all realize the scarcity of soils capable of sustained production.

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INTERNATIONAL
AG-SIEVE
"a sifting of news in regenerative agriculture"

"An old Chinese proverb says: 'If we don't change our direction, we'll end up where we're headed.' Where we're headed is toward another doubling of world population, nearly all of it in poor countries. We're headed for greenhouse climate change, for desertification and deforestation, for a world ever more desperate and turbulent. The demographic consequenses of our current divided, unequal and unjust world are clear. We don't have to end up there. We do have to change direction."
Donella Meadows, *Los Angeles Times*

An Index of Sustainable Agriculture Periodicals

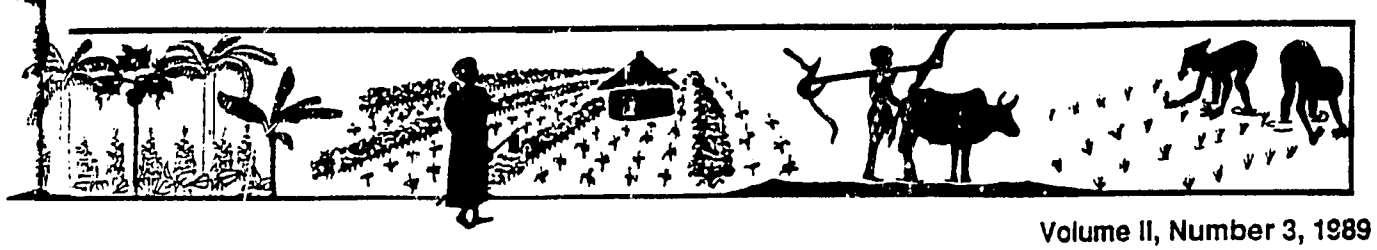
We must be resourceful in how we approach the rapid changes in communications technology. Foremost, we must constantly look at how media can assist in the process of decentralizing information and making sure it is available to those who need it. Bernard Woods of the Operations Policy Staff at the World Bank has said, "*. . .forms of mass media hold great potential for rural development; they have a cost advantage and have been shown to be able to perform functions in which other communications modes have failed, but their potential has not been realized. . .Forms of distance education and communication technology provide means of adult education and information transfer with application in all traditional sectors involved in rural development; these media are able to supplement traditional approaches and reach segments of rural communities little touched by earlier approaches.*"

At Rodale Institute's headquarters in Emmaus, we receive an abundance of current, high-quality printed information about sustainable agriculture and regenerative farming efforts from all over the world. Because of our position at the hub of an expanding information exchange network, we give high priority to keeping up with the constant flow of a broad range of information about low-input and regenerative agriculture, whether it be recent research findings, practical information from the field, or just informal correspondence about an interesting and successful project. People in the field, including researchers, field-workers and farmers, often must cope with the opposite situation— a scarcity of relevant and up-to-date material about subjects with which you are directly involved.

This issue of the **International Ag-Sieve** is addressed to providing our readers with a current listing, in alphabetical order, of many of the periodicals we screen to locate and extract the information that goes into our newsletter. Many of you will be familiar with a number of the publications listed here. We hope that all of you will find one or two on the list which you were not aware of. Our aim is to provide you with an up-to-date index of the best information sources, in the likely event that at some time you may need or wish to go directly to the publisher/editors for more detailed answers or perhaps order the periodical for your own information needs.

About 10 of the 50 publications described are less than a year old. This represents both an increased specialization in subject matter (for example, a newsletter specifically about cover crops for the Tropics) as well as an attempt to meet the ever-increasing demand for more locally appropriate information in all regions of the developing world.

Finally, this collection is by no means comprehensive. We only included those publications we consider of the best quality— a sort of Fortune 50 in the realm of sustainable agriculture periodicals. The are many others which deserve honorable mention. There are bound to be several that we have overlooked entirely. If you notice any omissions from this list, please take a moment to write us about them, so we can update our database for a future issue. Also let us know if you found this first effort helpful in steering you toward an information source that you were previously unaware of.



