Social and Economic Approaches to Biodiversity Conservation:

An Annotated Bibliography with Emphasis on Aquaculture

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February 1999

Acknowledgements

This work was produced as part of a project funded by the International Development Research Centre of Canada (IDRC). We thank IDRC's Brian Davy for his whole-hearted promotion and encouragement of the interdisciplinary work involved in the valuation of local-level biodiversity in aquaculture and in examining strategies for grass-roots biodiversity conservation. The project was jointly administered by Saint Mary's University (Department of Finance and Management Science) and Dalhousie University (Department of Biology and School for Resource and Environmental Studies) in Halifax, Canada. We thank all of the academic units involved for the provision of time to undertake this research.

We are especially grateful to our colleagues and co-principal investigators, Roger Doyle (Dalhousie University) and Zubaida Basiao (Southeast Asian Fisheries Development Center), for many stimulating and enjoyable interactions, and for their patience in introducing to us the complexities of aquaculture genetics and fish breeding, as well as encouraging us to explore the socioeconomic implications of genotype-environment interactions. Our collaboration with Roger and Zubaida made for truly interdisciplinary teamwork, and led to useful insights.

We are also grateful for the opportunity to work with and learn from our Asian project partners:

China:	Freshwater Fisheries Research Center
	Shanghai Academy of Social Sciences
Indonesia:	Bogor Agricultural University
	Central Research Institute for Fisheries
	Freshwater Aquaculture Development Center
	Research Institute for Freshwater Fisheries
Thailand:	Research and Development Institute, Khon Khen University
	Thailand Department of Fisheries
	National Aquaculture Genetics Research Institute

This report would not have appeared in print without the extensive research assistance of Cheryl Benjamin, Jessica Meeuwig and Scott Coffen-Smout. In particular, Ms. Benjamin was instrumental in compiling a large part of the references herein, and in carrying out the editorial work needed to bring material from disparate sources under a common format in this final report.

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Abstract

Social and economic issues and approaches in aquaculture biodiversity conservation are increasingly important and not well represented in the largely biological focus of the literature on biodiversity and food production. This annotated bibliography brings together various sources of information on social and economic aspects of biodiversity conservation. It is focused on aquaculture, agriculture and natural aquatic systems, as well as covering the discussion of issues in biodiversity conservation more generally. Selected themes are also introduced concerning technology transfer and adoption, aquaculture and rural development issues. A brief section is included which surveys social science methodologies relevant to research on biodiversity conservation, and a technical appendix is provided compiling selected literature on the science of genetic improvement in cultivation systems.

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Chapter 1.
INTRODUCTION

This annotated bibliography provides a compilation of social and economic references focused on biodiversity conservation, with an emphasis on aquaculture and other cultivation systems. Indeed, as described below, the impetus for producing this report arose out of a three-country study on biodiversity and genetic conservation in aquaculture, funded by the International Development Research Centre of Canada. A fundamental perspective of the project was the recognition that while biological aspects of aquaculture genetics and of biodiversity conservation have received considerable research attention, the same cannot be said of the social and economic aspects. In particular, a key component of the project was to examine the social and economic, as well as biological, value of local breeds used in aquaculture.

Thus this bibliography has, at its 'core', social and economic studies concerning biodiversity conservation and genetic improvement in aquaculture. When compiling the bibliography, it was recognized that:

- there were unlikely to be many references precisely fitting this description,
- insights could be obtained as well by examining social and economic analyses of biodiversity conservation outside the aquaculture sector, particularly in agriculture, but in other wild or non-cultivated sectors as well,
- it would be helpful as well to produce a compilation of social and economic studies on certain themes in aquaculture and agriculture that, while not focusing on biodiversity conservation, would provide an improved understanding of the structure and dynamics of these sectors, of use in biodiversity conservation efforts,
- to make this report more comprehensive, and useful to social scientists not familiar with aquaculture genetics, it would be helpful to include a selected set of relevant technical references, focusing on genetics and biology.

These four factors led to the content and structure of the present report, which is discussed in detail later in this Introduction. Before that, we provide a brief discussion, for the non-geneticist, of the rationale for examining biodiversity conservation in aquaculture and agriculture.

Background

The Green Revolution, the application of genetic improvement methods to produce new varieties of crops, has been a well-studied phenomenon. The Green Revolution has had a clear impact on agricultural productivity, notably through enhancing the growth rates of crops. At the same time, there have been concerns raised about impacts on biodiversity. One of these is a tendency for the number of crop varieties in use to decrease over time as farmers abandoned traditional varieties, whether through independent economic decisions, or due to the promotional and/or regulatory actions of governments, aid agencies and others. In addition, there have been various socio-cultural impacts, including those related to processes of implementation and of distributing new varieties, and changes in such factors as income distribution among farmers.

In recent years, the attention of many geneticists has turned to aquaculture. There is talk of a 'Blue Revolution', as efforts expand to breed new, improved varieties of fish. Efforts to apply genetic breeding approaches have become common with salmon (popular in locations such as Norway, Canada, Scotland and Chile), brackishwater shrimp (on the coasts of many tropical countries), carps (in pond culture, particularly in Asia) and tilapia (especially in southeast Asia).

As aquaculture genetics expands, there is a growing desire to avoid in the Blue Revolution the loss of genetic biodiversity that accompanied the Green Revolution. With issues of biodiversity conservation receiving attention globally, the idea in aquaculture is to ensure that genetic improvement goes hand-in-hand with genetic conservation. Concerns about genetic biodiversity conservation within a farm environment, whether aquaculture or agriculture, focus not on the potential extinction of whole species, but rather on the loss of within-species genetic diversity.

As noted above in the case of the Green Revolution, the diverse 'breeds' ('strains' or 'varieties') that have developed in a wide range of different environments represent a pool of biodiversity. Consider the process involved. Since farmers of, say, common carp, live in a wide range of climatic and topographical environments, the same breeding approach, carried out in these different locations, may lead to differentiated breeds, what are referred to as different 'genotypes'. When this occurs, when differing environments produce differing genotypes, a process referred to as 'genotype-environment interaction' -- this produces genetic diversity, a fundamental form of biodiversity.

Different breeds of fish may have different appearances (e.g., the colour or shape of the fish) or physiological conditions (e.g., a higher growth rate) or perhaps most importantly, they may be differentially adapted to specific environments in which they were bred. In other words, a breed in a certain location may be best adapted for the local climate or topography, or to withstand certain diseases or unusual conditions that appear from time to time in that location. The local breed may appear inferior to genetically-improved strains imported from elsewhere, based on short-term measures of growth rate, yet over the long-term, it may be more robust and provide less risk to the farmer, perhaps due to better resistance to local diseases or extremes in climate.

Thus the existence of locally-adapted breeds may be valued in terms of:

- an inherent biodiversity value, arising in part from risk-spreading benefits that multiple breeds provide against the possibility of a catastrophe that decimates one breed,
- a difficult-to-measure value implicit in long-term adaptation to local conditions, a value that may be especially important from the perspective of the risk-averse farmer, yet which may well be missed in the course of typical testing, focused on short-term performance measures such as growth rate,
- a sociocultural value, derived for example from the breed's importance in relations of obligation and exchange, in enhancing community cohesion or in ceremonial purposes,
- an economic value, arising for example if the local breed serves a particular market niche, whether locally or further afield.

The idea of assessing these values inherent in local aquaculture biodiversity lay at the heart of our interdisciplinary multi-national project, out of which this report has emerged. Funded by Canada's

International Development Research Centre (IDRC), the project sought to document the social, economic and biodiversity value of local breeds of cultured fish, and more generally to examine the implications of genetic improvement and conservation in aquaculture. A fundamental research hypothesis of the project was that the many breeds of cultured fish, developed over time through widespread breeding, represent an important source of genetic diversity that may have substantial value from both sociocultural and economic perspectives, in addition to its intrinsic biological value. The key goal of the project was therefore to examine social and economic, as well as biological, aspects of biodiversity conservation at the 'breed' (genetic) level. This goal defined the ultimate focus of the present report.

Content

The core of this report is found in Part A, presenting an annotated bibliography of social and economic studies on the topic of biodiversity conservation in aquaculture (Chapter 2), agriculture (Chapter 3), natural aquatic systems (Chapter 4), and "issues in biodiversity conservation" (Chapter 5). All of the references contained in part A focus on social and economic aspects, and all deal directly with biodiversity conservation. Almost all of the references on aquaculture and agriculture focus on aspects of genetic diversity. Those on natural aquatic systems, as well as those concerning other systems and general studies (in Chapter 5) are in most cases not specifically on genetic diversity; many deal with species-level biodiversity, while many others cover all forms of biodiversity in a general manner.

Of the 148 references in Part A, relatively few (13) were located on the core theme of the project within which this report was generated -- namely, the social and economic analysis of genetic diversity conservation in aquaculture (see Chapter 2). Also, rather few (20) were found on natural aquatic systems (see Chapter 4). In contrast, many more references were located on genetic diversity in agriculture (60) as well as more broadly to situate the debates on biodiversity conservation (55) - see Chapters 3 and 5 respectively. Indeed, it should be noted that the latter compilations are by no means expected to be exhaustive, since they arose while searching originally for material on aquaculture. It seems clear, therefore, that relatively little has been written on the social and economic analysis of biodiversity conservation in aquatic systems, whether natural or cultivated. Whatever the reasons for this -- such as a relatively recent appearance of genetic diversity discussions in aquaculture, certainly compared to the several decades of Green Revolution analyses in agriculture -- the limited number of references on the core theme of the project suggests a clear gap in research on this topic.

Part B of the report contains annotated bibliographies with a total of 142 social and economic references in aquaculture and agriculture, arranged according to two key themes: technology transfer and adoption (63 references, in Chapter 6), on aquaculture and rural development (40, in Chapter 7) and on social and economic research approaches (39, in Chapter 8). While these references are not on the topic of biodiversity conservation per se, they deal with social and economic factors of relevance to the implementation of programmes on biodiversity conservation, or on genetic improvement and management, in food production and cultivation systems. It must be noted that no attempt has been made to be exhaustive in coverage here. Instead the goal has been to compile a sampling of social and economic references on these themes, to indicate the

value of such social science analyses in examining biodiversity conservation for both aquaculture and agriculture.

Social and economic studies of technology transfer and adoption address questions of how people choose new technologies, how they accept and adapt to new technologies, and the social/economic impacts of these processes. Such questions are clearly relevant to the selection and adoption of new breeds of fish or new varieties of plants. The wide range of developmental issues covered here (dealing primarily with aquaculture) examine gender, environment, labour and many other factors that can affect the success of development efforts, wherever these may arise, including the development of biodiversity conservation programmes. Finally, references on research approaches, as well as some on research priorities, present a range of social and economic methods used to study farming systems, and thus oriented toward obtaining a better understanding of factors such as farmer needs, risk preferences, and the feasibility of genetic improvement and conservation options.

The report also contains an Appendix, compiling technical references on genetic and/or biological topics, organized according to the four areas of part A, namely (a) aquaculture, (b) agriculture, (c) natural aquatic systems, and (d) issues in biodiversity conservation. These are references that complement those of a social and/or economic nature in Part A, providing the scientific background involved, for social scientists. In addition, while the emphasis in these references is on technical aspects, some also deal with policy recommendations, albeit typically based on technical rather than social/economic analysis.

It should be noted that each reference in this report contains the standard bibliographic citation (author, title, publisher, etc.), followed, if available, by the author's institutional affiliation in square brackets. This data is accompanied in most cases by an 'annotation', which is often the abstract, but can be an excerpt from the text of the publication, or a summary written in the course of generating the bibliography. Those references without annotation are typically ones located in literature searches but not physically obtained in the course of this work. They are included here because they appear, based simply on the title, to be of some significance to the theme of the report. The index at the end is provided to increase the accessibility of entries in the bibliography; all entries in the bibliography are listed in order of appearance, with page numbers.

Finally, it is surely a fact of life that every bibliography, whatever the topic, must issue a caveat: there are undoubtedly significant omissions from this report. We apologize in advance for this, and would be grateful to receive copies of publications that should be included herein, so that omissions can be rectified in subsequent efforts. We hope that what is included here will provide a useful resource for both natural scientists and social scientists seeking to assess and conserve biodiversity, particularly that inherent in local breeds, whether in aquaculture, agriculture, or more broadly.

PART A:

SOCIAL AND ECONOMIC STUDIES

ON BIODIVERSITY CONSERVATION

Chapter 2.
SOCIAL AND ECONOMIC STUDIES ON BIODIVERSITY CONSERVATION IN AQUACULTURE

Bartley, D.M. 1992. Biodiversity and genetics in aquaculture and fisheries. FAO Aquaculture Newsletter 1:8-12.

Bartley, D.M.; Hallerman, E.M. 1995. A global perspective on the utilization of genetically modified organisms in aquaculture and fisheries. Aquaculture 137:1-7. [Fisheries Department, FAO, Rome, Italy]

"To evaluate globally the use, desires and constraints associated with the development of genetically modified organisms (GMO) in fisheries and aquaculture, a questionnaire was distributed internationally. The questionnaire focused on five main areas: (1) the current status of aquatic biotechnology, i.e. activities; (2) existing or proposed policies regulating the research, release, commercialization and patenting of GMO; (3) the level of interest in utilizing transgenic and ploidy-manipulated aquatic species; (4) the constraints associated with development of aquatic biotechnology; (5) public perception of biotechnology. Results indicated that policies and regulations on utilization of GMO are lacking in many developed countries, although this is more pronounced in developing areas. The level of interest to utilize GMO was highest in Latin America of the developing countries and they were desired as a means for augmenting production in aquaculture and fisheries. Manipulation of chromosome sets was the most common activity reported, other than education and training activities. Other common activities reported were research on transgenics, hybridization, and sex manipulation. The most important constraint to development of aquatic biotechnology was lack of financial support both in developed and developing countries. Overall, the reported public perception of biotechnology and of genetic modification of animals was favourable concerning moral issues, potential for economic benefit, ability to improve diet, and environmental safety. Results are discussed in terms of their implication to the Convention on Biological Diversity." [Abstract]

Bhaumik, U.; Chatterijee, J.G.; Mondal, S.K. 1989. Acceptance of exotic carps in aquaculture by fish farmers of West Bengal. Journal of Inland Capture Soc. India 21(2):37-40. [Cent. Inland Capture Fish. Inst., India, Barrackpore, India]

The acceptance of exotic carps by Indian farmers in aquaculture practices and the role of mass media in technology transfer were assessed. Studies conducted in 45 C.D. blocks, selected at random from 10 districts of West Bengal, revealed significant differences concerning the acceptance of various exotic carps. Among different communication media, radio was found to play maximum role in communicating information to fish farmers.

De Iongh, H.H.; Van Zon, J.C.J. 1993. Assessment of impact of the introduction of exotic fish species in north-east Thailand. Aquaculture and Fisheries Management 24:279-289. [Center for Environmental Science, The Netherlands]

"Within the framework of a fisheries project in north-east Thailand, project MK/FSPC/069 entitled 'The Fish Seed Production Centre, North East Thailand', an assessment was carried out of the ecological impact of introducing exotic fish species (common carp, *Cyprinus carpio* L., Nile tilapia, *Oreochromis niloticus* (L.), and Chinese and Indian carps). For the assessment, the protocol of Kohler & Stanley (1984) was followed, covering feasibility of introduction, acclimatization potential, potential impact, and control potentials. Regarding the (ongoing) use of the proposed exotic species in aquaculture, it was concluded that so far no clear ecological impact has been reported from escapes to open water; the use of the exotic species has shown to be highly beneficial from a socioeconomic point of view. Regarding the proposed introduction of the exotic species into public waters (natural lakes and man-made reservoirs), it was concluded that earlier releases of these species in north-east Thailand did not provoke severe ecological impact in terms of deterioration of aquatic ecosystems. Incidental cases of minor ecological impact were reported for common carp and Nile tilapia. Indications were obtained for niche competition between Chinese and Indian carps and indigenous carps, while similar niche competition was concluded for bighead carp, *Aristichthys nobilis* (Richardson), and indigenous pelagic zooplankton feeders. Observing the prolific development of the Nile tilapia in a number of reported cases, it was recommended not to include this species in stocking programmes for public water bodies, until more risk assessments are available." [Abstract]

Doyle, R.W.; Shackel, N.L.; Basiao, Z.; Uraiwan, S.; Matricia, T.; Talbot, A.J. 1991. Selective diversification of aquaculture stocks: A proposal for economically sustainable genetic conservation. Canadian Journal of Fisheries and Aquatic Sciences 48(supplement 1):148-154. [Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada]

"The genetic diversity of aquaculture stocks can be maintained, and their genetic impact on wild stocks minimized, by breeding programmes that deliberately generate genetic diversity. Current animal breeding practices are likely to reduce the diversity of domestic stocks if they are extended to aquaculture. It is proposed that national breeding programmes for aquaculture should, instead, try to develop numerous breeds specially adapted to local environments and aquaculture systems. An economic model is presented of decision-making by individual farmers who, in choosing which breed to produce, determine the 'fitness' of the breeds in a meta-population that includes all breeds. As long as strong genotype-environment interaction for production traits is maintained by artificial selection, the economic self-interest of farmers should ensure the stability of genetic polymorphisms among breeds. Genetic variation would be conserved (in the among-breed component of genetic diversity) but not the primordial distribution of gene and genotype frequencies. Economic benefits to farmers, plus a high return on investment at the national or supra-national level, makes breed diversification an attractive conservation strategy even though it is admittedly a compromise from a purely genetic viewpoint." [Abstract]

Eknath, A.E.; Bentsen, H.B.; Gjerde, B.; Tayamen, M.M.; Abella, T.A.; Gjedrem, T.; Pullin, R.S.V. 1991. Approaches to national fish breeding programs: Pointers from a tilapia pilot study. Naga, The ICLARM Quarterly 14(2):10-12.

Details are given of a framework for developing breeding programmes using experience from the Genetic Improvement of Farmed Tilapias project which focused on Nile tilapias (*Oreochromis niloticus*). The following aspects are outlined: Analysis of targeted production and marketing systems; Breeding goals; Systematic documentation and evaluation of available genetic resources and choice and genetic base; Number of strains; Breeding strategy; Selection criteria and evaluation; Production and dissemination of improved strains; and, Social, economic and environmental impacts.

FAO. 1993. Report of the Expert Consultation on the Utilization and Conservation of Aquatic Genetic Resources, Grottaferrata, Italy, 9-13 November, 1992. FAO Fisheries Report No. 491. Food and Agriculture Organization of the United Nations, Rome, Italy.

"This report discusses the need and methodologies for the utilization and conservation of genetic resources of aquatic animals. More than a review of genetic principles and technologies, the report addresses the application of such principles and technologies in development and conservation projects and research.

Specific recommendations are made with regard to the genetic resources contained in natural populations, fisheries stocks, and aquaculture. Recommendations concerning regulatory, policy and legal aspects of aquatic genetic resources are also presented." [Abstract]

This report concentrates on technical issues but also contains a comprehensive discussion of policy with social and economic implications.

FAO. 1981. Conservation of the Genetic Resource of Fish: Problems and Recommendations. Report of the Expert Consultation on the Genetic Resources of Fish, Rome, 9-13 June 1980. FAO Fisheries Technical Paper No. 217. Food and Agriculture Organization of the United Nations, Rome, Italy.

"The report reviews arguments for the preservation of the genetic resources of fish and various strategies for accomplishing this in both marine and continental waters. It reviews the significance of genetic diversity, especially within populations and subpopulations, to the viability of aquatic ecosystems and to the fitness of fish populations, and discuss the various means by which genetic impoverishment comes about. The report emphasizes the importance of maintaining breeding populations of an effective size of at least 50 for short-term fitness and of at least 500 for long-term survival; and of avoiding 'genetic bottlenecks' created by reduction of breeding populations to small size for one or more generations.

The report also considers available technologies for the monitoring, preservation and enhancement of genetic resources in closely managed fish stocks. It concludes by presenting recommendations addressed to five different groups: these are international organizations,

governments, aquaculturists and fishery managers, conservationists and research scientists." [Abstract]

This report concentrates on technical issues but also contains a comprehensive discussion of policy with social and economic implications.

Hu, B.; Chen, H. 1994. A Brief Survey Report on Common Carp Genetic Economics in China. Unpublished manuscript, Freshwater Fisheries Research Centre, Wuxi, China.

"Based on the characteristics of fish genetic diversity, we focus on two aspects: genetic conservation and genetic breeding. In 1993 and 1994, we conducted a survey in Jiangxi, Jiangsu and Zhejiang province on the production and breeding of common carps, especially three local carp strains: Hebao red carp, Xinguo red carp and Wanan transparent red carp. This is a brief report on the survey and some preliminary analysis." [Abstract]

MacLean, R.H.; Jones, R.W. 1995. Aquatic Biodiversity Conservation: A Review of Current Issues and Efforts. SIFR (Strategy for International Fisheries Research), Ottawa, Ontario, Canada.

"The purposes of this paper are to highlight the wide array of aquatic life forms and habitats that exist and to document some of the destructive patterns causing their demise. An attempt is also made to prioritize target conservation environments and taxonomic units and to outline strategies and mechanisms presently being developed to address problems associated with these environments." [from Executive Summary]

Pullin, R.S.V. 1990. Down-to-earth thoughts on conserving aquatic genetic diversity. Naga, The ICLARM Quarterly 13(1):5-8.

A discussion is presented on the topic of maintaining genetic diversity in aquatic ecosystems, considering the various threats caused by irreversible damage or loss to the environment. The current situation in aquaculture and future prospects regarding the conservation and protection of endangered species are outlined, describing the case of tilapias in Africa as one particular example of fish conservation.

Pullin, R.S.V.; Eknath, A.E.; Gjedrem, T.; Tayamen, M.M.; Macaranas, J.M.; Abella, T.A. 1991. The genetic improvement of farmed tilapias (GIFT) project: the story so far. Naga, The ICLARM Quarterly 14(2):3-6.

This article describes the genesis of the Genetic Improvement of Farmed Tilapias (GIFT) project from its beginnings of collaborative research efforts in the early 1980's to some of the significant results from the project. The objectives of the GIFT project are outlined as "wanting to develop more productive stocks of tilapia by selection for high growth rate and other economically important traits as and when appropriate and to provide such fish to national and regional testing programs and thence to fish farmers." Activities to accomplish this are given. [from article]

Zhong, R.; Zheng, L. 1994. Genetic Diversity in Aquaculture: Economically and Socially Sustainable Conservation and Development - A Sociological Research Report on the Genetic Diversity in Aquaculture in Jiangxi Province in China. Unpublished manuscript, Institute of Sociology, Shanghai Academy of Social Sciences, Shanghai, China.

This article describes the authors' investigations into sociological aspects of genetic diversity in aquaculture. Five species of carp are studied throughout Jiangxi, Xingguo red carp, Red transparent carp, Red purse carp, wild carp, and Pengze crucian carp.

Chapter 3.
SOCIAL AND ECONOMIC STUDIES ON BIODIVERSITY CONSERVATION IN AGRICULTURE

Altieri, M. 1989. Rethinking crop genetic resource conservation: a view from the south. Conservation Biology 3(1):77-79. [Division of Biological Control, University of California, Albany, California, United States]

In this 'comment', Altieri disagrees with S. Brush's view ('Rethinking Crop Genetic Resource Conservation', Conservation Biology 3(1):19) on how a conservation strategy should be implemented. He discusses the following three questions:
"1. What should be the main motivations and purposes of a genetic conservation strategy? 2. What institutions and actors should direct the strategy? 3. What kind of integrated research and development approach should underlie the strategy?" [from article]

Altieri, M.A.; Anderson, M.K. 1992. Peasant farming systems, agricultural modernization, and the conservation of crop genetic resources in Latin America. In: Fiedler, P.L.; Jain, S.K. (editors). Conservation Biology. The Theory and Practice of Nature Conservation, Preservation and Management. Chapman and Hall, an imprint of Routledge, Chapman & Hall, Inc., New York, New York, United States.

"Many traditional agroecosystems found in Latin America constitute major *in situ* repositories of crop genetic diversity. This native germ-plasm is crucial to developing countries and industrialized nations alike. Native varieties expand and renew the crop genetic resources of developed countries while also performing well under the ecological and economic conditions of the traditional farms where they are grown. With agricultural modernization and environmental degradation, crop genetic diversity is decreasing in peasant agricultural systems. Research is urgently needed to document rates and causes of genetic erosion in these systems and the role that peasants play in maintenance of crop genetic diversity. It is proposed that multidisciplinary teams that work under the paradigms of ethnoecology and agroecology be assembled to integrate farmers' knowledge with Western scientific approaches to design meaningful *in situ* crop genetic conservation strategies." [Abstract]

Altieri, M.A.; Merrick, C.L. 1987. *In situ* conservation of crop genetic resources through maintenance of traditional farming systems. Economic Botany 41:86-96. [Division of Biological Control, University of California, Berkeley, California, United States]

"A strategy is suggested for *in situ* conservation of crop genetic resources whereby conservation efforts are linked to rural development projects in Third World countries. We describe the development projects that emphasize preservation of traditional farming systems and succeed in sustaining production by relying on the maintenance of biological and genetic diversity in these systems. Basing agricultural development efforts on indigenous knowledge, technology,

and social organization can provide important guidelines for the design of cropping systems that allow low-income farmers to produce subsistence and cash crops without dependence on external inputs and seed supplies. By incorporating landraces and wild relatives of crops into these cropping systems, major achievements in the conservation of crop genetic resources can be obtained." [Abstract]

Altieri, M.A.; Anderson, M.K.; Merrick, L.C. 1987. Peasant agriculture and the conservation of crops and wild plant resources. Conservation Biology 1:49-58. [Division of Biological Control, University of California, Berkeley, California, United States]

"Peasant agroecosystems are seen as a continuum of integrated farming units and natural ecosystems where plant gathering and crop production are actively practiced. Many of these traditional agroecosystems still found throughout developing countries constitute major *in situ* repositories of both crop and wild plant germplasm. These plant resources are directly dependent upon management by human groups; thus, they have evolved in part under the influence of farming practices shaped by particular cultures.

Because genetic conservation programs are more effective when preserving the ecosystems in which the resources occur, maintenance of traditional farming systems and adjacent natural ecosystems is proposed as a sensible strategy for *in situ* preservation of crop and wild plant genetic resources. It is argued here that preservation efforts should be linked to rural development projects that take into account the ethnobotanical knowledge of rural people and that emphasize both food self-sufficiency as well as local resource conservation. Preservation of these traditional agroecosystems cannot be achieved when isolated from maintenance of the culture of the local people. Therefore, projects should also emphasize maintenance of cultural diversity." [Abstract]

Bedigian, D. 1991. Genetic diversity of traditional sesame cultivars and cultural diversity in Sudan. In: Oldfield, M.L.; Alcorn, J.B. (editors). Biodiversity: culture, conservation and ecodevelopment. Westview Press, Inc., Boulder, Colorado, United States.

This paper examines the link between the genetic diversity of traditional seasame cultivars and Nuba culture diversity in Sudan, in part by outlining cultural and ecological factors that affect the cultivar diversity. Threats to traditional Nuba agricultural techniques and seasame genetic resources are discussed as is the value of conserving the seasame cultivar diversity for crop genetic improvement.

Broswimmer, F. 1991. Botanical Imperialism: The Stewardship of Plant Genetic Resources in the Third World. Critical Sociology 18(1):3-17. [Department of Sociology, University of Hawaii, Honolulu, Hawaii, United States]

"This paper explores the social history of plant use from early European expansion to the present. The concept of 'botanical imperialism' is used to link issues of ecology and development. Specifically, it addresses the appropriation, control, and economic use of plant cultigens in the context of the capitalist world system. Notions of colonial stewardship and Western property rights are analyzed as the ideological underpinnings of Botanical Imperialism.

The paper then examines the relationship between the political economy, modern agronomy, and the development of hybrids by petrochemical monopolies, and the implications of these for issues of overproduction, underdevelopment, species extinction, and global environmental destruction." [Abstract]

Brush, S.B. 1991. A farmer-based approach to conserving crop germplasm. Economic Botany 45(2):153-165. [Applied Behavioral Sciences, University of California, Davis, California, United States]

"*In situ* conservation of crop genetic resources from centers of agricultural diversity is considered. This strategy has been rejected for several reasons, but other factors make it an important potential contributor to the overall conservation effort. Case studies of potato agriculture in Peru, maize agriculture in Mexico, and rice agriculture in Thailand indicate that farmers frequently engage in de facto conservation of landraces. Five principles should guide planning of *in situ* conservation: complementarity with off-site conservation, minimal institutional development, continuity with existing programs, meeting the development goals of increasing income and food, and accepting germplasm as an international public good. Four means to implement on-site conservation are presented: the institutional framework; the information base; the policy framework; and the role of grassroots organizations." [Abstract]

Brush, S.B. 1989. Rethinking crop genetic resource conservation. Conservation Biology 3(1):19-29. [International Agricultural Development, University of California, Davis, California, United States]

"A worldwide system of crop germplasm conservation has been developed around *ex situ* preservation. This system is based on a dual mandate of conservation and development, and it has largely ignored the farming systems that produce germplasm. A revisionist critique of the existing system is presented. Problems of the current strategy include incomplete collections, loss within these collections, isolation from evolutionary processes, and budgetary constraints. *In situ* conservation offers an alternative to current methods, especially if conservation rather than development is the priority. The concept of genetic erosion is discussed and evaluated in light of recent evidence of uneven change in areas of crop diversity. Farmers in many parts of the world are conserving traditional varieties even as they modernize and adopt improved varieties. This pattern is illustrated by reference to Asian rice agriculture. A new approach to conservation is needed that builds a collaborative program between farmers, crop scientists, ecologists, biogeographers, and social scientists. A first step is to analyze farming systems that already conserve traditional crop varieties." [Abstract]

Buttel, F.H.; Kenney, M.; Kloppenburg, Jr., J. 1985. From Green Revolution to Biorevolution: Some Observations on the Changing Technological Bases of Economic Transformation in the Third World. Economic Development and Cultural Change 34(1):31-55. [Cornell University, Ithaca, New York, United States]

"The principal argument of this article is that the technological pivot of the literature on international agricultural and rural development is in the process of being superceded by new technical forms that will significantly change the context within which technological change in the Third World is conceptualized and planned. We suggest that the cluster of emergent techniques generically known as 'biotechnology' will be to the Green Revolution what the Green Revolution was to traditional plant varieties and practices." [from article]

Clawson, D.L. 1985. Harvest security and intraspecific diversity in traditional tropical agriculture. Economic Botany 39:56-67. [Department of Anthropology and Geography, University of New Orleans, New Orleans, Louisiana, United States]

"The horticultural strategies of traditional tropical agriculturists center on the preservation of harvest security. In addition to cultivating simultaneously numerous species of crops, traditional tropical farmers also plant multiple varieties of each crop. These cultivars are frequently distinguished on the basis of color, ranging from white to yellow to red to purple. In addition to varying in appearance and taste and in resistance to environmental stresses, the color-based varieties often differ in length of growing season. By practicing multicolored, intraspecific poly-culture, the traditional tropical farmer either provides himself several opportunities to secure a complete single harvest and/or staggers his harvest throughout the year and thus, in either case, preserves his lifestyle. Acceptance of Green Revolution technologies by traditional tropical farmers would accelerate if they were offered multiple, high-yielding varieties of staple food crops of varying color and maturation periods." [Abstract]

Clawson, D.L.; Hoy, D.R. 1979. Nealtican, Mexico: A Peasant Community that Rejected the 'Green Revolution'. American Journal of Economics and Sociology 38(4):371-387.

"The 'green revolution' designates the application of Mendelian principles to seed selection and crossing beginning in the 1940s to establish new plant varieties affording higher-yielding crops. Its technology and products failed to win acceptance in some less developed countries. The case of Nealtican, Mexico helps to explain why. Its rejection is seen, given the specific circumstances of the cultural and physical environment, as a rational response. The policy problem is to overcome site-specific constraints - when scientific investigation has determined what they really are." [Abstract]

Comstock, G. (editor). 1991. Ethics and agricultural biotechnology: opposing viewpoints. Special Issue, Journal of Agricultural and Environmental Ethics 4(2).

This special issue of the *Journal of Agricultural and Environmental Ethics* is devoted to presenting opposing viewpoints on the following questions: Will the costs and benefits of bovine growth hormone be distributed fairly?; Is there a conflict between intellectual property rights and the rights of farmers in developing countries?; Does the very structure of scientific research mitigate against developing products to help the hungry, the poor, and the environment?; Should we manipulate the genome of domestic hogs?; Are publically funded scientific entrepreneurs

entitled to profit from their discoveries?; Should our vision for the agricultural sciences include biotechnology?

Cooper, D. 1992. Farmer's strategies for maintaining diversity. Appropriate Technology 18(4):22-25.

Cooper, D.; Vellve, R.; Hobbelink, H. for Genetic Resources Action International. 1992. Growing diversity: genetic resources and local food security. Intermediate Technology Publications, London, United Kingdom.

Papers in this text include the following: Facing the Challenge of Grassroots Conservation, C. Montecinos; Towards a Folk Revolution, P.R. Mooney; Community Plant Genetic Resources Management: Experiences in Southeast Asia, R. Salazar; and Towards an Integrated Plant Breeding System.

Cordova, V.G. 1982. New Rice Technology and its Effect on Labour Use and Shares in Rice Production in Laguna, Philippines 1966-78. In: Hainsworth, G.B. (editor). Village-Level Modernization in Southeast Asia. The Political Economy of Rice and Water. University of British Columbia Press, Vancouver, British Columbia, Canada.

"Based on survey data from an irrigated rice farming area in the southern Tagalog region of the Philippines from 1966 to 1978, this chapter seeks to quantify the impact of the new rice technology and related developments on labor-use and the relative earnings of those with claims upon the output." [from article]

Cowan, J.T. 1987. An Emerging Structure of Technological Domination: Biotechnology, the Organization of Agricultural Research, and the Third World. International Journal of Contemporary Sociology 24(1-2):31-44.

Dahlberg, K.A. 1979. Beyond the green revolution: the ecology and politics of global agricultural development. Plenum Press, New York, United States.

"Chapter 1 is a theoretical introduction to both the time-frames employed and to better ways to sort out the Western dimensions of science and technology... Chapter 2 gives an overview of agricultural history, describing how we got where we are, while at the same time trying to identify the major shifting parameters of recent centuries... Chapter 3 contains the central critique of the green revolution. Chapter 4 outlines the influence and momentum of those general institutions, infrastructures, and policies that have grown up during the past decades and that will have to be dealt with if alternatives are to be sought in any serious manner. It also contains a fundamental critique of conventional theories of economic development. Chapter 5 deals with new approaches to the future, essentially trying to sort various evolutionary,

developmental, and policy priorities... Chapter 6 applies the insights gained throughout the book to the problems of agricultural development, suggesting the ways in which alternative approaches can be developed... Chapter 7 reflects on the journey, the magnitude of societal changes and global transformations that are visible on the horizon, and the kinds of political skill and intellectual creativity that will be required to cope with them." [from Preface]

Feder, G.; O'Mara, G.T. 1981. Farm size and diffusion of green revolution technology. Economic Development and Cultural Change 29:59-76. [Development Research Center, World Bank, Washington, D.C., United States]

"The program of this paper is as follows: The next section presents the theoretical decision model and its implications for optimal farmers' behaviors. These are followed by a specific example which serves as a basis for numerical situations tracing the pattern of adoption in a hypothetical rural region over time. The simulations provide insights regarding the individual and the aggregate adoption performance and demonstrate the income distribution effects of the innovation at any point in time and over time." [from article]

Fitzhugh, H.; Wilhelm, A.E. 1991. Value and uses of indigenous livestock breeds in developing nations. In: Oldfield, M.L.; Alcorn, J.B. (editors). Biodiversity: culture, conservation and ecodevelopment. Westview Press, Boulder, Colorado, United States.

"Domestication of livestock was a major step in the evolution of primitive humans. As humans alter the environment, develop new technologies and change their needs and desires, the nature of their interdependence with animals also changes. Thus, the values and uses of livestock continue to evolve." [from article]

Fowler, C. 1991. Stakes High in Battle for Genetic Diversity. Forum for Applied Research and Public Policy 6(3):86-89.

Fowler, C.; Lachkovics, E.; Mooney, P.; Shand, H. (editors). 1988. The laws of life: another development and the new biotechnologies. Special Issue, Development Dialogue 1988(1-2).

This special issue of *Development Dialogue* is divided into three sections. Part One, *The Life Technologies,* "provides an overview of the basic socioeconomic and technical aspects of the new biosciences." Part Two, *The Economic Laws of Life*, "deals with the impact of the new biotechnologies on food production, food processing, animal husbandry, human health and the global environment seen in a socioeconomic perspective." Part Three, *The Political Laws of Life*, "discusses public versus corporate vested interests in the field of biotechnology and the role that the United Nations system can play in protecting its member-states - especially its weaker member-states - from the negative consequences of the developments in biotechnology." Part Four is titled Toward a People-oriented Biotechnology. [from Table of Contents]

Fowler, C.; Mooney, P. 1991. The threatened gene: food, politics, and the loss of genetic diversity. Lutterworth Press, Cambridge, United Kingdom.

Gibbons, D.S.; De Konick, R.; Hasan, I. 1978. The green revolution: its distributional impact. A study in regions of Malaysia and Indonesia. International Development Research Center, Ottawa, Ontario, Canada.

Hansra, B.S.; Shukla, A.N. (editors). 1991. Social, economic, and political implications of Green Revolution in India. Classical Publishing Company, New Delhi, India.

"The present book contains articles with the purpose of making a comparative study of the implications of Green Revolution in states of North-Western Region." [from Preface]

Harlan, J.R. 1984. Evaluation of wild relatives of crop plants. In: Holden, J.H.W.; Williams, J.T. (editors). Crop genetic resources: conservation and evaluation. George Allen and Unwin, London, United Kingdom.

Herdt, R.W. 1987. Equity considerations in setting priorities of third world rice biotechnology research. Development: Journal of the Society for International Development 4:19-26.

"Agricultural biotechnology promises to accelerate the rate of technical change in agriculture through more rapid invention of genetically improved microbes, plants and animals. The organisms changed and the way they are changed will determine the payoff of biotechnology, as a result, much interest is focused on the priorities for biotechnology research. Private biotechnology firms have an additional concern in setting research priorities. They need to be able to capture enough of the payoff to provide a reasonable return on their investment." [Abstract]

Hindmarsh, R. 1990. The need for effective assessment: sustainable development and the social impacts of biotechnology in the third world. Environmental Impact Assessment Review 10(1-2):195-208. [Division of Australian Environmental Studies, Griffith University, Brisbane, Australia]

"For sustainable development to occur in the Third World, an effective planning process is needed to control the adverse impacts of technological development. One public policy tool that may fit such a planning approach is development-level social impact assessment (SIA). However, there are grave doubts that SIA could prove effective. This is because Third-World adoption of SIA will most likely mirror the technical-level form of environment impact assessment (EIA) and structural constraints in the global organization of science and technology may inhibit SIA's potential. To demonstrate the effectiveness of developmental-SIA for analysis and the structural constraints that make SIA ineffective, this study evaluates the structural interaction between Third

World development, agro-biotechnological change, and past problems from earlier introduction of agricultural technology into Third World countries. The analysis concludes that to really make SIA effective for sustainable development, structural reform is necessary." [Abstract]

Hobbelink, H. 1988. Biotechnology in south-east Asia: farmers look for alternatives. Appropriate Technology 15(3):14-16.

Hobbelink, H. 1991. Biotechnology and the future of world agriculture. Zed Books Ltd, London, United Kingdom.

This book emphasises the importance of genetic resources, referring to them as the 'fourth resource' after soil, water and air. This is discussed in Chapter 1. Chapter 2 discusses the problems that exist in agriculture through strain on soil and water resources and the Green Revolution. A background to genetics and biotechnology is given in the third chapter. Biotechnologies and the role transnational corporations play is discussed in Chapter 4 and herbicide-tolerance is examined in Chapter 5. The affects these technologies can have on agriculture by diminishing nature's limitations and implications for economies is discussed in Chapter 6. Control of profit is the subject of Chapter 7, and Chapter 8 looks at the issues surrounding appropriate biotechnology use. The final chapter examines biotechnology in relation to indigenous knowledge.

Hodges, J. 1990. Conservation of animal genetic resources in developing countries. In: Alderson, L. (editor). Genetic conservation of domestic livestock. CAB International, Wallingford, Oxford, United Kingdom.

Holden, J.H.W.; Williams, J.T. (editors). 1984. Crop genetic resources: conservation and evaluation. George Allen and Unwin, London, United Kingdom.

Hoyt, E. 1988. Conserving the wild relatives of crops. International Board for Plant Genetic Resources, Rome, Italy, International Union for Conservation of Nature and Natural Resources, and World Wide Fund for Nature, Gland, Switzerland.

"The purpose of this booklet is to increase public awareness of these issues [conservation of wild relatives of crops] by providing a clear and balanced account of why conservation of crop relatives is important, how it can be effected and what actions need to be taken." [from booklet]

Juma, C. 1989. The gene hunters: biotechnology and the scramble for seeds. African Centre for Technology Studies Research Series No. 1. Zed Books Ltd., London, United Kingdom and Princeton University Press, Princeton, New Jersey, United States.

"...Chapter 1 traces the roots of the modern agriculture in early Western epistemology and identifies those key principles which have led to agricultural uniformity and reductionism.

In chapter 2 the reader will be introduced to the subject of historical botany. The role of genetic material in socio-economic evolution will be presented...

The US agricultural model (and the related social and political features) was... exported to a large number of Third World countries under the banner of the 'Green Revolution'. The model has taken root but has also resulted in a large number of social, economic, and ecological problems. This is the subject matter of chapter 3. Chapter 4 examines the implications of recent advances in biotechnology for the Third World countries in general and African countries in particular. ...Chapter 5 deals with intellectual property issues related to genetic resources and biotechnology and their potential impact on the African countries...

...Chapter 6 examines the history of Kenya and identifies some of the major legal and institutional obstacles to the expanded utilization of genetic resources and biotechnology. The final chapter provides policy guidelines on genetic resource conservation and biotechnology development." [from Introduction]

Kloppenburg, J. 1989. Agrigenetics and Agricultural Genetics. Appendix, "Biotechnology, Plant Breeding, and Intellectual Property: Social and Ethical Dimensions" by F.H. Buttel; J. Belsky. In: Weil, V.; Snapper, J.W. (editors). Owning scientific and technical information: Value and ethical issues. Rutgers University Press, London, United Kingdom.

This short appendix examined the 1982 U.S. patent issued to Agrigenetics Research Associates Limited that gave this company the rights to the process of using clonally propagated parental lines for the development of new hybrid plant varieties. The responses of public and private plant breeders are discussed.

Kloppenburg, Jr., J.R. (editor). 1988. Seeds and sovereignty: the use and control of plant genetic resources. Duke University Press, Durham, North Carolina, United States.

"...In chapter I, Otto H. Frankel provides a comprehensive overview of the biological and social components of what he terms the 'politicization of genetic resources.' This introductory chapter is followed by a section designed to illuminate the historical and contemporary contexts in which this politicization is occurring. The section on Germplasm and Geopolitics contains a series of chapters which explicitly address the FAO Undertaking from a variety of perspectives. And the chapters in the final section on Restructuring the Germplasm System focus on concrete proposals for changes in the institutions - especially the legal institutions - that now govern the flow of plant genetic resources around the globe." [from Preface]

Kloppenburg, Jr., J. 1984. The social impacts of biogenetic technology in agriculture: past and future. In: Berardi, G.M.; Geisler, C.C. (editors). The social consequences and challenges of new agricultural technologies. Westview Press, Boulder, Colorado, United States.

Kloppenburg, Jr., J.; Kleinman, D.L. 1987. Seed Wars: Common Heritage, Private Property, and Political Strategy. Socialist Review 17(5):7-41.

Marks, L.A.; Kerr, W.A.; Klein, K.K. 1992. Assessing the potential impact of agrobiotechnologies on Third World Countries. Science, Technology and Dev. 10(1):1-32.