Volume II, Number 3, 1989

agAccess Book Catalog

Publisher:
AgAccess Inc.
P.O. Box 2008
Davis, CA 95617 USA
Tel: (916)756-7177

Purpose:
"agAccess is an information company specializing in agricultural and horticultural books. We represent over 900 publishers worldwide and maintain a very large inventory of books in stock."

Price: Free
Language: English

Agrobookstore Catalog (1989)

Publisher:
Winrock International
1611 North Kent Street
Arlington, VA 22209
USA
Tel: (703) 525-9455
Telex:248589

Topic Focus/Purpose:
Listing of current and previous publications of the International Agricultural Research and Development Centers

Frequency: Annual
Price: Free

Agroforestry Systems

Publisher:
Kluwer Academic Publishers
(in cooperation with ICRAF)
P.O. Box 322
3300 AH Dordrecht
NETHERLANDS

Editor: H. J. von Maydell

Purpose:
The objectives of *Agroforestry Systems* are to: identify techniques, policies, education and training suitable for rural development in the various ecological regions of the world, predominantly in the tropics; to inform the decision maker at all levels on progress, constraints and advantages of multidisciplinary land-use planning; to contribute to solving dominant problems of rural development by stimulating demand-oriented applied science."

Frequency: Bi-monthly
Price: 278.00 Dutch guilders/ US $132.00, plus Dfl. 52/US $24 for post & handling

Agroforestry Today

Publisher:
International Council for Research in Agroforestry (ICRAF)
P.O. Box 30677
Nairobi, KENYA
Tel: 254-2-521450
Telex: 22048

Editor: Sidney Westley
Regional Focus: Worldwide, primarily the tropics
Topic Focus: Agroforestry systems
Frequency: Quarterly
Price: Free
ISSN: 0255-8173

Alternative Agriculture Resources Report

Publisher:
Institute for Alternative Agriculture
9200 Edmonston Rd, Suite 117
Greenbelt MD 20770
USA
Tel: (301) 441-8777

Editor: Dr. Garth Youngberg
Regional Focus: United States
Topic Focus:
Low-Input research, US Govt. policy, conferences & events

Purpose:
Alternative Agriculture Resources Report is edited especially for the agricultural education, extension, and research communities. IAA's other publications include a monthly newsletter, Alternative Agriculture News; a quarterly scientific journal, American Journal of Alternative Agriculture; and the proceedings from the annual scientific symposium series.

Frequency: Monthly
Price: Free
ISSN: 0892-175X

American Journal of Alternative Agriculture

Publisher:
Institute for Alternative Agriculture Inc.
9200 Edmonston Rd, Suite 117
Greenbelt, MD 20770
USA
Tel: (301) 441-8777

Editor: Garth Youngberg, Ph.D.
Regional Focus: United States

Purpose:
"The Institute for Alternative Agriculture is a nonprofit, tax-exempt research and education organization established in 1983 to encourage the adoption of low-cost, resource-conserving and environmentally sound farming methods. It works closely with producer groups, public research and education institutions, and government agencies in promoting a sustainable agriculture system."

Frequency: Quarterly
Price: Institutions- US $40
Individuals- $20
IAA Members- $15
Students- $10
(add $7 for overseas subs)
ISSN: 0889-1893

At ICRISAT

Publisher:
International Crops Research Institute for the Semi-Arid Tropics
Patancheru
Andhra Pradesh, 502 324
INDIA

Editor: Not listed
Regional Focus: Semi-arid tropics

Purpose:
"ICRISAT's mandate is to improve the yield, stability and food quality of five crops basic to life in the semi-arid tropics (sorghum, millet, chickpea, pigeonpea and groundnut) and to develop farming systems that will make maximum use of the human and animal resources and the limited rainfall of the region."