Maurya, D.M.; Bottrall, A.; Farrington, J. 1988. Improved livelihoods, genetic diversity and farmer participation: a strategy for rice breeding in rainfed areas of India. Experimental Agriculture 24:311-320. [Narendra Dev University of Agriculture & Technology, Faizabad India]

"The present structure of plant breeding and seed multiplication in India is highly centralized. Furthermore, only a small number of new varieties is officially released each year. The system therefore appears inappropriate for the requirements of the large proportion of Indian farmers located in risk-prone and highly diverse environments. An alternative strategy is described whose central feature is close matching of the characteristics of farmers' traditional rice varieties with those of advanced breeders' lines. A selection from these lines is then distributed in small quantities for on-farm trials managed by farmers themselves. If the success of these initial efforts is to be sustained, a more centralized approach to breeding and multiplication will be necessary." [Abstract]

McNeely, J. 1989. Conserving genetic resources at the farm level. ILEIA (Information Centre for Low-External-Input and Sustainable Agriculture) Newsletter 5(4):4-6.

Merrick, L.C. 1990. Crop genetic diversity and its conservation in traditional agroecosystems. In: Altieri, M.A.; Hecht, S.B. (editors). Agroecology and small farm development. CRC Press, Boca Raton, Florida, United States.

"The stability and sustainability of traditional agricultural production are based on crop diversity. The general strategy followed by farmers is to hedge against risk by planting several crop species and several varieties within species in both space and time. This chapter focuses on the genetic diversity within individual crops grown primarily for food production in traditional agroecosystems. Recently, the high degree of variability present within crop genetic resources in traditional farming systems has become increasingly threatened principally due to the adoption of genetically uniform modern cultivars. *In situ* crop genetic conservation should be linked to rural development projects that seek to improve traditional farming systems. In this way a strategy that simultaneously encourages preservation of crop genetic resources while allowing low-income farmers to produce subsistence and cash crops without dependence on external inputs and seed supplies can be achieved." [Introduction]

Munro, R.K.; Adams, D.B. 1991. Genetic diversity and sustainable agriculture - implications for animal production systems. In: ACIAR-Proc. Australian Centre for International Agricultural Research, Canberra, Australia.

Ornate, B.T. 1991. The negative socio-economic impacts of IRRI's biotechnology: Philippines. Schriften des Deutschen Ubersee-Instituts Hamburg 8:251-264.

Paoletti, M.G.; Pimentel, D.; Stinner, B.R.; Stinner, D. 1992. Agroecosystem biodiversity: Matching production and conservation biology. Agriculture, Ecosystem and Environment 40(1-4):3-23.

A review of the existing literature on biodiversity connected with agricultural activities has been developed, and the possible sustainable alternatives have been looked into. Following recent evaluations, only one-twentieth to one-sixtieth of the planet's species have yet been described and most of these will be lost if the destruction of the environment continues at its present rate. Most of the terrestrial environment (up to 95%) is affected by human activities including agriculture and the terrestrial habitats provide up to 98% of human food on the planet. Sustainable strategies in food production in agriculture improve the existing biodiversity and include the following items: increased porosity of the landscape through proper management of natural vegetation, better use and recycling of organic residues, introduction of integrated farming systems, reduced tillage, rotation, biological control, increased number of biota involved in human food-web.

Pearse, A. 1980. Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution. Oxford University Press, New York, United States.

"The argument of this book is divided into three parts. Part I (Chapters I and II) deals with some essentials of the conceptual framework, and the characteristics of the particular technology and its propagation. Part II (Chapters III and IV) is based on an assumption that variations in agrarian structure directly affect the mode of technology-induced economic and social transformation. ...Part III (Chapters IX-XIII) begins with a summing-up of the 'critical issues' that have arisen with the large-scale introduction of the genetic-chemical technology and the accompanying mechanization and capitalization of agriculture. Three further chapters take up questions about economic and technological policies that avoid the generation of poverty. The last chapter is about 'peasant-based' strategies in differing social systems by which productivities are increased without gross polarization of wealth, and examples of Japan, China, and Taiwan are cited." [Author's Note]

Perrolle, J.A. 1985. Building a Better Goat: The Prospects for an Indonesian Development Project. International Journal of Contemporary Sociology 22(3-4):241-264.

Pray, C.E. 1981. The green revolution as a case study in transfer of technology. The Annals of the American Academy of Political and Social Science 458:68-80. [Department of Agricultural and Applied Economics, University of Minnesota, Minnesota, United States]

"The green revolution was a transfer of the idea of fertilizer-responsive grain varieties and the capacity to develop them from temporate countries to the countries of South and Southeast Asia, the Middle East, and Latin America. Key actors in this transfer of technology included the public research institutions in the less-developed countries (LDCs), the International Agricultural Research Centers, the Ford and Rockefeller Foundations, and the United States Agency for International Development. Once these institutions had bridged the gap between countries, the farmers rapidly accepted the new technology in areas where the agroclimatic and economic conditions were favorable. The green revolution was neither the cure for the problems of world hunger, as some early enthusiasts suggested, nor an important cause of income inequality and poverty, as suggested by its critics. When separated from the impact of factors such as rapid population growth, the shortage of arable land, and government policy, it is clear that the green revolution has substantially increased the supply of food grain and thus kept food grain prices lower than they would have been in the absence of new technology. This lowering of prices generally had a positive impact on income distribution. At the same time these varieties have had a less positive impact on agricultural income through their impact on demand for factors of production: landowners have benefited more than laborers. However, laborers would have been in a worse position in the absence of the green revolution." [Abstract]

Rerkasem, B.; Rerkasem, K. 1985. Utilization of indigenous genetic resources by farmers in Northern Thailand. In: Soermarwoto, O. (editor). Proceedings of the EAPI-SUAN Symposium on Research on Impact of Development on Human Activity Systems in Southeast Asia. Padjadjaran University, Bandung, Indonesia.

Research Information System for Non-aligned and Other Developing Countries. 1988. Biotechnology revolution and the third world: Challenges and policy options. New Dehli, India.

Eighteen papers examine the developmental potential and other implications of biotechnologies for developing countries. Papers focus on the biotechnology revolution and the third world; biotechnology and sustainable agriculture; promise in agriculture, food, and energy; bio- energy and agroindustries for decentralized development; biotechnology and appropriate farming systems; pro-poor potential; trends and prospects for developing countries; incidence of biotechnology advances on developing countries; impact on commodity exports; emerging patterns in the global food chain; biotechnology and the North-South conflict; the genetic resources controversy; prospects and strategies for overcoming dependence; role of public research and nongovernmental organizations; the role of UNIDO; building local capability in Latin America; biotechnology in Brazil and prospects for South-South cooperation; and infrastructure development in India.

Research Information System for Non-aligned and Other Developing Countries. 1988. Biotechnology revolution and the third world: An annotated bibliography. Author, New Dehli, India.

Lists selected references to literature and documentation on agricultural biotechnology, focusing on agricultural biotechnology for development. Classifies references under nine broad headings: status, prospects, emerging developments, and policies in biotechnology; potential and applications of biotechnology in different fields; impact of advances in biotechnology on developing countries and environmental and safety concerns; plant genetic resources and international concerns and action for genetic conservation; plant breeders' rights, patents, and intellectual property protection in biotechnology; organization of RandD, commercialization and technology transfer in biotechnology; the biotechnology industry, transnational corporations, and start-up biotechnology companies; international cooperation; and regional and country studies.

Rigg, J. 1989. The Green Revolution and equity: who adopts the new rice varieties and why? Geography 74(2):144-150. [Department of Geography, School of Oriental and African Studies, University of London, London, United Kingdom]

"Since the first of the high yielding varieties of rice was released in 1966 there has been a tendency to stress the negative impacts that the Green Revolution has had on rural areas in developing countries. In particular, it has been argued that as the technology has been monopolised by the rich so it has caused inequalities in rural areas to widen. The following paper examines the evidence supporting the contention that the new technology has attractions for all classes of farmer and that it has been of benefit to rich and poor alike." [Abstract]

Shari, I.; Sundaram, J.K. 1982. Malaysia's green revolution in rice farming: capital accumulation and technological change in a peasant society. In: Hainsworth, G.B. (editor). Village-level modernization in Southeast Asia: the political economy of rice and water. UBC Press, Vancouver, British Columbia, Canada.

"The first section will outline the general situation of paddy production in Peninsular Malaysia. The second section will evaluate the impact of the GR on the output and incomes of rice farmers. The effect on land distribution and land tenure arrangements will be surveyed in section three. In section four, implications of government price-support policy and expansion of credit facilities to rice farms - vital to the success of the GR - will be examined. The impact of agricultural mechanization and other developments on labour utilization and migration will be discussed in section five while the consequences for income distribution will be considered in section six." [from article]

Shiva, V. 1991. The violence of the Green Revolution: third world agriculture, ecology, and politics. Zed Books, London, United Kingdom and Third World Network, Penang, Malaysia.

"The social and political planning that went into the Green Revolution aimed at engineering not just seeds but social relations as well. Punjab is an exemplar of how this engineering went out of control both at the material as well as the political level. Since this analysis is an attempt at grappling with the complex, and unanticipated factors unleashed by the Green Revolution, it avoids explanations based on deterministic and linear causality... The best one can strive for is contextual causation, in which indications and suggestions are made of how the creation of certain contexts creates overwhelming conditions for certain processes to be unleashed. It is in this larger framework of invisible and unforseen linkages that the roots of Punjab violence are traced to the ecological and political context of the Green Revolution." [from Introduction]

Simon, D.L. 1984. Conservation of animal genetic resources - a review. Livestock Production Science 11(1):23-26. [Institut fur Tierzuchtwissenschaft, Universitat Bonn, Bonn, West Germany]

"The success in breeding highly productive farm animals has resulted in a situation where animal breeders and other people consider it necessary to preserve less productive breeds. Arguments for conservation cover emotional, cultural and scientific reasons, as well as the concern of losing genetic material which could be valuable for future animal production. Costs and time require priorities for objectives, species and forms of conservation. International co-operation in documentation, evaluation, and conservation of genetic material seems necessary to ensure efficiency of actions." [Abstract]

Smith, N.J.H. 1990. Strategies for sustainable agriculture in the tropics. Ecological Economics 2(4):311-323.

"Sustainable agriculture has moved to the forefront of priorities within the global agricultural research system. Political leaders, donors, non-governmental organizations, farmers, and consumers are also increasingly aware of the need to raise and uphold crop and animal production while striving to conserve the natural resource base. Both traditional knowledge and science need to be harnessed to improve the productivity and long-term sustainability of agricultural systems. Strategies for sustaining yield gains include the conservation and evaluation of plant and animal genetic resources, integrated pest management, conservation and enlightened management of soil and water resources, and crop and livestock diversification." [Abstract]

Smith, N.J.H. 1987. Genebanks: A Global Payoff. The Professional Geographer 39(1):1-8. [University of Florida, Florida, United States]

"The number of crop genebanks, designed to conserve crop genetic resources and make them available to breeders, has risen dramatically in recent years. While few dispute the need to conserve crop germplasm to help boost and sustain agricultural productivity, the role of genebanks and their global distribution has become embroiled in controversy. Some suggest that genebanks are servicing mainly multinational seed companies and the industrial countries harbour the lion's share of cop germplasm collections. This article describes the importance of genebanks, analyzes

their distribution and beneficiaries, and outlines how geographers can become more involved in the servation and use of crop genetic resources." [Abstract]

Staub, W.J.; Blase, M.G. 1971. Genetic technology and agricultural development. Science 173:119-123. [Foreign Development and Trade Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C., United States]

"This article describes the impact and limits of the green revolution triggered by the new genetic technology. While the primary focus of this article is on India, where the initial impact has been significant, the discussion also affords insights into problems of agricultural development in other South Asian countries." [from article]

Tisdell, C.A. 1990. Economics and the Debate About Preservation of Species, Crop Varieties and Genetic Diversity. Ecological Economics 2:77-90. [Department of Economics, University of Queensland, Brisbane, Australia]

"The paper reviews and outlines criteria that have been suggested for determining whether or not to save a species for extinction. Priorities as set out in the World Conservation Strategy, cost-benefit analysis, and the safe minimum standard approach are given particular consideration. The different criteria also are compared assuming that there is an absolute upper constraint on the amount of resources available for the conservation of species. There is some discussion of whether the reduction in available crop varieties is adding to or reducing the instability of crop yields. It is claimed that relative variability appears to be falling but there may be an increasing risk of non-sustainability. The importance of the burden of proof in the conservation versus non-conservation extinguish a species." [Abstract]

Vellve, R. 1993. The decline of diversity in European agriculture. The Ecologist 23(2):64-69.

"There is a wide discrepancy between the claims of seed companies that European agricultural diversity is being maintained and the perception of consumers that a dwindling variety of fruit and vegetables is now available in shops. Precise figures on the state of genetic diversity in Europe as compared to a century ago are hard to find. But there is little doubt that the standardization demanded by modern agricultural methods is diminishing the number of species and varieties grown as well as the genetic distinctions between varieties." [Abstract]

Vellve, R. 1989. Grass roots alternative for conserving genetic diversity. ILEIA (Information Centre for Low-External-Input and Sustainable Agriculture) Newsletter 5(4):28-30.

Chapter 4.
SOCIAL AND ECONOMIC STUDIES ON BIODIVERSITY CONSERVATION IN NATURAL AQUATIC SYSTEMS

Beatley, T. 1991. Protecting Biodiversity in Coastal Environments: Introduction and Overview. Coastal Management 19:1-19. [Department of Urban and Environmental Planning, University of Virginia, Charlottesville, Virginia, United States]

"Much less attention has been paid in recent years to the threats to coastal and marine biodiversity, compared to biodiversity in more terrestrial habitats. The tremendous biodiversity at risk and the severity and magnitude of the pressures being exerted on coastal habitats suggest the need for much greater attention to be focused here by both the policy and scientific communities. The threats to coastal biodiversity are numerous and include air and water pollution; over exploitation and harvesting; the introduction of exotic species; the dramatic loss of habitat due to urbanization, agricultural expansion, and other land use changes; and the potentially serious effects of global climate change. These threats suggest the need for swift action at a number of jurisdictional and governmental levels. Major components of such an effort are identified and described. These include the need for comprehensive management approaches, the expansion of parks and protected areas, restoration and mitigation, multinational and international initiatives, and efforts to promote sustainable development and sustainable lifestyles. Suggestions for future research are also provided." [Abstract]

Cairns, M.A.; Lackey, R.T. 1992. Biodiversity and management of natural resources: the issues. Fisheries 17(3):6-10.

"The earth's genetic, species, community, and landscape-level diversity is declining at an unprecedented rate because of habitat alteration. The decline of biodiversity in the aquatic environment is now recognized as a serious concern by biologists. Development and use of natural resources commonly have been practiced in an unsustainable manner. Political institutions are challenged to reconcile both the competing private and public goals and the diverse set of expectations of our natural resources, including aquatic systems. This paper defines biodiversity, identifies many of its values, and reviews causes of its decline. The major ecological, ethical, economic, social, and political issues involved in natural resource management are summarized, as are some of the expected responses of scientists and natural resource managers to the issues." [Abstract]

Cognetti, G.; Curini-Galletti, M. 1993. Biodiversity Conservation Problems in the Marine Environment. Marine Pollution Bulletin 26(4):179-183. [Dipartimento di Scienze dell'Ambiente e del Territorio, Universita di Pisa, Pisa, Italy]

"Conservation of biodiversity - understood as the expression of complexity of a biological structure both at the community and at the species level - was one of the focal points of the Earth

Summit held in Rio de Janeiro. Reported estimates of loss of biodiversity which, with the current trend, will eventually lead to an extinction rate comparable to the massive extinctions at the boundary between Cretaceous and Tertiary, have caused widespread concern. Though it is not possible to quantify the actual level of the phenomenon, it seems undeniable that biodiversity is endangered not only in industrialized countries, but also in areas which, in the recent past, were affected. The cause is mainly linked to explosive population growth, leading, among other things, to a systematic destruction of forests and progressive desertification of vast areas.

The problems of conservation of biodiversity in the sea are just as serious and complex as on land, although, being less conspicuous and accessible to mass media, they have often received less attention - and, in some cases, information given is unacceptably distorted (see Cognetti, 1992)

The causes of reduction of biodiversity in the sea are manifold: for a better understanding of the problem, we enumerate the most conspicuous ones." [from article]

Colwell, R.R.; Greer, J.R. 1986. Biotechnology and the sea. Ocean Development and International Law 17(1/3):163-189. [Sea Grant College, University of Maryland, College Park, Maryland, United States]

"The applications of recent discoveries in genetic engineering to marine plants and animals offers enormous potential for harvesting more food, pharmaceuticals, and industrial compounds from the sea. Using biotechnology's ability to excise and replace genetic material selected for specific functions, such efforts would allow manifold increases in production of substances conventially reliant on the capture of often rare marine species. This article reviews the status of marine biotechnology with particular attention to its current and prospective uses for medicine, industrial chemicals, pollution control, and aquaculture. It concludes with some observations about the relationship of marine biotechnology to broader economic, legal, and ethical concerns about genetic manipulation." [Abstract]

Diegues, A.C. 1988. Biological diversity, economic incentives, and traditional coastal cultures in Brazil. Paper presented at workshop on economics, IUCN General Assembly, 4-5 February 1988, Costa Rica.

Dixon, J.A. 1993. Economic Benefits of Marine Protected Areas. Oceanus 36(3):35-40. [Environment Department, World Bank, Washington, D.C., United States]

"Marine protected areas contain valuable economic resources important to local and national economies. Careful management can allow both protection of biodiversity and economic development. Indeed, it is obvious that rather than selecting the extremes of strict preservation or unmanaged development, balanced use of these resources for both economic and ecological functions is central to their sustainable management." [from article]

Dixon, J.A.; Scura, L.F.; van't Hof, T. 1993. Meeting Ecological and Economic Goals: Marine Parks in the Caribbean. Ambio 22(2-3):117-125.

"Marine parks are increasingly being established to protect endangered marine ecosystems and the biological diversity that they support. Trade-offs exist between protection and use, however, and ways must be found to produce economic benefits from marine areas while still yielding protection benefits, a question of particular importance to poorer countries that can ill afford to forego development benefits by enforcing strict protection measures. This paper examines these issues in the context of Caribbean marine parks. A number of countries that have established marine protected areas also rely on ocean-based tourism as an important, sometimes central, component of their economy. Can protection and direct use be compatible? Bonaire Marine Park is examined in some detail and monetary estimates are presented. Initial results indicate that proper management can yield both protection and development benefits but questions ecosystem carrying capacity and national retention of revenues raise important issues for longer term sustainabilty." [Abstract]

Gray, J.S. 1997. Marine biodiversity: patterns, threats, and conservation needs. Biodiversity and Conservation 6:153-175. [Biological Institute, University of Oslo, Oslo, Norway]

"Marine biodiversity is higher in benthic rather than pelagic systems, and in coasts rather than the open ocean since there is a greater range of habitats near the coast. The highest species diversity occurs in the Indonesian archipelago and decreases radially from there. The terrestrial pattern of increasing diversity from poles to tropics occurs from the Arctic to the tropics but does not seem to occur in the southern hemisphere where diversity is high at high latitudes. Losses of marine diversity are highest in coastal areas largely as a result of conflicting uses of coastal habitats. The best way to conserve marine biodiversity is to conserve habitat and landscape diversity in the coastal area. Marine protected areas are only a part of the conservation strategy needed. It is suggested that a framework for coastal conservation is integrated coastal area management where one of the primary goals is sustainable use of coastal biodiversity." [Abstract]

Hallerman, E.M.; Kapuscinski, A.R. 1990. Transgenic fish and public policy: Patenting of transgenic fish. Fisheries 15(1):21-24.

Following the granting of the first patent for a transgenic animal, public debate has arisen over a number of contentious patenting issues, including the very patentability of higher life forms. Against the background of the legal history regarding patentability of novel animals and the viewpoints of the various interest groups, we identify key policy questions currently at issue in the U.S. Congress and the U.S. Patent and Trademark Office. Finally, we propose positions that the American Fisheries Society might advocate at this critical moment in the determination of national animal patenting policies which are likely to impact the community of fisheries professionals.

Hammer, M.; Jansson, A-M.; Jansson, B-O. 1993. Diversity Change and Sustainability: Implications for Fisheries. Ambio 22(2-3):97-106. [Stockholm University, Stockholm, Sweden]

"Conserving biodiversity is regarded one of the major issues for enabling sustainable use of natural resources. This paper, focusing on the Baltic Sea and Sweden's fisheries, emphasizes the value of preserving biodiversity for the maintenance of diverse, resilient and functioning ecological life-support systems. These constitute a fundamental and necessary base for all human activities. The major features of diversity: species diversity, genetic diversity, functional diversity, and spatial and temporal diversity and diversity changes in the Baltic Sea ecosystem are described and discussed together with the development of management approaches in Sweden's fisheries. The paper takes a systems perspective, focusing on the linkages between ecological and economic systems. Biodiversity is seen as an interdependent part of the cluster of diversities in the human society and in the ecological system. The need for broader integrated approaches enhancing diversity in resource-management systems are emphasized." [Abstract]

Heyman, A.M. 1988. Self-financed resource management: a direct approach to maintaining marine biological diversity. Paper presented at workshop on economics, IUCN General Assembly, 4-5 February 1988, Costa Rica.

Hughes, R.M.; Noss, R.F. 1992. Biological Diversity and Biological Integrity: Current Concerns for Lakes and Streams. Fisheries 17(3):11-19. [USEPA Environmental Research Laboratory, Cornvallis, Oregon, United States]

"In discussing various concepts of biological diversity and biological integrity, we trace development of the terms from a focus on species to a consideration of ecosystems. We urge the public to extend its concern with species extinction and tropical rainforests to include temperate aquatic assemblages. Examples of losses in biological diversity and biological integrity are given for the genetic, species, assemblage, fauna, ecosystem, and landscape levels of biological organization. After discussing the recent recognition of biological diversity concepts by the U.S. Environmental Protection Agency in its surface water assessment and regulation programs, we conclude that a broadening of environmental ethics is needed to protect ecosystems and species before they become endangered." [Abstract]

Lee, S.Y. 1993. The management of traditional tidal ponds for aquaculture and wildlife conservation in Southeast Asia: problems and perspectives. Biological Conservation 63(2):113-118. [University of Hong Kong, Shek O, Hong Kong]

"Despite the long history of tidal aquaculture ponds in Southeast Asia, they will undergo a largely traditional management with little fertilization, intensification or technology input. The recent appreciation of the conservation values of mangrove ecosystems calls for management protocols that can combine traditional exploitational use with wildlife conservation objectives. A case study on a Hong Kong tidal pond is described in which conflicts may arise when the same pond is managed simultaneously for aquaculture production and wildlife conservation. Sedimentation rate increases as a result of controlled water exchange in tidal ponds, leading to build-up in substrate level and changes in the type and amount of vegetation cover. Tidal ponds also support a different, and generally less diverse, fauna from the nonimpounded areas, probably

a result of the larger fluctuations in physical conditions. Water level management for shrimp and fish culture also conflicts with waterfowl use of the ponds. Wetland reduction, due to tidal aquaculture, reduces nursery areas for fish and crustaceans and makes serious inroads into mangrove swamps, which are a declining world resource." [Abstract]

Mathias, M.E.; Boyle, P. 1992. Wetland and aquatic habitats [conservation of diversity]. Agriculture, Ecosystems and Environment 42(1-2):165-176.

"Riparian wetland areas often represent critical corridors for animal and plant dispersion in wildland watersheds and downstream river systems. It is essential that integrated management of riparian wetland areas be developed to reverse the loss of biological diversity. Agricultural and urban uses, and related water developments, have led to a marked decline of stream-side wetland habitats. Six major ways are discussed in which conventional agriculture alters wetlands and aquatic habitats: wetland drainage, water diversions, stream channelization, bank stabilization, grazing, and the release of agricultural pollutants. This article discusses these practices and suggests ways biological diversity can be protected, or even enhanced. In addition, aquaculture is discussed as a new force which affects the diversity of aquatic organisms. Aquaculture methods range in intensity of management from low to high. The higher the intensity the potentially more disruptive practices can be surrounding aquatic systems. Management for biological diversity as well as for food production should be encouraged." [Abstract]

Munthali, S.M. 1997. Dwindling food-fish species and fishers' preference: problems of conserving Lake Malawi's biodiversity. Biodiversity and Conservation 6:253-261. [Department of Parks & Wildlife, Lilongwe, Malawi]

"Most of Malawi's popular foodfish species are in decline. The fishers attribute this decline to overfishing, changes in climate, inadequate fishing technology and supernatural powers. Sedimentation of the lake and rivers due to poor agricultural practices, which can also be implicated in the demise of Malawi's fisheries, was not recognized by the fishers. This study tested and confirmed that the fishers would readily switch to exploiting ornamental fish (Mbuna) for subsistence and cash if the more favored food-fish species continued to dwindle. However, as most of the Mbuna species are localized to specific rocky habitats and are endemic to certain parts of the lake, they may be vulnerable to overfishing. To safeguard Lake Malawi's rich fish species diversity: (i) alternative economic opportunities for the lakeshore people should be identified, evaluated and promoted to alleviate the fishing pressure, (ii) the Department of Fisheries should collaborate with local fishermen in promoting sustainable fish utilization, e.g., through public campaigns aimed at sensitizing fishermen on the status of the fisheries and the vulnerability of some fish communities to overfishing and environmental degradation, and (iii) the degree of Mbuna exploitation, now that the popular food fishes are in decline, should be monitored and, where necessary, regulated to promote sustainability." [Abstract]

Schweitzer, J. 1992. Conserving biodiversity in developing countries. Fisheries 17(3):35-38.

Countries richest in biological diversity ironically are often the poorest economically. In these countries, in which humans struggle daily to meet urgent basic needs, efforts to protect the environment will succeed only if implemented in the context of promoting economic growth. Yet economic growth itself depends on the normal functioning of ecosystems and on a sustainable supply of natural resources. This mutual dependence of development and environmental protection must provide the conceptual basis for any successful effort to protect diversity in the third world. Accordingly, the U.S. government, through the Agency for International Development (USAID), supports an extensive program to protect the world's biological resources as an integral component of foreign assistance. A primary goal of USAID's biodiversity program is to maximize the potential for both economic and environmental security in developing countries. A greater reliance on market forces, the judicious application of economic incentives, and the use of effective economic instruments within the framework of constructive regulations provide the foundation for USAID's approach to conserving biological diversity.

Smith, P.J.; Francis, R.I.C.C.; McVeagh, M. 1991. Loss of genetic diversity due to fishing pressure. Fisheries Research 10:309-316. [Fisheries Research Center, Wellington, New Zealand]

"Loss of genetic diversity, in the orange roughy, *Hoplostethus atlanticus.* caught off New Zealand, was measured by gel electrophoresis of nine polymorphic enzyme loci. There has been a significant reduction in genetic diversity on three spawning sites over the past 6 years, during which time the virgin biomass has been reduced by ~70%. It is suggested that fishing activities which concentrate on spawning populations differentially remove the older and more heterozygous individuals from the virgin stock. Commercial fishing activities may have had significant genetic effects on fish stocks without reducing them to near-extinction levels." [Abstract]

Thorne-Miller, B.; Catena, J.G. 1991. The Living Ocean: Understanding and Protecting Biodiversity. Island Press, Washington, DC, United States.

"Boyce Thorne-Miller and John Catena's *The Living Ocean* presents for the first time a comprehensive overview of biological diversity in the oceans and associates this with the need to implement programs that will protect marine ecosystems and species. They have taken a view of the planet that would likely appeal to first-time visitors." [from Forward]

Upton, H.F. 1992. Biodiversity and Conservation of the Marine Environment. Fisheries 17(3):20-25. [Center for Marine Conservation, Washington, DC, United States]

"Although the need to maintain biological diversity has received increasing attention from scientists and politicians in the last decade, little effort has been devoted to conserving the biological diversity of the oceans and seas, which cover 71% of the earth's surface. Marine systems provide food supplies, and, even more important in a greenhouse world, remove a large portion of the atmosphere's carbon dioxide. Overharvesting, introduction of alien species, toxic and nutrient pollution, coastal development, and increasing ultraviolet radiation threaten marine

species. As the human population rises and marine species and ecosystems are subjected to stresses comparable to those on land, conservation of marine biological diversity is being hindered by inadequate understanding of its composition and functioning, its vulnerabilities, and the manner in which we approach marine resource management. This paper examines some basic characteristics of marine life, provides examples of three basic levels of marine biological diversity, and defines problems and directions that marine conservation must take in the future." [Abstract]

Welcomme, R.L. (compiler). 1988. International introductions of inland aquatic species. FAO Fisheries Technical Paper, No. 294. Food and Agriculture Organization of the United Nations, Rome, Italy. [Fishery Resources and Environment Department, FAO Fisheries Department, Rome, Italy]

"A total of 1,354 introductions of 237 species into 140 countries are analyzed. The number of introductions carried out rose from the middle of the last century until the 1960s and have lessened since then. Introductions have been made for aquaculture, management of inland water fisheries, ornament and control of unwanted organisms. Many introductions have been made for purposes unknown or by accident. The introduction of new species of aquatic organisms involves a number of risks including community, genetic degradation of the host stock, introduction of diseases and socio-economic effects. Major risks of damage to native environments and fish communities are associated with introductions of species which stunt and with major predators. It is concluded that the introduction of new species is a valuable management tool but, because of the risks to the host community, any further introductions should be made only after careful consideration of any impacts. An updated register of known international introductions is presented." [Summary]

Chapter 5.
ISSUES IN BIODIVERSITY CONSERVATION

Bishop, R.C. 1993. Economic Efficiency, Sustainability, and Biodiversity. Ambio 22(2-3):69-73.

"An economy can be both efficient and sustainable, but efficiency does not guarantee sustainability. The safe minimum standard (SMS) for biological diversity illustrates the practical steps that could be taken to increase the likelihood that the economy is sustainable. Extinction threatens sustainability because it may effect the stability of economically important ecosystems and it may entail losses of plants, animals, and microorganisms that would otherwise have become important resources in the future. Wherever preservation is biologically feasible, extinction of species would be avoided unless the costs of avoidance are excessive or other social goals must receive a higher priority. The stated policies of the US and many other countries are consistent with SMS. However, in the US at least, lack of funding has been a major impediment to implementation. A tax on natural resource use would be a possible source of funding for programs to improve prospects for economic sustainability." [Abstract]

Blockhus, J.M.; Dillenbeck, M.R.; Sayer, J.A.; Wegge, P. (editors). 1992. Conserving Biological Diversity in Managed Tropical Forests. Proceedings of a Workshop held at the IUCN General Assembly, Perth, Australia, 30 November-1 December 1990. International Union for Conservation of Nature and Natural Resources (IUCN), Gland, Switzerland.

This publication contains three articles, 1) Biological Conservation Issues in Forest Management; 2) Proposed Guidelines for Conserving Biological Diversity in Production Forests; 3) ITTO and the Conservation of Biological Diversity. These are followed by country studies from the areas of Asia, Latin America and Africa.

Dahl, K.; Nabhan, G.P. 1991. Genetic resource conservation by grassroots organizations in North America: a southwestern case study. Background paper prepared for the WRI/IUCN/UNEP Biodiversity Conservation Strategy Program. World Resources Institute, Washington, DC, United States.

Dasmann, R.F. 1991. The importance of cultural and biological diversity. In: Oldfield, M.L.; Alcorn, J.B. (editors). Biodiversity: culture, conservation and ecodevelopment. Westview Press, Boulder, Colorado, United States.

"The subject of this paper is one that could easily be addressed at a superficial level, but upon more detailed examination proves to be rather complex. The topic relates to a long-standing concern for the perpetuation of human ways of life that have been sustainable over past centuries. The two can go forward together and both be realized, although looking at today's world, this belief is obviously more an article of faith than a statement of any visible reality. This is not written from the perspective of an expert systematist on the biological side, nor that of a cultural

anthropologist, but rather from that of a wildlife biologist whose occupation forces him to cross disciplinary boundaries into what often turns out to be thickets of controversy." [from article]

Ehrlich, P.R.; Daily, G.C. 1993. Population Extinction and Saving Biodiversity. Ambio 22(2-3):64-68.

"In the past decade a great deal of attention has been focused on the problem of protecting endangered species. Indeed, for historical reasons, biodiversity has largely been discussed by biologists in terms of the diversity of species, leading economists and others to reasonably conclude that conserving the Earth's species diversity is the crucial task before us. But the loss of species is only one aspect of the extinction crisis, and in many parts of the world may not be the most important facet of the decay of biological diversity (biodiversity). This paper examines the complementary issue of the extinction of populations, offers a preliminary assessment of its importance relative to the extinction of species, and examines relevant policy implications." [Abstract]

Ehrlich, P.R.; Ehrlich, A.H. 1992. The value of biodiversity. Ambio 21(3):219-226.

"Biodiversity, the vast array of non-human organisms of our planet, should be valued for four general reasons. First, we (and many others) believe that, as the dominant species on Earth, *Homo sapiens* has an ethical, stewardship responsibility towards humanity's only known living companions in the universe. Second, as attested to by activities as diverse as gardening, making of nature films, and ecotourism, biodiversity has esthetic values. Third, humanity has derived many direct economic values from biodiversity, including all of its food and many of its medicines and industrial products. The potential of nature's *genetic library* for providing more of these benefits is enormous. Fourth, and most important from an anthropocentric perspective, plants, animals, and microorganisms help to supply human beings with an array of free ecosystem services, without which civilization could not persist. These include such things as controlling the gaseous mix of the atmosphere, generating and maintaining soils, controlling pests, and running biogeochemical cycles. The present extinction episode caused by human activity seriously jeopardizes the ethical, aesthetic, direct economic and life-support values of biodiversity; it may be the single most important externality associated with human economic activity." [Abstract]

Eiswerth, M.E. and Haney, J.C. 1992. Allocating conservation expenditures: accounting for inter-species genetic distinctiveness. Ecological Economics 5(3):235-250. [Marine Policy Center, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, United States]

"During recent attempts to discuss biological diversity, economists have drawn upon the tools and techniques of mainstream resource economics to estimate the values of species. This can lead to a tendency to focus on the importance of species in isolation to one another and on the numbers of species (species richness) in natural areas. Such an approach does not incorporate the ongoing efforts of scientists to define and analyze different types of diversity among species and natural systems (e.g., genetic diversity and ecosystem diversity). Rather than address the explicit

valuation of individual species or of biological diversity, we show how potential guidelines for the allocation of conservation expenditures among regions might be changed by consideration of the 'genetic distinctiveness' of species, in addition to the number of species, inhabiting those regions. We use recent estimates of inter-species genetic distances originating from DNA - DNA hybridization as an example of the kind of weighted information that could prove useful in conservation planning, and as an illustration we examine crane ranges in Africa and Asia." [Abstract]

Gadgil, M. 1991. Conserving India's biodiversity: the societal context. Evolutionary Trends in Plants 5:3-8.

Gadgil, M. 1992. Conserving biodiversity as if people matter: A case study from India. Ambio 21(3):266-270.

"India has rich traditions of nature conservation as well as a vigorous official program of protection of nature reserves developed over the last 40 years. However, the official program suffers from total reliance on authoritarian management arrangements in which decisions are made centrally and coercion is used to implement them. At the same time, the state apparatus organizes subsidized resource flows to the urban-industrial-intensive agricultural complex which promote inefficient, non-sustainable resource-use patterns that are inimical to conservation of biodiversity. These processes are illustrated within the concrete setting of the district of Uttara Kannada in southern India. It is suggested that the interests of conservation would be served far better by an approach that withdraws the subsidies to the elite so that a much more efficient, sustainable and equitable pattern of resource use, compatible with conservation of biodiversity, can be instituted." [from Abstract]

Gadgil, M.; Rao, P.R.S. 1994. A System of Positive Incentives to Conserve Biodiversity. Economic and Political Weekly 29(32):2103-2107.

"India's current programmes for conservation of biodiversity suffer from major defects and need to be radically restructured to meet present-day challenges, such as the conservation of the entire spectrum of biodiversity including insignificant components, and the need to integrate traditional conservation practices of local communities in new programmes." [Abstract]

Gadgil, M.; Berkes, F.; Folke, C. 1993. Indigenous Knowledge for Biodiversity Conservation. Ambio 22(2-3):151-156.

"Indigenous peoples with a historical continuity of resource-use practices often possess a broad knowledge base of the behavior of complex ecological systems in their own localities. This knowledge has accumulated through a long series of observations transmitted from generation to generation. Such 'diachronic' observations can be of great value and complement the 'synchronic' observations on which western science is based. Where indigenous peoples have

depended, for long periods of time, on local environments for the provision of a variety of resources, they have developed a stake in conserving, and in some cases, enhancing, biodiversity." [from Abstract]

Hampicke, U. 1994. Ethics and Economics of Conservation. Biological Conservation 67:219-231. [Department of Economics, University of Kassel, Kassel, Germany]

"Nature can be valued in its own right or as an instrument for the benefit of humankind. The second valuation, although less fundamental from a philosophical point of view, is sufficient to substantiate conservation as a moral duty. The harm done to future human beings in burdening them with the prospect of life in an ecologically impoverished world cannot be justified by moral standards of a civilized society, when we consider the fact that conservation costs are not excessive.

Species and ecosystems can be thought of as economic resources possessing special properties: they can be irreversibly destroyed, their future usefulness is a matter of uncertainty, their services are difficult to replace and they exhibit properties of public goods. All aspects combined, prudence suggests that we must as far as possible prevent extinctions.

Even from a purely anthropocentric point of view it is logically impossible to assess the full monetary value of an irreversibly destructible ecological asset because for this purpose we would need to know the valuations of all future human beings. It is meaningless, therefore, to ask how much money a species is 'worth'. However, monetarization is possible within a limited scope. Many benefits obtained from species are amenable to evaluation in monetary terms. Independently, willingness-to-pay studies disclose the subjective value people place on species and biotopes.

Despite numerous methodological problems, the costs of conservation can in most cases be assessed at least approximately. In principle, they amount to the maximum monetary benefit foregone if profitable but nature adverse activities are displaced by conservation. Many empirical studies reveal low conservation costs by macroeconomic standards. In Germany, many conservation objectives in forests could be achieved virtually without any cost at all. A rather ambitious hypothetical conservation programme mainly for the agrarian countryside would bring about social costs of one thousand million DM per year. According to a first estimate, willingness-to-pay amounts to at least three thousand million DM per year." [Abstract]

Hanks, J. 1984. Conservation and Rural Development: Towards an Integrated Approach. In: Hanks, J. (editor). Traditional Life-styles, Conservation and Rural Development. Proceedings of a Symposium organised by the Institute of Ecology, of Padjadjaran University, Bandung, and the IUCN Commission on Ecology held in Bandung, Indonesia, on the 4th and 5th of October 1982. Commission on Ecology Papers Number 7. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

"The overall goal of rural development programmes should be the reduction of poverty, unemployment, malnutrition and inequity, and an integral part of all these programmes is the introduction of a positive rural landless strategy, which recognizes the prime importance of food production, but at the same time safeguards soil and representative areas of natural ecosystems.

The goal of the *World Conservation Strategy* is the integration of conservation and development so that we may all have a way of life which is sustainable. However, it is becoming increasingly difficult to sustain legitimate human demands because high rates of human population growth, coupled with a high rate of world economic growth are threatening the four basic biological systems that support the global economy, the grasslands, fisheries, croplands and forests.

This paper gives an outline of how these systems are threatened, with emphasis on the relationship between rural development, as defined by the *World Conservation Strategy*, conservation and environmental degradation. The importance of determining felt needs and aspirations in designing both conservation and rural development activities is discussed, with particular reference to the advantages and disadvantages of traditional life-styles." [Abstract]

Hanson, B.; Nelkin, D. 1989. Public Responses to Genetic Engineering. Society 27(1):76-80. [Department of Sociology, New York University, New York, United States]

This article discusses the varying perspectives that exist since the decision to patent transgenic animals and that were represented at hearings held in the United States to consider placing a moratorium on these patents. Opinions vary widely from the scientific (medical research) to economic (farmers) to moral (animal rights activists).

Kenney, M. 1983. Is Biotechnology a Blessing for the Less Developed Nations? Monthly Review: An Independent Socialist Magazine 34(11):10-19.

This article outlines some of the current biotechnology innovations and their implications in the Third World. It has been argued that biotechnology has the potential to decrease the costs of many goods, particularly food and medicine, and this in turn would benefit the LDCs; however, the author describes the benefits as going to transnational corporations. The article is concluded with alternatives to improve the position of LDCs against transnational corporations.

King, F.W. 1984. Preservation of genetic diversity. In: Thibodeau, F.R.; Field, H.H. (editors). Sustaining tomorrow: a strategy for world conservation and development. Published for Tufts University by University Press of New England, Hanover, Pennsylvania, United States.

Kloppenburg, J.; Kleinman, D.L. 1988. The Genetic Resources Controversy. Research and Information System for the Non-aligned and Other Developing Countries. Biotechnology revolution and the third world: Challenges and policy options. Author, New Dehli, India.

Knutson, L.; Stoner, A.K. (editors). 1989. Biotic diversity and germplasm preservation, global imperatives. Kluwer Academic Publishers, The Netherlands.

Krattiger, A.F.; McNeely, J.A.; Lesser, W.H.; Miller, K.R.; St. Hill, Y.; Senanayake, R. 1994. Widening Perspectives on Biodiversity. The World Conservation Union, Gland, Switzerland and The International Academy of the Environment, Geneva, Switzerland.

"*Section 1: Introduction* reveals the Forum's [Global Biodiversity Forum] and the Convention's [Convention on Biological Diversity at the Earth Summit in Rio] origins, objectives, and characteristics. The Forum is a mechanism which demonstrates that many ideas and interests must contend, reflected throughout the book but particularly in *Section 2: Achieving Convention Objectives through Regional Collaboration, Section 4: The Contribution by Specific Groups* and *Section 5: Issues in Conserving and Utilizing Genetic Resources.* The ambitiousness of the objectives of the Convention and the complexity of its provisions are indicated in the scope of *Section 3: Activities to Incorporate the Objectives of the Convention into National Endeavours and Legislation*; and *Section 6: Biodiversity and Environmental Impact Assessment.* And the web of diverse but mutually reinforcing contributions which are required, and which it is possible to achieve, is depicted in *Section 7: The Role of NGO's and Other Institutional Mechanisms in Implementing the Convention.* [from Foreword]

Krimsky, S. 1983. Biotechnology and unnatural selection: the social control of genes. In: Summers, G.F. (editor). Technology and social change in rural areas: a festschrift for Eugene A. Wilkening. Westview Press, Boulder, Colorado, United States.

Kux, M.B. 1991. Linking rural development with biological conservation: a development perspective. In: Oldfield, M.L.; Alcorn, J.B. (editors). Biodiversity: culture, conservation and ecodevelopment. Westview Press, Boulder, Colorado, United States.

There are many questions that arise when considering linking rural development with the conservation of biodiversity. For example, what role should donors play in conservation, what balance should be achieved between 'pure' conservation programs vs. those that relieve pressure on parks and reserves, or what economic benefits actually accrue to countries and to local people from investments in parks and protected areas? This paper attempts to address these questions, and more, with a literature review. Options for maintaining diversity that have been or can be incorporated into economic development programs are given.

Lohmann, L. 1991. Who defends biological diversity? Conservation strategies and the case of Thailand. The Ecologist 21(1):5-13.