Frequency: Quarterly
Price: Free

Baobab

Publisher:
Arid Lands Information Network,
(Sponsored by OXFAM UK)
274 Banbury Road
Oxford OX2 7DZ
United Kingdom
(0856)56777
Telex: 83610

Editor: Katharine McCullough
Regional Focus:
The Sahel and semi-arid Africa

Purpose:
Information networking among individuals and groups working in the Sahel and semi-arid

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Africa in general.
Frequency:
Occasional/quarterly
Price: Not listed

Bean Newsletter (also Cassava Newsletter)

Publisher:
Centro Internacional de Agricultura Tropicale (CIAT)
Apartado Aéreo 6713
Cali, COLOMBIA
Editor:
Jack Reeves
Regional Focus:
Humid tropics worldwide
Topic Focus:
Abstracts and excerpts from research reports on all aspects of bean and casava germplasm breeding & cultivation.
Frequency: Quarterly
Price: Free upon application to Publications Dept, CIAT
Language:*
English and Spanish
ISSN: 1011-3843

Biological Agriculture and Horticulture

Publisher:
A B Academic Publishers
P.O. Box 97
Berkhamsted
Herts, ENGLAND HP4 2PX
Editor:
Dr. R.D. Hodges
Regional Focus:
Worldwide
Topic Focus & Purpose:
"*Biological Agriculture and Horticulture* aims to act as the central focus for the wide range of studies into alternative systems of husbandry, and particularly the biological approach to food production. The areas covered include: soil fertility and management: biological control methods: energy utilization studies; agricultural systems and environmental management."
Frequency: Quarterly
Price: £69/US $125, postpaid.
ISSN: 0144-3765

** where the language of the periodical is not indicated, it is printed only in English.*

Biomass Users Network News

Publisher:
Biomass Users Network (B.U.N.)
P.O. Box 33308
Washington, DC 20033 USA
Editor:
Shailu Iyengar, Information Cordinator
Regional Focus:
Developing countries worldwide
Purpose:
"The Biomass Users Network was established to promote South-South cooperation in developing and strengthening national capabilities to increase production and use of biomass resources as a means of advancing economic, social and ecological well-being, primarily in the rural areas."
Frequency: Quarterly
Price: Not listed

CIKARD News

Publisher:
Center for Indigenous Knowledge for Agric. & Rural Development
318B Curtiss Hall
Iowa State University
Ames, IA 50011 USA
Tel: ((515) 294-4111
Editor: D. Michael Warren
Regional Focus: Worldwide
Purpose:
CIKARD serves as a clearinghouse for collecting and disseminating information on indigenous agricultural and rural development knowledge. They facilitate multidisciplinary research on indigenous knowledge and develop methodologies for identifying and documenting this knowledge.
Frequency: Quarterly
Price: Not listed

Cover Crops News

Publisher:
International Cover Crops Clearing House (CIDICCO)
P.O. Box 278-C
Tegucigalpa, D.C.
HONDURAS, C.A.
Editor: Milton Flores
Regional Focus:
Central and South America
Topic Focus:
Sustainable farming methods using leguminous crops.
Purpose:
"Cover Crops News is for private and governmental agencies and individuals who are interested in promoting the use of legume species for the purpose of increasing productivity, especially of small farmers. We want to stress only those forms of cover crop use that are simple and low cost."
Frequency: Quarterly
Price: Not listed

Drylander

Publisher:
Dry Lands Research Institute
University of California
Riverside, CA 92521
USA
Tel: (714) 787-5797
Wesley M. Jarrell, Director
Regional Focus:
Semi-arid regions. Southwestern North America
Purpose:
"Given the condition of dry lands around the world and California in particular, our future efforts will emphasize: conservation biology of species and habitats in dry lands, desertification, sustainable agriculture in dry regions."
Frequency: Quarterly
Price: Not listed
ISSN: 0888-5532

ECHO News

Publisher:
Educational Concerns for Hunger Organization (ECHO)
17430 Durrance Rd.
North Ft. Myers, FL 33917
USA
Tel: (813) 543-3246
Editor: Dr. Martin Price
Regional Focus:
Developing countries worldwide.
Topic Focus:
Underutilized and lesser known vegetable & tree crops of the tropics. Can provide limited quantities of seed.
Frequency: Quarterly
Price: By donation- $15 or more

EcoAfrica

Publisher:
African NGOs Environment Network (ANEN)
P.O. Box 53844, Nairobi
Tel: 26255
Telex: 25222 KENGO KE