"It is often assumed that giving economic value to biological diversity will motivate business, governments and villagers to preserve it. However, this approach tends to justify handing the defence of biodiversity over to the forces that have proved its worst stewards - corporations and the state. As the Thai example makes clear, emphasizing the market value of biodiversity gives short shrift to its most effective defenders - those villagers whose livelihoods depend upon protecting their local environment from economic development." [Abstract]

Machlis, G.E. 1992. The contribution of sociology to biodiversity research and management. Biological Conservation 62(3):161-170. [Department of Forest Resources and Sociology, University of Idaho, Moscow, Idaho, United States]

"As the loss of biodiversity is a serious ecological problem, biodiversity research and management are important components of current conservation biology. This paper describes how sociology can contribute to biodiversity research and management. Biodiversity is, like all scientific and environmental issues, partially a socially constructed problem. Case study and comparative multi-national data suggest that the causes of biodiversity decline are largely socio-economic, and solutions will require interdisciplinary approaches. Sociology can make several contributions to biodiversity research and management, including (1) a better understanding and management of habitat change; (2) improved research and decision-making methodologies; (3) development of a theoretical synthesis: and (4) analysis of the social organization of conservation and conservation biology." [Abstract]

McNeely, J.A. 1993. Economic Incentives for Conserving Biodiversity: Lessons for Africa. Ambio 22(2-3):144-150.

"Economics provides a useful perspective on issues of biodiversity, at three levels. At the international level governments may need to consider the impact of global economic policies, such as commodities prices, on biodiversity; and because the conservation of biodiversity provides global economic benefits, economic incentives should be provided to governments at the international level (for example, through the Global Environment Facility, but also through terms of trade). At the national level, governments need to be able to assess the impact of their policies on the biological resources of the country, and consider the utility of using a combination of economic incentives (such as differential access to resources, compensation for animal damage, subsidies and grants) and economic disincentives (such as fines and withholding of benefits) to promote conservation objectives. Governments need to address, the problem of 'perverse incentives' - economic instruments which promote the destruction of biodiversity. Many government subsidies and foreign assistance projects have had such effects. At the level of government agencies responsible for conserving biodiversity, incentives can often be used to enhance the performance of staff, improve relations with surrounding communities, and provide long-term financial support to the agency. Examples from throughout Africa are provided to show how economic incentives can enable governments and the private sector to support national conservation objectives more efficiently than can traditional regulatory approaches." [Abstract]

McNeely, J.A. 1988. Economics and Biological Diversity: Developing and Using Economic Incentives to Conserve Biological Resources. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

"The document, perhaps wrongly, takes as a starting point the current world economic system, and describes what can be done within that system to enhance the conservation of species

and ecosystems. It offers pragmatic and immediate solutions to pressing problems which cannot wait until the world's economy is fundamentally reformed.

Building upon principles stated in the *World Conservation Strategy* (IUCN, 1980) and in the report of the World Commission on Environment and Development, the document describes mechanisms which will enable sustainable forms of economic development to contribute positively to conservation of biological diversity. In support of this approach, the case studies and other material also demonstrate that conservation is a form of sustainable development.

A fundamental issue which remains to be solved is determining the optimal distribution of benefits from utilizing biological resources. Most of today's benefits from harvesting the forests, grasslands, wetlands, and seas flow to the global community at large. Relatively few benefits are provided to the local people who bear the bulk of the costs either of the impacts of over-exploitation or of abstaining from destructive harvesting practices. Similarly, the greatest value in conserving biological diversity flows to the global community, while the cost of preservation falls on the comparatively few who seldom are provided any economic incentive to conserve the resource. We hope that this paper will begin to stimulate action to redress this imbalance." [from Preface]

McNeeley, J.A.; Dobias, R.J. 1991. Economic incentives for conserving biological diversity in Thailand. Ambio 20(2):86-90.

"The Thai economy is booming, but much of the rapid economic growth is being fueled by unsustainable use of natural resources (often subsidized by government policies), resulting in a loss of biodiversity. Based on the premise that conservation would be most successful if it were to be promoted by economic incentives, studies were carried out in the fields of forestry, protected areas, marine fisheries, mangroves, and nature tourism. New incentives were defined for each sector, along with changes in government policies to be included in Thailand's Seventh Five-Year Plan." [Abstract]

McNeely, J.A.; Miller, K.R.; Reid, W.V.; Mittermeier, R.A.; Werner, T.B. 1990. Conserving the world's biological diversity. International Union for Conservation of Nature and Natural Resources, World Resources Institute, Conservation International, World Wildlife Fund-US, and the World Bank; Gland, Switzerland and Washington, DC, United States.

"*Conserving the World's Biological Diversity* is a guide to all who would like to turn the tide of destruction [of nature] into a new positive relationship between people and nature. A new form of civilization based on the sustainable use of renewable resources is not only possible, but essential. This book suggests the principles and tools that are available to promote the new civilization, based on community self-reliance, diversity in both nature and human cultures, economic systems that consider all costs and benefits of alternative actions, scientific research that is applied to the challenges of managing natural resources, and the use of modern information technology to ensure that decisions are based on full knowledge of the likely consequences." [from Foreword]

McNeely, J.A.; Norgaard, R.B. 1992. Developed country policies and biological diversity in developing countries. Agriculture, Ecosystems and Environment 42(1-2):194-204.

"This article examines ways developing countries are interlocked with wealthy nations in terms of agriculture practices, how that affects biodiversity and habitat conditions in developing countries, and how developing countries could develop agricultural policies and strategies that would address and correct the loss of biological diversity." [from Abstract]

Montgomery, C.A.; Pollack, R.A. 1996. Economics and Biodiversity: Weighing Benefits and Costs of Conservation. Journal of Forestry 94(2):34-38. [Department of Forest Resources, Oregon State University, Corvallis, Oregon, United States]

"The authors believe that the perspective of economists can help achieve the goal of biodiversity preservation within the limitations imposed by finite time, money, and efforts. The methods they propose to resolve public policy conflict can be useful in establishing conservation priorities, identifying effective means of attaining conservation objectives, and determining who pays the costs under alternative policies." [from article]

Morowitz, H.J. 1991. Balancing species preservation and economic considerations. Science 253(5021):752-754.

"From a narrow economics point of view, we need a monetary metric of a species value to balance benefits against cost of preservations. Viewed from environmental ethics no such direct measure is possible. These considerations apply to ecosystems as well as to individual taxa. We are often left trying to balance the 'good' of ethics with the 'goods' of economics." [from article]

Munasinghe, M. 1993. Environmental Economics and Biodiversity Management in Developing Countries. Ambio 22(2-3):126-135.

"Reconciling and operationalizing the three main concepts of sustainable development - the economic, ecological, and sociocultural - poses formidable problems. Environmental economics and valuation can play a key role in helping to incorporate concerns about biodiversity loss into the traditional decision-making framework. A case study from Madagascar examines the impact of a new national park on tropical forests by using both conventional and newer techniques to economically value damage to forests and watersheds, timber and nontimber forest products, other impacts on local inhabitants, impacts on biodiversity, and ecotourism benefits. In the Sri Lanka case study, an integrated energy-environmental analysis was developed, which helps to eliminate projects with unacceptable impacts, and redesign others. Where economic valuation of environmental impacts was not possible, multiple attribute evaluation techniques were used. Improving the incomes and welfare of local communities, especially poor ones, while simultaneously preserving physical and biological systems, offers opportunities for developing countries to pursue all three goals of sustainable development in a complementary manner." [Abstract]

Munasinghe, M. 1992. Biodiversity protection policy: Environmental valuation and distribution issues. Ambio 21(3):227-236.

"This paper seeks to show how the conservation of natural habitats and protected areas contributes to sustainable development, with special emphasis on economic arguments. The role of environmental economics and valuation of natural resources, as analytical tools that facilitate the avoidance of adverse environmental impacts, is discussed. An integrated environmental economic framework is outlined, and some practical case studies of environmental impact valuation in developing countries are summarized. The paper goes on to discuss the links between economy-wide policies (both macroeconomic and sectoral) and natural-resource degradation, and explains the important role of environmental accounting. Issues that arise in the practical implementation of efforts to conserve biodiversity in developing countries are delineated, and the status of international dialogue on agreements to protect the environment is summarized. The role of the Global Environmental Facility (GEF) is described, and key issues in recent GEF projects are highlighted. In-country issues arising from the implementation of policy for the protection of biodiversity are reviewed. Recent integrated conservation development projects (ICDPs) are examined, which have attempted to link protected area management with social and economic development in local communities. The final section contains the principal conclusions." [Abstract]

Muchiru, S. 1985. Conservation of species and genetic resources: an NGO action guide. Environment Liaison Centre, Nairobi, Kenya.

Myers, N. 1993. Biodiversity and the Precautionary Principle. Ambio 22(2-3):74-79.

"The precautionary principle is becoming an established guideline for policy makers tackling environmental problems. In salient aspects, it applies to biodiversity more than to any other problem. This is because the mass extinction gathering force will, if it proceeds unchecked, not only eliminate half or more of all species, but will leave the biosphere impoverished for at least 5 mill. years - a period twenty times longer than humankind itself has been a species. Present society is effectively taking a decision on the unconsulted behalf of perhaps 100 trill. of our descendants, asserting that future generations can certainly manage with far less than a full planetary stock of species. Yet despite the ostensible certainty we display in taking this decision, the biodiversity issue is attended by exceptional uncertainty, notably as concerns the adverse repercussions - biological, ecological, and economic among others - of mass extinction. Thus, there is a super-premium on applying the precautionary principle to the biotic crisis in a manner expansive enough to match the scope and scale of the problem. Policy implications have received all too little attention. Far from supplying the right answers, we are hardly at a point where we are asking all the correct questions." [Abstract]

Nelson, J.G.; Serafin, R. 1992. Assessing biodiversity: A human ecological approach. Ambio 21(3)212-218.

"As the concept biodiversity has gained in popularity, it has become increasingly subject to misunderstanding not only in terms of what it means to the scientist, planner, manager and citizen, but also in terms of how it relates to human activities and interests. If misunderstandings about biodiversity are not addressed explicitly, they will lead to conflicts and controversies in environmental planning and resource management. Fundamentally, biodiversity has been viewed from a biological perspective and a relatively narrow one at that. Plant and animal species and habitats have been of principal concern to the neglect of a broader ecosystem or human ecological perspective which would include the activities and influences of humans, particularly land-use. Assessing biodiversity in an area of interest, in relation to past and present land and resource use, offers a way of reducing or avoiding altogether some of the misunderstandings and providing a basis for dealing with conflict and controversy. Rooting such assessments in the broad context of human ecology also helps to promote understanding of the interactions between natural or biophysical systems or human activities and interests. Such understanding is likely to be helpful to those involved in management and planning and the many other groups likely to be affected by economic, technical, institutional and environmental changes. Land and resource assessments that strive to provide a comprehensive or holistic image of biophysical and cultural settings, such as the ABC approach developed at the University of Waterloo, can provide not only a basis for understanding human and environment interactions and for monitoring and assessing outcomes as a proposed undertaking proceeds, but also a basis for managing or avoiding altogether many land-use controversies and resource conflicts." [Abstract]

Norton-Griffiths, M.; Southey, C. 1995. The opportunity costs of biodiversity conservation in Kenya. Ecological Economics 12:125-139. [Center for Social and Economic Research on the Global Environment, University College London, London, United Kingdom]

"This paper estimates the opportunity costs of biodiversity conservation in Kenya from the potential net returns of agricultural and livestock production, and compares them with the net returns from tourism, forestry and other conservation activities. At the national level, agricultural and livestock production in the parks, reserves and forests of Kenya could support 4.2 million Kenyans and generate gross annual revenues of $565 m and net returns of $203m. These forgone net returns of $203m, some 2.8% of GDP, represent the opportunity cost to Kenya of biodiversity conservation. The current combined net revenues of $42m from wildlife tourism and forestry are quite inadequate to cover these opportunity costs to land.

The government of Kenya is clearly subsidizing conservation activities whose chief values are all indirect and external to Kenya, and their ability to continue doing so will be a function of growth and modernisation in the Kenyan economy. Dependency on land will increase if the economy stagnates and rural populations continue to grow, and while the government of today may not consider degazetting parks and reserves, the situation could be quite different in 25 years when rural populations have doubled yet again. In contrast, dependency on land will fall only once the economy grows and modernises and rural populations are drawn off the land and into industrial and service sectors.

Given the global nature of the benefits from Kenya's conservation efforts, it is quite inappropriate that so much of the cost is born by Kenya. The present scale of subsidies should instead form the basis for international negotiations to transfer funds to meet all or part of them. At present the global environment facility (GEF) is the only operational programme through which such contributions can be channeled to meet the incremental costs of biodiversity conservation, but situations such as the one described here for Kenya were never envisaged when the GEF was designed. If the developed world expects a country like Kenya to maintain conservation estate on its behalf, then it must be prepared to contribute substantially towards these costs until such time as Kenya can afford to carry the burden itself." [Abstract]

Oldfield, M.L. 1989. The value of conserving genetic resources. Sinauer Associates, Sunderland, Massachusetts, United States.

Oldfield, M.L.; Alcorn, J.B. (editors). 1991. Biodiversity: culture, conservation and ecodevelopment. Westview Press, Boulder, Colorado, United States.

"The dual themes of conservation of biological resources and rural development are explored in this book by biologists, anthropologists, agricultural scientists, and policy analysts. Using traditional resource management systems as the basis of study, the contributors assess traditional management of plant and animal diversity, explore the rationale for *in situ* conservation, and discuss existing and possible linkages between development and conservation." [from Summary]

Palmberg, C.; Esquinas-Alcazar, J.T. 1990. The role of the United Nations agencies and other international organizations in the conservation of plant genetic resources. Forest Ecology and Management 35(1-2):171-197.

The paper briefly reviews the mandates and main activities of the United Nations and other major international organizations concerned with the conservation of plant genetic resources, with special reference to forestry. It highlights the vital role that international organizations can and should play in this field. To succeed, global programmes must respect national priorities and complement the overall development plans of each nation. International action must be carefully coordinated, recognizing that the role of multilateral organizations complements that of bilateral organizations, development banks and nongovernmental organizations. Some recent developments in the field of genetic resource conservation are examined in a historical perspective, focusing on continuing programmes, trends, and needs in the field of plant genetic resources. The paper also provides a list of references to some relevant documentation by international organizations.

Pearce, D.; Moran, D. 1994. The Economic Value of Biodiversity. In association with the Biodiversity Programme of IUCN - The World Conservation Union, Gland, Switzerland. Earthscan Publications Ltd., London, United Kingdom.

"The theme of the volume is... roughly as follows:
* economic forces drive much of the extinction of the world's biological resources and biological diversity; yet
* biodiversity has economic value. If the world's economies are rationally organized, this suggests that biodiversity must have less economic value than the economic activities giving rise to its loss;
* yet we know that many biological resources do have significant economic value. We also know that many of the destructive activities themselves have very low economic value; therefore
* something is wrong with the way actual economic decisions are made - for some reason they fail to 'capture' the economic values that can be identified;
* these 'economic failures' lie at the heart of any explanation for the loss of biological diversity. If we can address them, there is a chance of reducing biodiversity loss." [from Preface]

Plucknett, D.L.; Horne, M.E. 1992. Conservation of genetic resources. Agriculture, Ecosystems and Environment 42(1-2):75-92. [The World Bank, Washington, DC, United States]

"An overview of current conservation systems is presented along with a general framework of principles and concepts that govern resource conservation work. The article surveys national and international genetic resource conservation programs, outlines the current state of conservation systems for plants, animals, and microorganisms, and calls for a global plan for conservation of biological diversity. Programs for plant germplasm are more organized and developed than those for animals. *In situ* conservation, the maintenance of a population within the community of which it forms a part, is examined, including maintenance of species economic interest within natural ecosystems. This approach has numerous advantages and tends to conserve more than the target species. A contrasting view is given of conservation biology and agriculture as to the value of genetic conservation of wilderness areas as reservoirs for genetic variability. Ex situ conservation, the conservation of organisms outside of natural habitats, is considered especially for seeds of major crop plants. Germplasm banks fulfill an important long-term need and their functionality is dependent on the collection, characterization, preservation, and distribution of genetic resources." [Abstract]

Reid, W.V. and Miller, K.R. 1989. Keeping options alive: the scientific basis for conserving biodiversity. World Resources Institute, Washington, DC, United States.

"...Reid and Miller provide an overview of where the world's species and genetic resources are located and why they are valuable, a new analysis of species extinctions in tropical forests that supports previous estimates and reinforces the magnitude of the problem that we face, and a survey of the most recent findings of conservation biology. The authors also suggest how these findings can best be put to work for both *in situ* and *ex situ* conservation, and they add to evidence that the biodiversity crisis is not restricted to tropical forests, but threatens biological resources in temperate zones and marine ecosystems as well. Finally, this report underscores the important interdependence between biological diversity and human cultural diversity and the policy implications of this critical bond." [from Foreword]

Rice, K. 1992. Theory and conceptual issues. Agriculture, Ecosystems and Environment 42(1-2):9-26.

"This paper examines the parallel organization of biological diversity in both agricultural and natural systems across spatial and temporal scales and shows that there are many theoretical concepts of common concern to both as well as real differences between the two disciplines." [from Abstract]

Riggs, L.A. 1990. Conserving genetic resources on-site in forest ecosystems. Forest Ecology and Management 35(1-2):45-68.

Three elements are required to realize the values of biodiversity: genetic materials; environments; and information about the functional relationships of the first two. Effective conservation involves uniting these elements. Thorough review of historical, scientific, socio-economic, and practical information about particular elements of biodiversity is necessary to assess the constraints on the opportunities for conservation activities. The California Gene Resources Program activities from 1980 to 1983 are examples of this kind of undertaking. Computerized information systems can assist managers and researchers in uniting these elements and facilitating both conservation of, and access to, genetic resources. The California Forest Genetic Sources Catalog, a microcomputer database application developed by GENREC for the Wildland Resources Center, is one such application.

Rose, R. 1992. Economic aspects of conserving biological diversity. Agriculture and Resources Quarterly 4(3):378-388.

Sandlund, O.T.; Hindar, K.; Brown, A.H.D. 1992. Conservation of Biodiversity for Sustainable Development. Scandinavian University Press, Oslo, Norway.

Section 1 of this text contains two introductory articles on biodiversity. Section 2 contains articles relating genetic resources and conservation biology. Section 3 discusses the ecological context of genetic erosion, while strategies for ex situ conservation are examined in section 4 and biotechnological challenges in section 5. Finally, biodiversity and sustainable development are connected in the last two sections with recommendations for actions in biodiversity conservation being made.

Shiva, V.; Anderson, P.; Schucking, H.; Gray, A.; Lohmann, L.; Cooper, D. 1991. Biodiversity: social and ecological perspectives. Zed Books Ltd., London, United Kingdom and World Rainforest Movement, Penang, Malaysia.

"Heffa Schucking and Patrick Anderson in *Voices Unheard and Unheeded* analyse the dominant paradigm of conservation and reflect on its lacunae. Andrew Gray's contribution is

based on his experience with indigenous peoples of Latin America. Larry Lohmann's article, *Who Defends Biological Diversity?*, reflects the conservation strategies of the peasant and forest dwelling communities in the case of Thailand. David Cooper provides a critique of the global biodiversity convention and suggests the vital components needed for a meaningful agreement. [Vandana Shiva's] piece attempts to show that production based on principles of uniformity is the biggest threat to biodiversity..." [from Introduction]

Smith, C. 1984. Economic benefits of conserving animal genetic resources. Animal Genetic Resources Information 3:10-14.

Solow, A.; Polasky, S.; Broadus, J. 1993. On the measurement of biological diversity. Journal of Environmental Economics and Management 24(1):60-68.

"In optimizing strategies aimed at the conservation of biological diversity, it is necessary to compare the consequences of competing strategies for biological diversity. This paper presents a general approach to this problem. An example concerning the conservation of crane species is given." [Abstract]

Tisdell, C.A. 1995. Issues in Biodiversity Conservation Including the Role of Local Communities. Environmental Conservation 22(3):216-222. [Department of Economics, University of Queensland, Brisbane, Australia]

"This paper points out some limitations of existing economic and ecological approaches to assessing conservation of biodiversity, and suggests a few possibilities for dealing with these approaches. The theoretical/structural aspects of optimal biodiversity are then briefly discussed, followed by biodiversity issues involving local communities. Illustrations are given of these issues from Xishuangbanna Prefecture in Yunnan, China." [from Introduction]

Tobey, J.A. 1993. Toward a Global Effort to Protect the Earth's Biological Diversity. World Development 21(12):1931-1993. [Organization for Economic Cooperation and Development, Paris, France]

"The preservation of biological diversity is discussed from a global perspective, with a focus on tropical deforestation. Economic issues in tropical deforestation, market failure, and the costs and benefits of preserving biological diversity are surveyed. It is found using a straightforward economic model based on the cost-benefit criterion that industrialized countries can realize 'gains-from-trade' by financing preservation of biological diversity in tropical developing countries. This provides a strictly economic rationale for the introduction of an international system to transfer funds for the protection of biological diversity in developing countries." [Abstract]

Wells, M. 1992. Biodiversity conservation, affluence and poverty: Mismatched costs and benefits and efforts to remedy them. Ambio 21(3):237-243.

"Considerable progress has been made recently in identifying and measuring protected area economic costs and benefits in developing countries. This paper departs from this approach by concentrating not on the measurement of total economic costs and benefits from protected areas but on their distribution. Protected area benefits and costs are discussed at three separate spatial scales: local, national/regional, and global/transnational. The overall picture shows that economic benefits - although difficult to measure and varying from site to site - are limited on a local scale, increase somewhat on a regional/national level and then become potentially substantial on a transnational/global scale. The economic costs follow an opposite trend, from being locally significant, regionally and nationally moderate, and globally small. It is evident that there are few local incentives and very limited regional and national incentives for protected area establishment and management in developing countries. Very little, if any, empirical work has been done on the distribution of protected area costs and benefits. The conclusion of this paper is that such analysis can provide an essential bridge between economic valuation studies and the identification of necessary and practical action steps." [Abstract]

Wells, M.P.; Brandon, K.E. 1993. The Principles and Practice of Buffer Zones and Local Participation in Biodiversity Conservation. Ambio 22(2-3):157-162.

"Recognition is growing that the successful management of protected areas ultimately depends on the cooperation and support of local people. As a result, there has been a dramatic increase in financial support for projects attempting to link the conservation of biodiversity in protected areas with local social and economic development. Drawing on our recent analysis of 23 integrated conservation development projects (ICDPs) in 14 developing countries, this paper explores the challenges which have arisen in operationalizing two key concepts which lie at the heart of community-based conservation. First, buffer zones around park boundaries. Second, greater participation of local people in conservation and development. We describe important practical constraints which have so far limited the effective implementation of these two concepts. But - despite some critical constraints operating outside individual projects' sphere of influence - we conclude that innovative, well-designed projects at carefully selected protected area sites that constructively address local people-park relationships will be essential to the conservation of biodiversity, and thus to sustainable development." [Abstract]

Wilson, E.O. (editor). 1988. Biodiversity. National Academy Press, Washington, DC, United States.