Editor: Simon Muchiru
Regional Focus: Africa
Purpose:
"Ecoafrica is a bi-monthly environmental and development information networking magazine for African NGOs. It focuses on grassroot NGO initiatives that promote environmentally sound and sustainable development and natural resources management for Africa."
Frequency: Bi-monthly
Price: African NGOs- Free
All others: US $15/yr
Students- $ 12/yr
Language: English, French

Ecoforum

Publisher:
Environment L... ...n Centre International
P.O. Box 72461
Nairobi, KENYA
Tel: 24770, 340849
Telex: 23240 ELC KE
Editor: Ravi Sharma
Regional Focus:
Developing countries, primarily Africa; also worldwide
Purpose:
"ECOFORUM functions as a networking tool for NGOs around the world to share information and strategies relating to environment and sustainable development issues. It also acts as a window on the United Nations Environment Programme."
Frequency: Bi-monthly
Price: Not listed
Language:
English, French, Spanish

Enlace

Publisher:
Red de Accion en Plaguicidas de America Latina
c/o Fundacion Natura
Casilla 253
Quito, ECUADOR
Editor: Teodoro Bustamente
Regional Focus: South America
Topic Focus: Pesticide regulation and alternative practices in Latin America
Frequency: Biannual
Price: Not listed
Language: Spanish

Entre Nous

Publisher:
Rodale International
B.P. A237
Thiés
SENEGAL
Tel: (221)511028
Editor: Rob Petersen
Regional Focus: West Africa
Purpose:
Information networking in regenerative farming methods appropriate for Sahelian agroclimatic zone.
"ENTRE NOUS est un bulletin bimestriel de liaison et d'échange d'information dans le domaine de l'agriculture régénératrice."
Frequency: Six times per year
Price: US $10/year FCFA 1000/year
Language: French

Experimental Agriculture

Publisher:
Cambridge University Press
The Edinburgh Building
Shaftesbury Road
Cambridge, UK CB2 2RU
Editor: Dr. F.G.H. Lupton
Regional Focus: Worldwide
Topic Focus:
"It publishes the results of analytical studies of the agronomy of crops, particularly of the food, forage and industrial crops of the warmer regions of the earth. It is especially concerned with experimental work conducted in the field and designed to explain results in biological and environmental terms."
Frequency: Quarterly
Price: £57/US $136
ISSN: 0014-4797

Gardens for Development

Publisher:
Sun Station Box 41243
Tucson, AZ 86717-1243 USA
Editor: Vera Niñez
Regional Focus:
Developing countries.
Topic Focus:
Small-scale food production, home gardens in LDCs, importance of gardening programs in rural development.
Frequency: Semi-annual
Price: Libraries-US$ 25
Professionals, students-$15
LDC Students-$ 5

HortIdeas

Publisher/Editors:
Greg & Pat Williams
Route 1, Box 302
Gravel Switch, KY 40328
USA
Regional Focus: USA
Purpose:
"Reporting on the latest research, methods, tools, plants, books, etc., for vegetable, fruit and flower gardeners, gathered from hundreds of popular and technical sources, worldwide."
Frequency: Monthly
Price: US $10
Canada & Mexico $12;
Overseas air mail $24

IDRC Reports

Publisher:
International Development Research Centre
250 Albert St.
P.O. Box 8500
Ottawa, CANADA
Editor:
Jean-Marc Fleury
Regional Focus:
Developing countries worldwide
Purpose:
IDRC is a public corporation created in 1970 by Parliament of Canada to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors; agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; communications.
Frequency: Quarterly
Price: Free
Language: English, French, Spanish and Arabic
ISSN: 0315-9981

IFOAM—Bulletin for Organic Agriculture

Publisher:
International Federation of Organic Agriculture Movements
IFOAM General Secretariat
c/o Ökozentrum Imsbach
D-6695 Tholey-Theley,
Fed. Rep. GERMANY
Tel: 06853/5190
Editor: Bernward Geier
Regional Focus:
Europe, developing countries.

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Topic Focus:
The metamorphosis of the Organic Farming Movement
Frequency: Quarterly
Price: US $15 per year
20 Sfr, 28 DM
7.00£UK
Language: English & German

IITA Research Briefs

Publisher:
International Institute of Tropical Agriculture
PMB 5320
Oyo Road
Ibadan
NIGERIA
Editor: Not listed
Regional Focus: The tropics
Topic Focus:
Summarized reports of current research programs at IITA
Frequency: Quarterly
Price: Free
ISSN: 0331-9512

ILCA Newsletter

Publisher:
International Livestock Center for Africa (ILCA)
P.O. Box 5689
Addis Ababa
ETHIOPIA
Editor: Not listed
Regional Focus: Africa
Topic Focus:
Livestock research and development information, conferences, training courses, open positions
Frequency: Quarterly
Price: Free
ISSN: 0255-0024

ILEIA

Publisher:
Informationcentre for Low External Input and Sustainable Agriculture
P.O. Box 64
3830 AB Leudsen
NETHERLANDS
Tel: 033-94-30-86
Editors:
Wim Heimstra, Coen Reijntjes, Bertus Haverkort
Regional Focus:
Developing countries, Europe
Topic Focus:
Recent issues focused on livestock in the Agroecosystem, Mountain Agriculture, "Towards Sustainable Agriculture," Participatory Technology Development, and Enhancing Dryland Agriculture.
Frequency: Quarterly
Price: Students/Third World subscribers- US$12.50
Others- US$20.00
ISSN: 0920-8771

International Agricultural Development

Publisher:
John Madeley
19, Woodford Close
Caversham, Reading
Berks, UK RG4 7HN
Tel: (0734) 476063
Editor: John Madeley
Regional Focus:
Developing world.
Purpose:
"*International Agricultural Development* serves as a forum for debate on agricultural issues in the developing world. It is a channel through which people can talk to each other about how to increase food output, improve distribution and create the conditions under which hunger can be overcome."
Frequency: Bi-monthly
Price: £25 per year postpaid.

International Tree Crops News

Publisher:
International Tree Crops Institute
P.O. Box 283
Caulfield South
Victoria 3162
AUSTRALIA
Tel: (613) 211-6209
Editor: Geoff Wilson
Regional Focus: Australia, East Asia, Pacific basin.
Purpose:
"The International Tree Crops Institute is a non-profit, non-governmental organization aimed at further development of multi-use trees (food, fodder, fuelwood, fibre, feedstocks and pharmaceuticals, flowers, essential oils and timber). ITCI also promotes agroforestry systems, particularly those that reduce or eliminate land degradation."
Frequency: Bi-annual
Price: US $30 per year
ISSN: 1032-7290

IPPC Infoletter

Publisher:
International Plant Protection Center
Oregon State University
Corvallis, OR 97331 USA
Editor: A. E. Deutsch
Regional Focus: Worldwide
Topic Focus:
Information on weed management/identification, new books and developments in pest management technology.
Frequency: Occasional
Price: Free
ISSN: 0145-6288

IRED Forum

Publisher:
Innovations et Reseaux pour le Developpement
(Development Innovations and Networks)
IRED/Forum
3, rue de Varembe, case 116
1211 Geneva 20
SWITZERLAND
Tel: 34 17 16 Telex: 289450
Editor: Fernand Vincent
Regional Focus: Worldwide
Purpose:
"IRED Forum is the communication tool of an international network of 600 peasant associations, artisans' and women's groups, organizations for development action in urban surroundings and of centres and institutes giving their support to grassroots groups.
Frequency: Quarterly
Price: Europe/USA/Canada US $25
Third World $12
Language:
English, French, Spanish

Journal of Soil and Water Conservation

Publisher:
Soil and Water Conservation Society
7515 N.E. Ankeny Rd.
Iowa 50021-9764 USA
Tel: (515) 289-2331
Editor: Max Schnepf
Regional Focus: Worldwide
Purpose:
"To enhance the science and art of good land and water use worldwide."
Frequency: Bi-monthly
Price: US $30/year
US $35 outside USA & Canada
ISSN: 0022-4561