"...The book before you offers an overall view of this biological diversity and carries the urgent warning that we are rapidly altering and destroying the environments that have fostered the diversity of life forms for more than a billion years.

The source of the book is the National Forum on Biodiversity, held in Washington, D.C., on September 21-24, 1986, under the auspices of the National Academy of Sciences and Smithsonian Institution..." [from Forward]

WRI. 1992. Global Biodiversity Strategy: Guidelines for Action to Save, Study, and Use Earth's Biotic Wealth Sustainably and Equitably. World Resources Institute/ The World Conservation Union/ United Nations Environment Programme.

"The conservation of biodiversity is fundamental to the success of the development process. As this *Global Biodiversity Strategy* explains, conserving biodiversity is not just a matter of protecting wildlife in nature reserves. It is also about safeguarding the natural systems of the Earth that are our life-support systems; purifying the waters; recycling oxygen, carbon and other essential elements; maintaining the fertility of the soil; providing food from the land, freshwaters, and seas; yielding medicines; and safeguarding the genetic richness on which we depend in the ceaseless struggle to improve our crops and livestock." [from Foreword]

PART B.

RELATED THEMES IN

AQUACULTURE AND AGRICULTURE

Chapter 6.
TECHNOLOGY TRANSFER AND ADOPTION

Aquaculture

Ahmed, M.; Rab, M.A. 1992. Feasibility of Adopting Aquaculture to Increase Resource Productivity in Existing Bangladesh Farming Systems. Naga, The ICLARM Quarterly 15(4):21-22. [ICLARM, Manila, Philippines]

This article discusses the results of a survey in the district of Gazipur that looked at resource (farm by-products) availability and use in different farm enterprises. These results were used to look at the feasibility of extending new technologies using these resources to farmers.

Anon. 1990. Report of the Workshop on Methods to Promote Aquaculture in Rural Development, Chipata, eastern province, Zambia, 10-14 July 1989. FAO/SIDA; Food and Agriculture Organization of the United Nations, Harare, Zimbabwe.

The report describes topics discussed at the workshop which include the results of the ALCOM pilot project field testing of aquaculture in rural development conducted in the eastern province of Zambia and also the development of fish farming extension methods and guidelines. Conclusions of the workshop and recommendations on aquaculture extension are given.

Bai, N.J.; Seshadri, C.V. 1988. Small scale culture of Spirulina (Arthrospira) as a food supplement for rural households - technology development and transfer. Archiv fuer Hydrobiologie (Supplement) 80(10):565-572.

A simple technology of growing Spirulina (Arthrospira) fusiformis in mud pots to provide nutritive food supplement for a family has been developed. The technique of pot culture, its advantages, nutritive value of the product, cost analysis etc. have appeared already in earlier reports. Here preliminary testing for comparative yields of a few strains, monitoring for healthy and optimum yields and adaptability of this method as a family enterprise have been considered. The successful transfer of this technology to a village near Madras through training given to the women has been briefly reported.

Bhaumik, U.; Pandit, P.K.; Chatterjee, J.G. 1992. Adoption of paddy-cum-fish culture practice in rained coastal paddy fields of Sunderbans, West Bengal. Environment and Ecology 10(2):366-370.

Biswas, A.; Acharjee, S.K.; Haque, M.A. 1991. Adoption of composite fish culture in the context of some psychological orientation. Environment and Ecology 9(3):661-663. [Dep. Agric. Ext., Bidhan Chandra Krishi, Mohanpur, India]

The study was conducted among the selected fish farmers to elicit the relationships of their psychological orientations with the adoption of innovative practices of composite fish culture. Psychological orientations such as achievement motivation, production orientation, orientation towards competition, innovation proneness, economic motivation, risk orientations and attitude towards composite fish culture were found to be positively and significantly related with the adoption of composite fish culture while secular orientation and planning orientation were depicted as to be insignificantly related with that of adoption.

Brown, J.H.; Prayitno, B. 1987. Backyard Fish Farming in Java, Indonesia. Community Development Journal 22(3):237-241.

This article discusses backyard fish culture in Java, Indonesia with an examination of the village Ngrajek. The various levels of fish culture are detailed from the simplest of purely for household consumption to the more sophisticated production of fish for sale, and more recently, the production of fry and fingerlings and integrated aquaculture. Factors that have contributed to the success of this village include a good supply of water and government extension progammes. Insecticides and pesticides are recognized as problems by the government. The potential of other South East Asian villages to have similar successes to Ngrajek is promoted given that they have appropriate extension services.

Chong, K.C. 1988. Economic and social considerations for aquaculture site selection: An Asian perspective. NACA, Bangkok, Thailand.

This short paper discusses the major economic and social considerations for aquaculture site selection. By pointing out, as well as bringing together all possible considerations from the economic and social perspectives, the author not only hopes to broaden the technical evaluation of aquaculture sites but to enrich and show the equal importance of these factors in site selection.

Costa-Pierce, B.A.; Zainal, S.; Effendi, P. 1988. ICLARM and south-south technology transfer: Philippine aquaculture technology and Indonesia. Part 1. Naga, The ICLARM Quarterly 11:10-11.

A historical account is given of the discovery of Tilapia mossambica and its culture in Indonesia and the resulting success in Java of this species in rural development programs. Consequent introduction of this species to the Philippines and development of the tilapia culture industry is described, comparing it with development of the industry in Indonesia. Although tilapia production showed a great increase in the Philippines following introduction of Oreochromis niloticus from Thailand, the situation was quite different in Indonesia, where strong market biases had been formed and regional preferences for freshwater fish exist.

Das, P.; Bhaumik, U.; Pandit, P.K.; Roy, B.; Banerjee, B.K.; Mondal, S.K. 1988. Some variables contributing to the adoption of composite fish culture. In: Joseph, M.M. (editor). The First Indian Fisheries Forum, Proceedings. Dec. 4 - 8, 1987, Mangalore, Karnataka. Asian Fisheries Society, Indian Branch, Mangalore, Karnataka, India. [National Bureau of Fish Genetic Resources, Allahabad, India]

Knowledge on the role of important independent variables in acceptance or rejection of technological innovations by farmers is a prerequisite in extension programme formulations. A study was designed to establish relative importance of 14 selected independent variables in relation to the dependent variable adoption of composite fish culture innovations. In socio-personal variables, education of the farmers showed positive while farmer's age showed negative regression coefficient. Both the socio-psychological variables, i.e. experience in composite fish culture and experience in traditional farming, showed positive effects.

Dela Cruz, C.R.; Lightfoot, C.; Sevilleja, R.C. 1992. Rice-fish farming in the Philippines: the farmer's perspectives. World Aquaculture 23(1:)52-55.

This article discusses a study whose purpose was to determine the reasons behind the failure of Philippine rice-fish farming to continue beyond the end of the program that introduced the technology. Informal rapid rural appraisal was used to reveal farmers' assessments of the reason for the loss in popularity of this practice.

Gonzales, E.R. 1984. Small scale tilapia cage technology adopted in fishing villages in Laguna Lake, Philippines. Aquaculture 41(2):161-169. [Binangonan Research Station, Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC), Binangonan, Rizal, Philippines]

"A small scale tilapia cage project was tested in two fishing villages in the Philippines. The results showed that household incomes of participating families increased from P6183 to P41768 per year, and household savings from about zero to P71.02 per day. Participating families consequently purchased gear for sustenance fishing, and luxury foods for their households." [Abstract]

Gupta, M.V.; Ahmed, M.; Bimbao, M.A.P.; Lightfoot, C. 1992. Socioeconomic impact and farmer's assessment of Nile tilapia culture in Bangladesh. ICLARM Technical Reports 35. International Center for Living Aquatic Resources Management, Manila, Philippines.

"A socioeconomic study of tilapia culture in seasonal ponds in Mymensingh, Bangladesh, indicated that these unused or under-used seasonal waterbodies, most of which are actually ditches, can be beneficially used for farming tilapia. The tilapia culture technology is simple, requiring very low labor input and hence can also be undertaken by women and children. Ponds

of 169 m^2 yielded an average 23.6 kg of fish, which is almost equivalent to the national annual consumption of low-income rural households with six family members.

The study further indicated that 70% of fish produced is consumed on-farm, improving the nutrition of farming families. Revenue from 28% of fish and fingerlings sold was enough to meet the operational costs and this makes the operation sustainable. Return on investment was 343%, indicating economic viability of the operation. Ninety per cent of the farmers surveyed indicated that they are happy with the technology and of these 80% indicated that they will expand their operations.

In addition to economic returns, the implementation of the technology resulted in social benefits to farmers, in that they were able to present fish to their neighbors, resulting in better relationships. Also, some farmers could pay for the education of their children through income generated from the operation.

Further research needs to be undertaken to address some of the problems reported by the farmers, such as overpopulation of fish due to breeding and easy ways to catch fish so that the technology could become more profitable." [Abstract]

Harrison, E. 1994. Aquaculture in Africa: Socio-Economic Dimensions. In: Muir, J.F.; Roberts, R.J. (editors). Recent Advances in Aquaculture V. Blackwell Science Ltd., Oxford, U.K.

"This review discusses a range of literature relating to socio-economic and socio-cultural aspects of the adoption of aquaculture in sub-Saharan African. This work was completed in 1992 as part of a wider ODA funded study. It does not attempt to be a synthesis of all that is known about aquaculture development in Africa. Rather it is the response to a specific hypothesis: that aquaculture development in Africa has not been as successful as had been hoped, and that this has in part been due to inadequate consideration of social and cultural factors and their interaction with the technical element of production." [from Introduction]

ICLARM; GTZ. 1991. The context of small-scale integrated agriculture-aquaculture systems in Africa: a case study of Malawi. International Centre for Living Aquatic Resources Management, Manila, Philippines and Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), GmbH, Eschborn, Germany.

"This study, supplemented by field surveys, summarizes available literature on aquaculture and the context of aquaculture in Malawi. It is intended to provide a national case study of one African context in which small-scale aquaculture has developed and in which integrated systems of agriculture-aquaculture might be promoted. The study is divided into two parts. The first, Chapters 1 and 2, deals with Africa as a whole, and the second, the remaining chapters, deals specifically with Malawi.

[The chapters that are most relevant to this work are the following.] Chapter 1 summarizes the whole book. Based on a resource systems concept, it gives an overview of the factors involved in African aquaculture for nonspecialist policymakers and development planners, and helps in the organization of feasibility studies and research prerequisites to planning for aquaculture development... Chapter 7 is an examination of the research, training, extension and development projects in Malawi. Chapter 8 focuses on small-scale aquaculture, particularly in the

Southern region. The constraints to aquaculture development in Malawi, based on socioeconomic and microeconomic factors, are described in Chapters 9 and 10." [from Abstract]

Jhocson, N.I. and Smith, I.R. 1984. Bibliography on Socio-cultural, Economic and Institutional Aspects of Tropical Aquaculture and Small-scale fisheries. ICLARM Contribution No. 226. International Center for Living Aquatic Resources Management, Manila, Philippines. [ICLARM, Manila, Philippines]

The bibliography is divided into the following five sections 1) socio-economic aspects of aquaculture, 2) technology transfer in aquaculture, 3) general issues in aquaculture, 4) social, economic and institutional aspects of capture fisheries and, 5) socio-economic aspects of aquaculture and small-scale fisheries.

Leelapatra, W.; Tongpan, M.; Sollows, J.; Chapman, G. 1992. Participatory research and extension in Thailand [In aquaculture]. World Aquaculture 23(1):58-60. [Kalisan Fisheries Station, Amphur Muang Kalasin, Thailand]

"In the early 1980's, a number of nongovernmental organizations (NGOs) observed the spread of rice-fish culture and took steps to extend it. In 1984, the Canadian volunteer organization, CUSO, in cooperation with the Farming Systems Research Institute of the Thai Department of Agriculture, documented the viability of the practice and investigated its interrelationships with other farming systems components. The results presented here are part of that investigation." [from article]

Lovshin, L.L.; Pretto M., R. 1983. A strategy for the use of tilapias in rural Latin America: The Panamanian integrated approach. In: Fishelson, L.; Yaron, Z. (compilers). International Symposium on Tilapia in Aquaculture, Nazareth, Israel 8-13 May 1983. Proceedings. Tel Aviv University, Tel Aviv, Israel. [Department of Fisheries and Allied Aquacultures, Alabama Agricultural Experiment Station, Auburn University, Alabama, United States]

"Simple systems of culturing fish are needed for inexperienced rural producers. Systems and pond installations should permit the rural culturist to produce his own seed, and fatten, harvest, and market his product at a locally acceptable price. The growers' ability to produce fish seed will allow them to continue producing fish even in times of political and economic instability and expand their operations when opportunity exists." [Abstract]

Lovshin, L.L.; Schwartz, N.B.; de Castillo, V.G.; Engle, C.R.; Hatch, U.L. 1986. Cooperatively Managed Panamanian Rural Fish Ponds. The Integrated Approach. International Center for Aquaculture Research and Development Series No. 33. Alabama Agricultural Experiment Sation, Auburn University, Alabama, United States. [Auburn University, Auburn, Alabama, U.S.]

Description and achievements of the 4 year pilot fish culture project carried out in Panama. The main goals of the program were: to teach organized groups of poor rural people to manage

the integrated systems by themselves; to focus on integrated production activities; to have multiple benefits for the rural poor, and; to design a simple, practical technology compatible with microenvironmental and local community conditions. The program was carried in twenty-two communities in a five-province area. The study includes four sections: technical evaluation; nutritional monitoring and evaluation; socioeconomic considerations, and; economic evaluation.

Mandima, J.J. 1995. Socioeconomic Factors that Influence the Adoption of Small-Scale Rural Fish Farming at Household Level in Zimbabwe. Naga, The ICLARM Quarterly 18(2):25-29.

"The objective of this study was to compare the socioeconomic profile of fish and nonfish farming households in three different agroecological regions in Zimbabwe and investigate how these factors might influence the adoption of fish farming." [from Introduction]

Mathias, J.A.; Charles, A.T. and Baotong, H. (editors). 1998. Integrated Fish Farming. Proceedings of a Workshop on Integrated Fish Farming held in Wuxi, Jiangsu Province, People's Republic of China, October 11-15, 1994. CRC Press, Boca Raton, Florida.

These proceedings have articles relating to the subject of technology transfer. In particular Chapters 6 and 7 deal with extension and adoption of integrated fish farming and adapting integrated fish farming to non-traditional environments.

Mathur, S.K.; Jain, A.K.; Subbarao, P.V. 1979. Inter-disciplinary approach to aquaculture - with special reference to Damdama, Haryana. J. Indian Fish. Assoc. 8-9:37-43.

Successful aquaculture development depends not only on the economic evaluation of the cost parameters involved, but also a careful consideration of various biosocio-economic factors is required. Financial viability has to be linked with location specific technology packaging within the framework of integrated rural development.

McClellan, S. 1991. Integrated systems: Re-thinking a panacea. Ceres, The FAO Review (131):22-25.

A discussion is presented on the topic of integrated fish culture systems and their economic viability in different parts of Southeast Asia. Problems faced in trying to introduce this system in Thailand and West Java are discussed, examining the different requirements of each area and measures which must be taken to ensure viability of integrated farming systems and their acceptance by the local populations.

McGoodwin, J.R. 1982. Aquaculture development in atomistic societies. In: Smith, L.J.; Peterson, S. (editors). Aquaculture Development in Less Developed Countries: Social, Economic, and Political Problems. Westview Press, Boulder, Colorado, United States.

Aquaculture development in atomistic societies is considered with particular reference to an impoverished rural community in Mexico - Teacapan. Family house-site aquaculture ponds are thought to be an appropriate strategy for development in Teacapan. Site availability, security, compatibility with the community's economic structure, low initial investment, management and potential benefits and problems involved are discussed.

Middendorp, A.J.; Verreth, J.A.J. 1986. The potential of and constraints to fish culture in integrated farming systems in the Lam Pao Irrigation Project, Northeast Thailand. Aquaculture 56:63-78. [Department of Fish Culture and Fisheries, Agricultural University, Wageningen, The Netherlands]

"In an irrigated area of the Lam Pao region, Northeast Thailand, a survey was undertaken to assess the potential of and constraints to fish culture in small farm holdings. Local agriculture traditions are favorable for integration of fish with rice, growing a long-stalked variety of rice and making restricted use of pesticides. Yields of paddy averaged +-2.2 metric tons$*$ha^{-1}. Concurrent fish farming yielded +-260 kg of fish$*$ha^{-1}. With few extra operating costs, returns of traditional rice culture may be doubled through concurrent fish culture, without affecting the farmers' way of living.

Pond fish culture generated much higher fish yields (+-2.2 metric tons$*$ha^{-1}) and profits than rice and/or rice-cum-fish culture. However, high initial investment costs prevent small-scale farmers from taking part in this fish culture activity. Furthermore, as fish farming is economically more risky than rice cultivation, it does not fit well into the traditional attitude of small-scale farmers regarding risk acceptance. Therefore, pond fish culture should be recommended to commercial farmers rather than to subsistence farmers." [Abstract]

Mitra, A.; Nayak, T.K.; Sarkar, S.K. 1989. Social acceptance and economic returns of tilapia culture in West Bengal. Exotic Aqu. Spe. In India; Spec. Publ. Asian Fish Soc., No. 1, pp. 101-104. [Agric. Eng. Dep., Indian Inst. Tech., Karagpur, India]

Tilapia has been accepted by the people of Calcutta and its suburbs. When it was first introduced, people did not take this fish. Gradually due to its low price, tasty nature and exorbitantly high price of other varieties of fish, tilapia became a popular fish. The culture process, growth, economics, and social impact of culture of tilapia in the sewage-fed bheries and paddy-cum-fish culture fields are discussed in this paper.

Molnar, J.; Rubagumya, A.; Adjavon, V. 1991. The sustainability of aquaculture as a farm enterprise in Rwanda. Journal of Applied Aquaculture 1(2):37-62.

"Beginning in 1983, the Rwanda National Fish Culture Project assisted farmers to upgrade their ponds and also identified and provided a species of tilapia suitable for the high-elevation, cool-water environment. Important questions pertain to the amount and quality of technical

assistance farmers received, the degree to which farmers adopted the technical package extended to them, and the existence of various signs and conditions that signaled the incorporation of fish culture into the cycle and mosaic of farm activity. Data were obtained from a sample of 186 Rwandan farmers taken from project rolls throughout the nation. Most respondents planned new ponds; most felt capable of doing without extension assistance; and very few reported conflicts with other enterprises. When extensionists visited more frequently, farmers attended to their ponds more frequently. Wealthier farmers were less happy with the technical assistance they received. Women gave the male extension representatives lower helpfulness ratings. The results showed the advanced degree to which farmers have grasped the technical aspects of fish culture and their relatively favorable perceptions of the extension assistance." [Abstract]

Nij, A. 1986. Social, cultural and economic determinants of the adoption of fish pond culture in Menoua, Mezam and Momo division of Cameroon. DUC Research Report No. DUC/RSE/86/1. Dschang University Center, Dschang, Cameroon. [Department of Rural Sociology and Extension, Dschang Univ. Center, Dschang, Cameroon]

Noble, R.P.; Rashidi, B. 1990. Aquaculture technology transfer to smallholder farmers in Malawi, Southern Africa. Naga, The ICLARM Quarterly 13(4):14-16.

[The authors] "describe in this article how a large and diverse range of aquaculture technologies can be transferred to farmers through processes that encourage farmer participation and technology adoption." [Abstract]

Padilla, J.E. no date. Economics of innovation adoption: the case of brackishwater aquaculture in Bulacan, Philippines. AFSSRN Working Paper Series: Working Paper No. 2. [ICLARM, Manila, Philippines]

The study analyzes the basis of fish farmers in making decisions regarding the introduction of new technology in their farms. The paper concluded that fish farmers are rational economic units who are responsive to changing economic conditions such as the declining profitability. The decision making also embraced physical considerations.

Palm, R. 1989. Management of community small water bodies for fish production in Africa. In: Giasson, M.; Gaudet, J.-L. (editors). Summary of proceedings and selected papers. Symposium on the Development and Management of Fisheries in Small Water Bodies. Accra, Ghana, 7-8 December 1987. FAO Fisheries Report No. 425. Food and Agriculture Organization of the United Nations, Rome, Italy.

"This review consolidates and analyses information on the history, construction and management of community small water bodies in Africa for which fish production is a major objective. The impact on yield of various environmental parameters and management options is examined. Among the various types of community groups involved in fish production,

community institutions such as schools and missions were found to be the most successful. Overall, community fisheries and aquaculture activities in ponds and reservoirs in Africa have been a failure. Although biological, engineering and economic factors have often contributed to this failure, the primary reasons are social and cultural. Four case studies are presented, regional trends are discussed, and future research needs are targeted." [Abstract]

Pollnac, R.B. 1982. Sociocultural aspects of implementing aquaculture systems in marine fishing communities. In: Smith, L.J.; Peterson, S. (editors). Aquaculture development in less developed countries: social, economic, and political problems. Westview Press, Boulder, Colorado, United States.

"The purpose of this paper is twofold: first, to apply a generalized model of those sociocultural factors which influence the diffusion of innovations to the problem of aquaculture development; and, second, to examine sociocultural aspects of introducing aquaculture systems into communities already adapted to small-scale marine capture fishing." [from article]

Rubino, M.C.; Stoffle, R.W. 1990. Who Will Control the Blue Revolution? Economic and Social Feasibility of Caribbean Crab Mariculture. Human Organization 49(4):386-394. [Bluewaters, Inc., Behesada, Maryland, United States]

"New mariculture technologies that use 'appropriate' technology or rely on the natural productivity of the oceans to supply feed sources for seafood farming in coastal waters are being developed. These technologies may be feasible for small scale commercial mariculture projects implemented by fishermen - farmers in developing countries. The article presents research data regarding the economic and social feasibility of the adoption of a new mariculture technology by artisanal fishermen in two small fishing villages in Antigua and the Dominican Republic in the Caribbean. The technology involves growing algae on offshore screens and feeding it to Caribbean spider crabs (*Mithrax spinosissimus*) raised in offshore cages. The research indicates that the adoption of crab mariculture by fishing crews is feasible because they have requisite values, skills, corporate resources, market relationships, and territorial rights. However, fishing crews may lack start-up capital and may require visible evidence of technological feasibility before adoption. If fishermen make a commitment to mariculture, their new activity may conflict with other relationships in their villages and they may catch fewer subsistence fish for local and urban markets." [Abstract]

Ruddle, K. 1993. The Impacts of Aquaculture Development on Socioeconomic Environments in Developing Countries: Toward a Paradigm for Assessment. In: Pullin, R.S.V.; Rosenthal, H.; Maclean, J.L. (editors). Environment and Aquaculture in Developing Countries. International Center for Living Aquatic Resources Management, Manila, Philippines.

"The principle components of a resource systems paradigm for analyzing the human ecological consequences of aquaculture development in developing countries are presented, specifically for freshwater pond aquaculture, based on examples from eastern Central Africa,

southern China and Panama. Aquaculture as an innovative food production technology is examined in terms of the main perceptions in forming policy design, and the innovation adoption process by small-scale farm households. The principle social characteristics that influence the manner in which any innovation is received are discussed and, in terms of those, the impacts at the household, community and governmental-international agency level of the adoption of aquaculture, as well as major administrative changes within an old-established system, are examined." [Abstract]

Satia, B.P. 1991. Why not Africa? (status of aquaculture). Ceres, the FAO Review (131):26-31.

An examination is made of the current situation of aquaculture in African countries. Presently, most activity concentrates on freshwater environments; all 3 production systems - extensive, semi-intensive and intensive - are practiced. Cultivated species include more than 30 indigenous and exotic kinds of fish, crustaceans and mollusks. The African aquaculture industry is typified by numerous small production units, with low inputs and few supporting services; as a result, production is limited compared with historical levels in Asia and modern production in Europe. Problems which limit further development and development options which exist are also examined. It is concluded that the sector shows potential to meet many economic and social goals, but requires guidance in policy formulation, optimal use of natural resources, protection of the environment and also capital investment.

Smith, I.R.; Pestano-Smith, R. 1985. Social Feasibility of Coastal Aquaculture. ICLARM Newsletter 8(1):6-8. [ICLARM, Manila, Philippines]

This paper discusses "appropriate community-based aquaculture systems", developed with community participation and institutional support. The message of the paper is summed up in the statement that "social structure, economic needs and cultural wishes of a coastal community must be understood before those who desire to work with such communities can contribute constructively to change and [to] the community's possible adoption of aquaculture technology."

Tengchumroon, D. 1981. How to transfer sciences and technology to rural areas. Thai Fisheries Gazette 34(1):87-108.

The author found the major constraints in transferring science and technology to rural areas in Thailand to be: 1) misunderstanding of the rural inhabitants (mainly the farmers): 2) inadequate methods in transferring information; 3) too little technical transfer. He describes his experiences gained from doing research and training on several rural development projects in the central and the northeast regions. Recommendations for further activities are given.

Thomas, D.H.L. 1994. Socio-economic and cultural factors in aquaculture development: a case study from Nigeria. Aquaculture 119:329-343. [Wetlands Programme, IUCN, Gland, Switzerland]

"Intensification of fish production from pools in an African floodplain through water management, fertilization and stocking with fingerlings, was technically a success. Fish production per hectare was 171 % greater in managed ponds compared with unmanaged ponds, and in terms of income derived from labour inputs for pond management (the main 'cost' of production) returns per man hour compared favourably to alternative activities. However, due to a poor understanding of socio-economic and cultural factors the technology as originally introduced was not adopted by the community." [Abstract]

Weeks, P. 1990. Aquaculture development. An anthropological perspective. World Aquaculture 21(3):69-74. [University of Houston-Clear Lake, Houston, Texas, United States]

A discussion is presented on the development of aquaculture in developing nations, considering in particular the effects on the local population. The introduction of commercial aquaculture programmes can often negatively affect the rural poor in the related areas of resource competition, altered familial work patterns, increased unemployment and the degradation of nutrition. The need to take into account the social and cultural habits of the local population before venturing aquaculture development projects is stressed.

Wijkstrom, U.N. 1991. How fish culture can stimulate economic growth: Conclusions from fish farmer surveys in Zambia. Aquaculture for Local Development Programme, Report No. 9. Food and Agriculture Organization of the United Nations, Harare, Zimbabwe.

This report is the last in a series of 6 about Zambian farmers who culture tilapia in ponds, or are about to do so. An examination is made of results, available in detail in other reports, and the consequences of these findings for governmental support to rural fish farming are considered. These include a discussion of the possible magnitude of resources that should be allocated for such support and a strategy for their use. The farmers surveyed were divided into 3 groups: those who were culturing fish (almost exclusively tilapia) in ponds at the time of the survey; those who had done so, but abandoned the activity; and those who, because of their access to land and water, were believed to have the resources and incentives to culture fish in ponds in the future. The main aim of the questions addressed to farmers was to find out what factors (economic, social, bio-technical) were critical to success. Between November 1987 and August 1988, 338 randomly selected farmers were interviewed in Northern, North-western and Luapula provinces. Roughly two thirds were "practicing" farmers, the remaining one third divided between ex-farmers and "potential" farmers.

Wijkstrom, U.N.; Aase, H. 1989. Fish farmers in rural communities: Results of a socio-economic pilot survey in northern province of Zambia. GCP/INT/436/SWE.5. Food and Agriculture Organization of the United Nations, Rome, Italy. [FAO/UN, Lusaka, Zambia]

The report presents the findings of a survey conducted on fish farming and fish farmers in the northern province of Zambia. The survey aimed to provide information regarding the status of production and also regarding the fish farmer and reasons for carrying out tilapia culture activities.

Agriculture

Ahmad, A. 1989. Evaluating Appropriate Technology for Development: Before and After. Evaluation Review 13(3):310-319.

"Developing countries today face serious dilemmas regarding introduction of new technologies for development. Their need for a wide variety of technologies is increasing rapidly. Lacking expertise and experience, they find it hard to determine the appropriateness of technological alternatives in terms of cost, quality, scale, degree of sophistication, risk of failure, and environmental risks. Having made certain choices may sometimes compound problems rather than solve them, particularly if the chosen technology happens to be an advanced technology (to be) acquired from abroad, involving high costs and high risks. Criteria and mechanisms for evaluating appropriateness of the needed or chosen technologies before and after their introduction have not been fully developed in most developing countries. The article discusses these issues in light of the contemporary experience of Third World societies and suggests some measures to help incorporate technology assessment in the policy and planning apparatus at various levels." [Abstract]

Antle, J.M.; Crissman, C.C. 1990. Risk, Efficiency, and the Adoption of Modern Crop Varieties: Evidence from the Philippines. Economic Development and Cultural Change 38(3):517-537. [Montana State University, Montana, United States]

"In this article we address the empirical analysis of technical efficiency as farmers adopt new production technology, taking into account production risk and learning. We utilize recently developed efficiency criteria applicable when production is risky and implement these criteria using an approximation to a representative farmer's decision model. Pooled time series and cross-sectional data collected by the International Rice Research Institute are used to investigate the behavior of rice farmers when a modern rice variety was introduced in a region of the Philippines in the 1970's." [from article]

Campbell, M.J. (editor). 1990. New technology and rural development: the social impact. Routledge, London, United Kingdom. [International Fellowship for Social and Economic Development, Canberra College of Advanced Education, Canberra, Australia]

"In most developing countries agriculture is still the predominant occupation of the majority of the people. Recently, however, the transfer of technology from developed to less developed countries has stimulated quite rapid change. This book contains a comparative study of the impact of increased modernization in the rural sector in six important developing countries. It considers cases where the deliberate introduction of technology has formed part of a wider

national development plan, and examples where technology has been introduced into communities as a result of pressure from within these communities. In both cases the impact of the technology can be seen to have been profound with new skills having to be learnt and new working relationships adopted." [Summary]

Das, J.K.; Mazumber, G.; Sarkar, A. 1991. Some influencing variables of technology adoption for small paddy growing farms. Environment and Ecology 9(1):103-107.

Feder, G.; Just, R.; Zilberman, D. 1985. Adoption of agricultural innovations in developing countries: a survey. Economic Development and Cultural Change 33:255-298. [The World Bank, Washington, DC, United States]

"The purpose of this paper is to survey various studies that have attempted to explain these patterns of adoption behaviour either theoretically or empirically. Because the volume of such published research is overwhelming, we will attempt to simply review representative works rather than to present an exhaustive discussion of all work to date. The next section introduces a general conceptual framework for analyzing adoption and diffusion processes and then proceeds to survey the existing conceptual and theoretical literature regarding adoption patterns of agricultural innovations in LDCs within this framework. Section III reviews empirical studies that have attempted to clarify and validate various aspects of adoption processes in the light of the theoretical literature. Section IV provides a critique of methodologies and models used in empirical literature and suggests new approaches and directions. The implications of the survey are indicated in the last section." [from article]

Ganjanapan, L. 1982. An approach to understanding farmer decision-making applied to the adoption of multiple-cropping technology in Chiang Mai valley, Thailand. In: Hainsworth, G.B. (editor). Village-level modernization in Southeast Asia: the political economy of rice and water. UBC Press, Vancouver, British Columbia, Canada.

"The central premise of the study by the MCP (Multiple Cropping Project) Agricultural System Group... is an interdisciplinary effort to gain a basic understanding of the key relationships among the various factors that make up a farm system, and to see how such relationships affect the farmer's decision-making as related to adopting modern agricultural techniques. This paper is a preliminary report on this project." [from article]

Haque, M.M. 1991. Sustainable development and environment: a challenge technology choice decision-making. Project Appraisal 6(3):149-157.

Henry, C.M. 1988. Risk, uncertainty and adoption of new agricultural technology: an empirical application of expected utility maximization. Oxford Agrarian Studies 17:78-94.

Herdt, R.W.; Mandac, A.M. 1981. Modern technology and economic efficiency of Philippine rice farmers. Economic Development and Cultural Change 29:375-400. [International Rice Research Institute, Manila, Philippines]

"This paper presents the analysis of research conducted between 1974 and 1977 [on the subject of the rice yield gap] in one province of the Philippines. The theoretical basis of the 8efficiency measures are first discussed. An estimate of a global engineering-type production function for rice is obtained. Measures of technical and economic efficiency are developed for each subject farmer using an empirically derived individualized production function. In the final section of the paper, the differences in efficiency among farmers are explained." [from article]

Herdt, R.W. 1989. The Impact of Technology and Policy on Seasonal Household Food Security in Asia. In: Sahn, D.E. (editor). Seasonal variability in third world agriculture: The consequences for food security. Johns Hopkins University Press for the International Food Policy Research Institute, Baltimore, Maryland, United States.

Hossain, S.M.A.; Crouch, B.R. 1992. Patterns and determinants of adoption of farm practices: some evidence from Bangladesh. Agricultural Systems 38(1):1-15. [Department of Agriculture, University of Queensland, St. Lucia, Queensland, Australia]

"This paper investigates whether opinion leaders and their followers differ in adopting certain current and potential recommended farm practices. Also studied is the innovativeness of the opinion leaders and factors associated with the adoption of agricultural practices. The paper is based upon farm-level data obtained from a remote area in Bangladesh, and is derived from employing the snow-ball sampling procedure." [from Abstract]

Kikuchi, M.; Hayami, Y. 1982. Technological and institutional response and income shares under demographic pressure: a comparison of Indonesian and Philippine Villages. In: Hainsworth, G.B. (editor). Village-level modernization in Southeast Asia: the political economy of rice and water. UBC Press, Vancouver, British Columbia, Canada.

"This chapter compares Indonesian and Philippine villages and analyzes the processes by which the village institutions adapt to changes in resource endowments, technology, and government policies. The influence of the institutional change on income distribution in village communities will also be assessed." [from article]

Lin, J.Y. 1991. Education and innovation adoption in agriculture: evidence from hybrid rice in China. American Journal of Agricultural Economics 73(3): 713-723. [Peking University, China]

"This paper uses the diffusion of F1 hybrid rice as a case for examining the effects of education on the adoption of new technology in China. A simple behavioral model that treats the

adoption of hybrid rice as a portfolio selection problem is presented. The implications of the model are tested with farm-level data collected from a sample of 500 households in Hunan Province. The results from a dichotomous probit model and a two-limit tobit model are consistent with the hypothesis that education has a positive impact on the adoption of new technology." [Abstract]

Molnar, J.J.; Clonts, H.A. (editors). 1983. Transferring food production technology to developing nations: economic and social dimensions. Westview Press, Boulder, Colorado, United States.

Papers in this text include the following: Sociocultural constraints on the transfer and adoption of agricultural technologies in low income countries; and Risks and information: farm level impediments to transforming traditional agriculture.

Napier, T.L. 1991. Factors affecting acceptance and continued use of soil conservation practices in developing societies: A diffusion perspective. Agriculture, Ecosystems and Environment 36(3-4):127-140.

The purpose of this paper is to examine social, economic and institutional factors which affect the adoption of soil conservation practices in developing societies. The traditional diffusion model is discussed in the context of its utility for facilitating adoption of soil conservation at the farm level. Factors discussed are as follows: awareness of soil conservation practices; potential impacts of adoption; attributes of the innovation; relevance of soil conservation practices; and institutional barriers to adoption. It is concluded that institutional barriers will be the most difficult barriers to remove in developing societies.

Pachico, D.; Ashby, J. 1983. Stages in technology diffusion among small farmers: biological and management screening of a new rice variety in Nepal. Agricultural Administration 13:23-37. [International Center for Tropical Agriculture (CIAT), Cali, Colombia]

"Agricultural research and extension systems in low-income countries like Nepal face an array of highly varied small farm systems for which new technology must be screened and adapted. A case study of a new rice variety in Nepal shows that in the initial stage of diffusion large farmers are more able to absorb the risk of evaluating the biological potential of the new technology. In the take-off stage of diffusion, when adopters move to full-scale production with the new technology, it is evaluated for its management characteristics and small farmers may emerge as the greater adopters. This paper suggests that rapid adoption of new technology by small farmers requires, firstly, decentralization of biological screening to small-scale site-specific trials with farmers and secondly, a focus of extension efforts on the evaluation of full-scale management requirements with the participation of small farmers." [Abstract]

Parayil, G. 1991. Technology as Knowledge: An Empirical Affirmation. Knowledge 13(1):36-48.

Prattis, J.I. 1973. Gambling, Fishing and Innovation - A Cross Situational Study of Decision Making. International Journal of Comparative Sociology 14(1-2):76-88. [Carleton University, Ottawa, Ontario, Canada]

"The problem addressed here is the examination of the dilemmas of decision making in different substantive contexts. The contexts include peasant farmers deciding whether or not to accept an agricultural innovation, sophomore students gambling, and fishermen on British Columbia's west coast making up their minds where to fish. The major implication drawn from this work is that the structure of decision making can be studied as a cross-cultural variable, and that socio-cultural factors may profitably be viewed as a framework within which a similar structure of decision making occurs." [from article]

Ruttan, V.W.; Hayami, Y. 1973. Technology Transfer and Agricultural Development. Technology and Culture 14(2):119-151.

"In this paper, from earlier research on the diffusion of culture and technology, we draw insights that can contribute to a more adequate understanding of the processes involved in the international transfer of agricultural technology and the impact of such transfer on the location of agricultural production and international trade in agricultural commodities. This analysis leads us to place major emphasis on the emergence of national experiment-station capacity for adaptive research and development as a critical element in the international transfer or 'naturalization' of agricultural technology." [Abstract]

Rymon, D.; Or, U. 1991. Accelerating technology transfer by means of ATTA (advanced technologies in traditional agriculture). Journal of Sustainable Agriculture 2(1):103-118.

This article discusses the case of agricultural technology transfer in the Jiftlik Valley, west of the Jordan River in Israel. The case study covers 20 years of accelerated technology transfer proving that it is a viable option as opposed to a step-by-step approach. The development approach and methodology, social structure, and infrastructure of the valley are all discussed. Economic results are given in conclusion.

Sharif, M.N.; Sundararajan, V. 1984. Assessment of Technological Appropriateness: The Case of Indonesian Rural Development. Technological Forecasting and Social Change 25(3):225-237. [UN-ESCAP Center for Technology Transfer, Bangalore, India]

"It is commonly recognized at the present that technological appropriateness is not an intrinsic quality of any technology, but is derived from the surroundings (technological, as well as sociocultural, politicolegal, economic, and environmental) in which it is to be utilized, and the specific purpose of its application. On this basis, this paper presents two case studies for the selection of appropriate technologies for rural development in Indonesia. The first deals with the

problem of identifying a 'set of appropriate technologies' to be promoted for accelerated rural development. The second case deals with the problem of selecting the 'most appropriate one' among available technologies of one kind. The assessment exercises are carried out using existing methodologies and inputs (such as national priorities, assessment factors, and decision weights) from Indonesian nationals. It is shown that the analysis can provide useful guidelines for science and technology policy planning in developing countries." [Abstract]

Stone, B. 1990. Evolution and diffusion of agricultural technology in China. In: Kotler, N.G. (editor). Sharing innovation: global perspectives on food, agriculture, and rural development. Papers and Proceedings of a Colloquium Organized by the Smithsonian Institution. Smithsonian Institution Press, Washington, D.C., United States. [International Food Policy Research Institute, Washington, D.C., United States]

"The first section of the paper places the elements of innovation in a theoretical framework. The second section focuses on China's progress overall in diffusing the most fundamental technical components for the first stage of agricultural transformation and food consumption development. The third section tracks during the last decade the diffusion process for these components within China's 29 provinces and major municipal areas, and then within China's poorest and most remote counties.

The fourth section reviews economic system reform in China and its implications for the diffusion process. The fifth section identifies several areas of applied scientific research related to agriculture, state-of-the-art farmer practices for which China is a principal source of innovation, and discusses the primary mechanisms of diffusion. The final section summarizes the main arguments." [from article]

Tisdell, C.; Maitra, P. (editors). 1988. Technological change, development and the environment: Socio-economic perspectives. Routledge, London, United Kingdom.

Fourteen papers, revised versions of essays originally presented at the Fourth World Congress of Social Economics held in Toronto in August 1986, examine the social, economic, and environmental questions raised by the role of technology in development. Papers examine population growth, technological change, and economic development in India; new agricultural technology and sustainable food production in Bangladesh; technology and its transfer to less developed economies; a new model for development assistance; the applicability of economic evaluation to China's urban transportation projects; structural change and adjustment in the Australian rural sector; the relationships between technological change and social development; sustainable resource use and development - uncertainty, irreversibility, and rational choice; the changing role of the household economy in a world of expanding technology; telecommuting, work from home, and economic change; attitudes of bank employees to technological change in South Africa; socioeconomic implications of new technology in banking in Australia and New Zealand; social determinism, technology, and economic externalities; and measuring and describing technological advances.

Van Dusseldorf, D.B.W.M.; Box, L. 1990. Role of sociologists and cultural anthropologists in the development, adaptation and transfer of new agricultural technologies. Netherlands Journal of Agricultural Science 38(4):697-709.

Chapter 7.
AQUACULTURE AND DEVELOPMENT

ALCOM (Aquaculture for Local Community Development Programme). 1991. Gender issues in fisheries and aquaculture, including proceedings of the workshop on enhanced women's participation in fisheries development. GCP/INT/436/SWE/REP/7. Food and Agriculture Organization of the United Nations, Rome, Italy.

Anon. 1987. Socio-cultural, Socio-economic, Bio-environmental, and Bio-technical Aspects of Aquaculture in Rural Development. Reports prepared for the Aquaculture for Local Community Development Program. FAO FI/GCP/INT/436/SWE-1. [FAO/UN, Rome, Italy]

Reports are given of studies conducted in Southern Africa regarding the integration of aquaculture in rural development, investigating the following four subject areas: socio-cultural, socio-economic, bio-environmental and bio-technical aspects.

Bailey, C.; Jentoft, S. and Sinclair, P. (editors). 1996. Aquacultural Development: Social Dimensions of an Emerging Industry. Westview Press, Inc., A Division of Harper Collins Publishers, Inc., Boulder, Colorado, United States.

Contents include: (1) Social Change Contributions to Aquaculture Development; (2) The Sky is the Limit? The Rise and Fall of Norwegian Salmon Aquaculture, 1970-1990; (3) Norway's Cod Farming Industry: Adaptation, Imitation or Innovation? (4) Aquaculture in the Baltic Sea: Regional Development and Environmental Conflict; (5) Along the Coast and in the State: Aquaculture and Politics in Nova Scotia and New Brunswick; (6) Paradise Under Siege: A Case Study of Aquacultural Development in Nova Scotia; (7) The Political and Social Context of Technology Transfer: Two Oyster Projects in Florida; (8) Catfish in the Framing System of West Alabama; (9) Colonizing the Coastal Frontier: Governing Marine Salmon Farming in Scotland; (10) Shrimp Mariculture Development in Two Rural Mexican Communities; (11) Social and Environmental Impacts of Coastal Aquaculture in Indonesia; (12) Household and Community Factors Affecting Development of Small-Scale Farming in Africa; (13) Institutional Requirements for Aquacultural Development in Africa: Lessons from Rwanda; (14) Cages, Controversies, and Conflict: Carp Culture in Lake Toba, Indonesia; (15) Fish, Pigs, Poultry, and Pandora's Box: Integrated Aquaculture and Human Influenza.

Bailey, C.; Skladany, M. 1991. Aquacultural development in tropical Asia: A re-evaluation. Natural Resources Forum 15(1):66-71.

Differences between inland and coastal aquacultural production systems in Asia are discussed in terms of market orientation, resource allocation and property rights, and scale of operations. The production of shrimp grown in coastal brackish water ponds has featured prominently in aquacultural development programmes in Asia. Emphasis placed on capital-

intensive shrimp production for export, however, has distracted attention from the potential of inland freshwater aquaculture to generate employment opportunities for rural people and food production for domestic consumers. The paper concludes with a discussion of an alternative policy direction for promoting aquacultural development on a socially sound basis, recognizing the need to balance equity and human nutrition with profitability and foreign exchange earnings.