Manna

Publisher:
International Alliance for Sustainable Agriculture (IASA)
University of Minnesota,
Newman Ctr.
1701 University Ave. S.E.
Rm 202
Minneapolis, MN 55414 USA
Tel:(612) 331-1099
Editors: Peggy Johnson, Terry Gips
Regional Focus:
Midwestern USA, worldwide.
Purpose:
"IASA is a non-profit, tax-exempt organization of individuals and groups cooperating to develop economically viable, ecologically sound, socially just and humane agricultural systems around the world. Our three major program areas are: research and documentation; organizational support & network building; education & public outreach."
Frequency: Quarterly
Price: Individuals: US $15/yr
Institutions: $25/yr

Native Seeds SEARCH 1989 Seedlisting & Catalog

Publisher:
Native Seeds/SEARCH
2509 N. Campbell Ave. #325
Tucson, AZ 85719
(602) 327-9123
Editor: Not listed
Regional Focus:
Southwest USA, Mexico
Topic Focus:
Listing of native & wild seeds for exchange with master gardeners and researchers working in arid & semi-arid areas.
Frequency: Quarterly
Price: US $10 for Associate membership

New Alchemy Quarterly

Publisher:
New Alchemy Institute
237 Hatchville Rd.
East Falmouth, MA 02536
USA
Tel: (508) 564-6301
Editor: Bill O'Neill
Regional Focus:
United States, Costa Rica
Purpose:
"New Alchemy Institute serves students, teachers, households and small-scale farmers with research and education projects focusing on food, energy, water and waste treatment systems. The Institute is a nonprofit, tax-exempt organization supported by foundation grants, individual contributions, research contracts, earned income and membership fees."
Frequency: Quarterly
Price: US $8 per year.
ISSN: 0895-1497

NFTA News

Publisher:
Nitrogen Fixing Tree Association (NFTA)
P.O. Box 680
Waimanalo, HI 96795 USA
Tel: (808) 259-8555
Editor: Bill Macklin
Regional Focus:
Developing countries worldwide.
Topic Focus:
Information about developments in sustainable agriculture, agroforestry and the products and services of related organizations. "NFTA is a non-profit organization that encourages more and better use of nitrogen fixing trees to benefit people, especially small farmers in the developing tropics."
Frequency: Quarterly
Price:
Individuals: US $10
Institutions: $15

Partners in Research for Development

Publisher:
Australian Centre for International Agricultural Research
GPO Box 1571
Canberra, A.C.T. 2601
AUSTRALIA
Editor: Brian Lee
Regional Focus:
Worldwide
Topic Focus:
"...presents articles that summarise results from ACIAR-sponsored rsearch projects, and put ACIAR research thrusts into perspective."
Frequency: Occasional
Price: Free
ISSN: 1031-1009

STAR (Science & Tech. Agricultural Reporter)

Publisher:
U.S. Agency for International Development
A.I.D./Science &Technology/ Agriculture
Room 406H, SA-18
Washington, DC 20523-1809
USA
Tel: (703) 875-4266
Editor: Harold A. Le Sieur
Sr. Communications Advisor
Regional Focus: Worldwide
Purpose:
"STAR responds to a demnad for regular communications between A.I.D.'s 6ffice of Agriculture and a worldwide audience. It provides current information on collaborative research programs sponsored by A.I.D. STAR's objective is to increase professional collaboration, avoid duplication of effort, and facilitate the transfer of agricultural technology.
Frequency: Quarterly
Price: Free

Spore

Publisher:
Technical Centre for Agricultural and Rural Cooperation (CTA)
Postbus 380
6700 AJ Wageningen
NETHERLANDS
Tel: 8380 20484 Telex: 30169 CTA(Technical Divison)
Regional Focus: Developing countries, worldwide.
Topic Focus:
"SPORE is an international bulletin for the dissemination of scientific and technical information on agricultural and rural development to ACP countries."
Frequency: Bi-monthly
Price: Free
ISSN: 1011-0046

Sustainable Agriculture News

Publisher:
USDA Cooperative Extension/ University of California, Davis
Sustainable Agriculture Research & Education Program
University of California
Davis, CA 95616 USA
Tel: (916)752-7556

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Editor: Lyra Halprin
Regional Focus:
State of California
Purpose:
Regular communication and co-operation between several University of California programs investigating aspects of sustainable agriculture, as well as other California based groups.
Price: not listed

The Cultivar

Publisher:
Agroecology Program
University of California
Santa Cruz, CA 95064
USA
Tel: (408) 429-4140
Editor: Martha Brown
Regional Focus:
North, Central & South America
Topic Focus:
Updates on research activities of the UCSC Agroecology Program
Frequency: Bi-annual
Price: Free

The IPM Practitioner

Publisher:
Bio-Integral Resource Center (BIRC)
P.O. Box 7414
Berkeley, CA 94707 USA
Tel: (415) 524-2567
Editors: Shelia Daar, Helga & William Olkowski
Regional Focus: Worldwide
Topic Focus:
"Monitoring the Field of Pest Management"
Frequency: 10 times/yr
Price: US $50/year (institutions, libraries, businesses); $25/year (individuals); $18/yr (registered students); add $23 foreign air, $10 surface mail
ISSN: 0738-968X

The New Farm

Publisher:
Regenerative Agriculture Asociation
222 Main Street
Emmaus, Pa., 18098 USA
Tel: (215) 967-5171
Editor: George DeVault
Regional Focus: USA
Purpose:
"*The New Farm* is dedicated to putting people, profit and biological permanence back into farming by giving farmers the information they need to take charge of their farms and their futures."
Frequency: Seven times per year
Price: US $15 per year
ISSN: 0163-0369

The Sustainable Agriculture Newsletter

Publisher:
CUSO/IDRC
17 Phahonyothin
Golf Village, Phahonyothin Road
Bangkhen, Bankok 10900
THAILAND
Editor: Janet Durno
Regional Focus: Southeast Asia
Purpose:
"Sustainable Ag. Newsletter will endeavor to share information on crucial issues in sustainable agriculture throughout the Asia-Pacific region."
Frequency: Quarterly
Price: Not listed

The Tillers Report

Publisher:
Tillers Small Farm Program
Kalamazoo Nature Center, Inc.
7000 N.Westnedge Ave.
Kalamazoo, MI 49007 USA
Tel: (616)381-1574
Editor: Richard Roosenberg
Regional Focus: North America
Topic Focus:
Adapting early farm methods for rural development
Frequency: Quarterly
Price: Not listed.

VITA News

Publisher:
Volunteers in Technical Assistance (VITA)
1815 North Lynn St., Suite 200
Arlington, VA 22209-2079
USA
Editor: Margaret Crouch
Regional Focus: Worldwide
Purpose:
"VITA is a nonprofit international development organization. It makes available to individuals and groups in developing countries a variety of information and technical resources aimed at fostering self sufficiency –needs assessment and program development support."
Frequency: Quarterly
Price: US $15/year
ISSN: 0882-0937

World Development Foum

Publisher:
The Hunger Project
1300 19th Street, NW, Suite 407
Washington, DC 20036 USA
Tel: (202)785-2490
Editor: Peggy Streit
Regional Focus: World-wide
Topic Focus:
"A twice-monthly report of facts, trends and opinion in international development"
Frequency:
Bi-monthly
Price: Free

WorldWatch

Publisher:
Worldwatch Institute
1776 Massachusetts Ave. NW
Washington, DC 20036
USA
Editor: Lester R. Brown
Regional Focus: World-wide
Purpose:
"Our goal is to help reverse the environmental trends that are undermining the human prospect...to raise public awareness of these threats to the point where it will support an effective political response."
Frequency: Bi-monthly
Price: US $20/yr USA and overseas surface, US $35 overseas air.
ISSN: 0896-0615

Other interesting periodicals:

CODEL News
Coordination in Development
475 Riverside Drive, Room 1842
New York, NY 10115 USA

Kidma
Isreal Journal of Development
Society for International Development, Israel Chapter
P.O. Box 13130
91131, Jerusalem, ISRAEL

News from CGIAR
Consultative Group on International Agricultural Research
1818 H Street, NW
Washington, DC 20433 USA

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