Baluyut, E. 1987. Women in aquaculture production in Asian countries. In: Proceedings Women in Aquaculture Workshop. Food and Agriculture Organization of the United Nations, Rome, Italy. [Inland Resou. Dev. Corp., Manila, Philippines]

A description of the present role of Asian women in the various types and stages of aquaculture production is presented, quantifying the extent or value of such participation in the various countries. Areas where their involvement may be strengthened or expanded in view of the increasing importance of aquaculture in fish production in Asia and the Pacific are reviewed.

Born, A.F.; Verdegem, M.C.J. and Huisman, E.A. 1994. Macro-economic factors influencing world aquaculture production. Aquaculture and Fisheries Management 25:519-536. [Department of Fish Culture and Fisheries, Wageningen Agricultural University, Wageningen, Netherlands]

"The influence of macro-economic factors on production and consumption of aquatic products in the world was evaluated. World aquaculture production and its growth were analyzed in terms of commodities, species, countries and regions. Special attention was given to interpreting the consequences of the results obtained on policy and planning of future aquaculture development.

The consumption of both aquafood and meat increased significantly with income on a per caput basis in the world. The ratio aquafood : meat decreased with increasing per caput income, stressing the relative importance of aquafood in low-income countries. A significant correlation between the consumption of aquafood and aquaculture production was found for Asia, Europe and on a world-wide scale and it is therefore argued that fisheries pave the way for aquaculture development. Growth of finfish culture tends to correlate with agricultural growth. Africa and Latin America have low aquaculture production compared with their aquafood consumption. These regions offer the highest probability for rapid growth in aquaculture production in the near future." [Abstract]

Burkey, S. 1993. People first: a guide to self-reliant, participatory rural development. Zed Books Ltd, London, United Kingdom.

"Chapter 1 begins with a review of the most commonly held theories of poverty. Some readers may wish to skim this section, but the second part of the chapter illustrates how poverty needs to be analysed at the local level in order to respond to root causes rather than symptoms. Likewise, Chapter 2 begins with a brief review of the more common theories of development and ends with an illustration of how development needs to be seen from the grassroots. The macro-

theories tend to disregard the role of ordinary people in development as well as to ignore the important relationships between human, economic, political and social development.

Part II - Action - looks at practice: the methodology of the self-reliant participatory approach to development. Naturally, this section of the book accepts and builds upon the theoretical basis for self-reliant participatory development defined in Part 1. Finally, Part 3 - Reflection - is a summing up of the general objectives and the basic principles of self-reliant participatory development followed by a final cautionary chapter which attempts to analyse the obstacles, risks and traps which practitioners may expect to encounter as well as the limitations of grassroot development in a hostile external environment." [from Introduction]

Cernea, M.M. 1991. Putting people first: sociological variables in rural development. 2nd ed., rev. and expanded. Published for the World Bank [by] Oxford University Press, Oxford, U.K.

The contents are as follows: Knowledge from social science for development policies and projects; Planning technical and social change in irrigated areas; Developing irrigators' organizations; Middle-level farmer organizations as links between farms and central irrigation systems; A sociological framework for the analysis of new land settlements; Involuntary resettlement; Pastoral production system and livestock development projects; Social and cultural characteristics in small-scale fishery development; Sociological and environmental dimensions of social forestry projects; The social actors of participatory afforestation strategies; Social analysis in rural road projects; When people don't come first; Fitting projects to people; Shortcut and participatory methods for gaining social information for projects.

Costa-Pierce, B.A.; Lightfoot, C.; Ruddle, K.; Pullin, R.S.V. (editors). 1991. Aquaculture research and development in rural Africa. Summary report on the ICLARM-GTZ/Malawi Fisheries Department/University of Malawi Conference, Zomba, Malawi, 2-6 April 1990. Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), GmbH, Eschborn, Germany and International Center for Living Aquatic Resources Management, Manila, Philippines.

The report includes summaries of the presentations of the conference under the following section headings: Background social, cultural, bioeconomic and technical basis; Ecology of smallholder farms; Results of biological research; Other reviews and related studies from African nations and statements from development agencies; and, Working Group reports and recommendations.

Cross, D. 1991. FAO and aquaculture: ponds and politics in Africa. The Ecologist 21(2):73-76.

"FAO and other aid agencies have promoted fish farming in the Third World as a key method of increasing the production of protein and earning foreign exchange. While traditional aquaculture methods have been ignored, FAO have established grandiose high-tech schemes totally unsuited to the needs and capabilities of the poor people they are intended to help. The poor do not have the necessary capital to set up the fish farms, and cannot afford to eat the expensive fish produced. The politics behind the ill-conceived schemes show how agricultural

development policies serve the needs of bureaucrats and politicians rather than the rural poor." [Abstract]

DeVoe, M.R.; Pomeroy, R. 1992. Use conflicts in aquaculture, a worldwide perspective on issues and solutions. World Aquaculture 23(2):13.

"The special session: 'Use Conflict in Aquaculture: A Worldwide Perspective on Issues and Solutions,' was convened at World Aquaculture 90, in Halifax, Nova Scotia (Canada) in June of 1990. The intent was to provide a forum for invited participants from different regions of the world to exchange information on use conflicts in aquaculture, discuss the institutional and regulatory programs that selected countries have developed to ameliorate these conflicts, and identify problem areas so that solutions might be devised...

Each participant in the special session was asked to provide a brief history of aquaculture in his or her area, identify and describe the major use conflicts that have arisen, discuss the approaches that have been taken to address those conflicts, and to conclude by suggesting what works and what does not." [from Introduction]

The papers that were presented are included in the section following this introduction.

Folke, C.; Kautsky, N. 1992. Aquaculture with its Environment: Prospects for Sustainability. Ocean and Coastal Management 17(1):5-24. [Department of Systems Ecology, Stockholm University, Stockholm, Sweden]

"The rapid expansion of intensive one-species aquaculture has generated severe environmental as well as socio-economic problems. A major reason is that Western-oriented aquaculture has been managed as an isolated part of its supporting environment. In this paper, the authors compare the use of industrial energy for various aquaculture, fisheries and agriculture systems and analyze the connection between resource use, methods of culturing and environmental impacts. The characteristics of one-species aquaculture, such as intensive throughput-based salmon cage-farming and shrimp pond-farming, are found to be similar to those of stressed ecosystems. Among these characteristics are a very inefficient resource use and generation of by-products that are stored or exported. Because of the problems with these monocultures, there is a great need for Western-oriented aquaculture to redirect the industry's present behavior towards a path of synergy between development and environment. Based on principles of ecological engineering, Chinese integrated systems are synthesized, intensive mangrove-destructing shrimp farming is opposed to integrated shrimp farming, and how a coastal culturing system of seaweeds, mussels and salmon could be developed is suggested. Such systems aim at increased efficiency, reduced resource use, avoidance of chemicals and medicals, less waste generation and the recycling of nutrients and materials. The authors conclude that the more a cultivation system recognizes and mimics natural ecosystem functions the less environmental effects can be expected. A successful aquaculture system does not have wastes, only by-products, to be used as positive contributors to the surrounding ecosystems and the economy." [Abstract]

Grivetti, L.E. 1982. The Rationale, Promise, and Realities of Aquaculture: A Cultural-Nutritional Perspective. In: Smith, L.J.; Peterson, S. (editors). Aquaculture Development in Less Developed Countries: Social, Economic, and Political Problems. Westview Press, Boulder, Colorado, United States.

"If the world food crisis is based on caloric, not protein need, can aquaculture projects be justified? In this paper, I will examine three themes associated with this important question: (1) rationale for developing and implementing aquaculture projects, (2) program planning errors, and (3) factors contributing to program success or failure." [from article]

Hannig, W. 1988. Towards a Blue Revolution: Socioeconomic Aspects of Brackishwater Pond Cultivation in Java. Gadjah Mada University Press, Yogyakarta, Indonesia. [Sociology of Development Research Center, University of Bielefeld]

"This study is based on partial results from a field research which covered three rice-fish culture villages and two brackishwater pond cultivation villages by intensive investigation as well as some forty villages of either type by short-term surveys in 1984-85...

We will start this report with a concise discussion of conditions under which Indonesian development plans and programmes have to be executed...

...In Chapter B, we will try to elaborate the position of fisheries in general, and inland fisheries in particular, within the Indonesian economy, and fisheries development plans which were/are to be executed in the course of the third and fourth Five-Year Plan...

Chapter C will exclusively refer to conditions of brackishwater pond cultivation in Central Java. First of all problems related to regional programme implementation as well as the regional situation in the production and distribution sphere will be illustrated...

In Chapter D we will elaborate the situation of brackishwater pond cultivation and the living conditions of aquaculturally-based households on local level...

Finally, in Chapter E, we will try to outline very succinctly some possible improvement chances (not only) for aquacultural development with regard to increased production and productivity, but first and foremost with regard to a higher degree of socioeconomic equity among aquacultural producers." [from Preface]

Henderson, H.F. 1985. Aquaculture and rural development. In: Selected working papers submitted to the eleventh session of the advisory committee of experts on marine resources research, Rome, 21-25 May 1985. FAO Fisheries Report No. 338 Supplement. Food and Agriculture Organization of the United Nations, Rome, Italy.

Many development projects in aquaculture include the improvement in the standard of life of impoverished rural populations among their major objectives. However, such improvement has rarely been achieved, in part at least, because the special characteristics and needs of rural communities have been overlooked in planning the aquaculture projects intended for them. With basic problems in mind, FAO is cooperating with the government of Sweden in undertaking a long-term programme of improving the effectiveness of assistance to disadvantaged rural communities in the field of aquaculture.

Lightfoot, C. 1990. Integration of Aquaculture and Agriculture: A Route to Sustainable Farming Systems. Naga, The ICLARM Quarterly 13(1):9-12. [ICLARM, Manila, Philippines.]

The integration of agriculture and aquaculture as a means of intensifying resource use and improving the productivity of many current farming practices in Southeast Asian and African countries is discussed. A brief account is given of work undertaken by ICLARM in Malawi and India on the improved use of marginal lands to integrate crops, vegetables, trees, livestock and fish, outlining also the problems involved in the extension of such integrated fish farming systems.

Little, D.; Skladany, M.; Rode, R. 1987. Small-scale hatcheries in north-east Thailand. Aquaculture and Fisheries Management 18(1):15-31.

"The development of small-scale hatcheries is placed in perspective with other commercial methods of fish seed production, private and public, in the north-east region of Thailand. Case studies of six small-scale hatcheries operated by farmers in this region are presented with details of the production, costs and returns of these farms in relation to their size, location, species of fish produced, amount of capital invested and marketing and sales strategies. Rates of return were found to be favourable, with the exception of a group-based hatchery. The relationship between the production of carp and tilapia fry, which is believed to be incompatible under present systems, is discussed. The wider implications of the role of small-scale hatcheries to provide fish seed for farmers in rural areas and the future of public sector involvement are considered." [Abstract]

Lovelace, G.W. 1984. Cultural beliefs and the management of agroecosystems. In: Rambo, A.T.; Sajise, P.E. (editors). An introduction to human ecology research on agricultural systems in Southeast Asia. University of Philippines at Los Banos under its University Publications Program, College, Laguna, Philippines.

"Rural development programs frequently encounter and, indeed, are often specifically aimed at groups of indigenous people who possess cultural beliefs and values that are different from those possessed either by the people who originally designed the development program or by the people who are charged with carrying out the program. ...Traditional beliefs and values are generally viewed as superstition and as reminders of a 'primitive' past...

In this chapter, I take a different point of view and focus upon traditional belief and value systems as bodies of knowledge - knowledge that is related at least in part to the natural environment and to human interactions with and within that environment..." [from article]

Mazur, R.E.; Titilola, T. 1992. Social and economic dimensions of local knowledge systems in African sustainable agriculture. Sociologia Ruralis 32(2-3):264-286. [Sociology Department, Iowa State University, Ames, Iowa, United States]

"The aim [in this article] is to propose a model for understanding the role of local knowledge systems (LKS) in achieving sustainable agriculture in Africa. The specific objectives will be realized by: demonstrating the problems inherent in approaching sustainable agriculture within the existing paradigm; outlining the components of LKS, emphasizing social and economic dimensions; and presenting a model of how LKS can contribute to sustainable agricultural production (SAP) in Africa." [from article]

Meltzoff, S.K.; LiPuma, E. 1985/1986. The Social Economy of Coastal Resources: Shrimp Mariculture in Ecuador. Culture and Agriculture 28:1-19. [University of Miami, Florida, U.S.]

"In the past ten years (1975-1985), shrimp mariculture has become Ecuador's second most important industry, generating some $225 million in foreign exchange (up to 95% is exported to the United States) and 150,000 jobs. A handful of biological analyses of the shrimp industry and its relationship to coastal ecology have appeared in the past several years (Barniol n.d., Cun and Marin 1982, Weidner 1985, and Mock 1981). However, the absence of social and economic data has mitigated their value for an understanding of both economic development and coastal resource management. Our goal is to describe the social economy of shrimp mariculture in Ecuador, illustrating how cultural concepts and institutions orient production. In so doing, we take issue with two common views about export industries in developing countries: (1) that an industry's value can be measured by the dollar value of exports; and (2) that the structure of export markets determines the internal structure of the export-directed industry." [Introduction]

Newkirk, G.F.; Field, B.A. (editors). 1991. Oyster Culture in the Caribbean. Proceedings of the Oyster Culture in the Caribbean Workshop sponsored by the International Development Research Centre, Ottawa (Canada) and arranged by the Mollusc Culture Network, the Institute for Social and Economic Research, University of the West Indies, Jamaica and the Ministry of Agriculture, Jamaica. Held in Kingston, Jamaica, 19-22 November 1990. Mollusc Culture Network, Dalhousie University, Halifax, Nova Scotia, Canada.

This conference was held to bring together 'the status of current knowledge of the biology and culture technology and the constraints and opportunities for commercial development' of oysters. Of particular interest is the article 'Transforming a biology project into rural development: Lessons from the oyster culture project in Jamaica' which looks at the non-technical and socioeconomic reasons for the oyster culture industry not developing successfully. As well, the many country reports discuss this similar situation and give their own reasons for lack of sustainable growth in the industry.

Nyman, L. 1988. Eco-environmental aspects of integrating small-scale aquaculture with rural development programs in southern Africa. Fish. Dev. Ser. Natl. Swed. Board, No. 24. NSBF, Goeteborg, Sweden.

A discussion is presented on the integration of semi-intensive pond culture with agriculture and animal husbandry in rural populations of southern Africa. The following aspects are

considered: the aquaculture system; fish resources in relation to capture fisheries; effects of river management on wild fish populations and fisheries; general constraints to development of small scale aquaculture in Africa; environmental factors influencing aquaculture development; environmental impact on/of small scale aquaculture; site selection; selection of fish species; selected species of tropical origin; and, analyses of selected countries in southern Africa. The eco-environmental aspects of a methodology for implementing small scale aquaculture at the community level in Southern Africa are also examined briefly.

Pillay, T.V.R. 1994. Aquaculture Development: Progress and Prospects. Fishing News Books, Oxford, United Kingdom.

This book examines the conceptual basis of aquaculture, looking at culture versus capture, site and species selection, role in human food and nutrition, employment opportunities, and market and trade opportunities. Planning at the national and project/enterprise level and assessment of development potential are discussed. The various factors of production are outlined and integrated farming is looked at. Structure of the aquaculture sector, production and marketing, risks and insurance, environmental concerns, legal support and external aid are all discussed.

Pillay, T.V.R. 1992. Aquaculture and the environment. Halsted Press: an imprint of John Wiley & Sons, Inc., New York, New York, United States.

"This book is an attempt to bring together available information pertinent to environmental consequences of aquaculture development, with a view to assisting in the evaluation of future projects...The book... includes suggested procedures for environmental managment of aquaculture comprising the major elements of planning, information, impact assessments, and mitigatory measures supported by technological improvements, increased research and legislation." [from Preface]

Pollnac, R.B. 1992. Multiuse Conflicts in Aquaculture - Sociocultural Aspects. World Aquaculture 23(2):16-19.

"One of the problems facing aquaculture producers is that they must compete with frequently larger and more powerful groups for resources such as land, water, feeds, etc. Those industries which require water or adjacent space are the greatest competitors. These use rights are considered as social risks to aquaculture production." [from article]

Pollnac, R.B.; Peterson, S.; Smith L.J. 1982. Elements in evaluating success and failure in aquaculture projects. In: Smith, L.J.; Peterson, S. (editors). Aquaculture development in less developed countries: social economic, and political problems. Westview Press, Boulder, Colorado, United States.

"During the decade since 1970 several hundred aquaculture projects have been developed with agency, foundation, government, or private industry funding. Here we use examples from

projects in Latin America and Africa to describe general requirements of aquaculture development, decision points in a development project, and evaluations of success and failure by the personnel from funding agencies." [from article]

Rahman, M.A. 1984. Grass-roots participation and self-reliance: experiences in South and South East Asia: a study prepared for the International Labour Office within the framework of the World Employment Programme. Oxford and IBH Co. in collaboration with Society for Participatory Research in Asia, New Dehli, India.

Rajasekaran, B.; Warren, D.M.; Babu, S.C. 1991. Indigenous Natural-Resource Management Systems for Sustainable Agricultural Development- A Global Perspective. Journal of International Development 3(4):387-401. [Centre for Indigenous Knowledge for Agriculture and Rural Development (CIKARD), Iowa State University, Iowa, United States]

"Increasing pressure for food production due to the rapidly growing population has led to the gradual disappearance of numerous indigenous knowledge systems (IKSs) related to natural-resource management. This process exposes the earth's natural resources to constant ecological instability (such as loss of genetic diversity) and severe environmental vulnerability (such as soil degradation and soil erosion). Recent research on indigenous natural-resource management systems indicates that they are highly sophisticated and complex, reflecting generations of careful observations of the natural and physical environment. Keeping this in view, a literature review has been conducted to identify major consequences of the disappearance of IKSs related to natural-resource management. An attempt has been made to categorize indigenous natural-resource management systems. IKSs documented from all over the globe and received at the Center for Indigenous Knowledge for Agriculture and Rural Development (CIKARD) were used to illustrate specific instances of locally adapted and economically viable indigenous natural-resource management systems. Such examples were found in indigenous agronomic practices, agroforestry, indigenous genetic resources, and pastoral management. An integrated natural-resource management model has been developed with an overall goal of increasing food production by small-scale farmers with a least amount of deterioration of nature's resource base." [from Abstract]

Schmidt, U.W. 1983. The role of inland fisheries and aquaculture in rural development. In: Case studies and working papers presented at the expert consultation on strategies for fisheries development (with particular reference to small-scale fisheries), Rome, 10-14 May 1983. FAO Fisheries Report No. 295, Supplement. Food and Agriculture Organization of the United Nations, Rome, Italy. [FAO, Rome, Italy]

"This paper reviews the present situation of inland fisheries and aquaculture and looks at some specific problems such as: urban bias, lack of socio-political representation, resource limitation and technology transfer. The paper concludes by looking at the contributions of inland fisheries and aquaculture to rural development and suggests the principles for optimization." [Abstract]

Schmidt, U.W. 1982. Selected socio-economic aspects of coastal aquaculture in tropical regions with respect to planning and implementation. In: Coche, A.G. (editor). Coastal Aquaculture: Development Perspectives in Africa and Case Studies From Other Regions. CIFA Technical Paper No. 9. Food and Agriculture Organization of the United Nations, Rome, Italy. [Aquaculture Development and Coordination Programme, FAO, Rome, Italy]

The paper outlines briefly the potential role of coastal aquaculture in integrated rural development and emphasizes the relevance of socio-economic aspects for adequate planning and implementation. Concluding from the findings of a socio-economic analysis, the paper suggests to formulate a social postulate which, followed throughout planning and implementation, would ensure the development effort to yield a significantly positive socio-economic impact. The process of studying a socio-economy and formulating the social postulate is outlined using a case study undertaken by the author in Kenya. The process of implementing coastal aquaculture is discussed and the active and responsible involvement of the people is proposed as one of the decisive factors for its success. Additionally, it stresses the relevance of vertical and horizontal integration for coastal aquaculture.

Shang, Y.C. 1990. Socioeconomic constraints of aquaculture in Asia. World Aquaculture 21(1):34-35, 42-43. [Department of Agricultural and Resource Economics, University of Hawaii, Honolulu, Hawaii, United States]

"In 1985, nine Asian countries (Bangladesh, China, India, Indonesia, Malaysia, Nepal, Philippines, Sri Lanka and Thailand) produced about 5.5 million metric tons of aquaculture products and accounted for about half of the world's aquaculture production. In this region, the average annual rate of increase in aquaculture production between 1980 and 1985 was about 11.6 per cent, indicating that it is a fast-growing industry. Aquaculture plays a vital role in Asian countries as a source of animal protein, employment and foreign exchange earnings, as well as a means of improving farm income. However, in their development of aquaculture, these countries must contend with a shortage of credit, high cost of supplies and equipment, marketing problems, land-use conflicts, and social-cultural barriers." [Abstract]

Shang, Y.C. 1986. Coastal aquaculture developments in selected Asian countries: status, potential, and constraints. FAO Fisheries Circular No. 799. Food and Agriculture Organization of the United Nations, Rome, Italy.

Skladany, M. 1992. Use conflicts in Southeast Asian aquaculture development - an institutionalist perspective. World Aquaculture 23(2):33-35.

[This article adopts] "an institutional perspective in order to examine the three major use conflicts in Southeast Asian aquaculture development: conflicting property relations, unequal resource distribution, and overproduction for a limited world market.

A sharp contrast is drawn between intensive coastal and extensive inland aquaculture development in order to illustrate these conflicts." [from article]

Smith, L.J.; Peterson, S. (editors). 1982. Aquaculture development in less developed countries: social, economic and political problems. Westview Press, Boulder, Colorado, United States.

"This book, intended to improve planning for further development of aquaculture, examines the factors that can determine the success or failure of aquaculture projects in developing countries. Focusing on Latin America, Africa, and the Middle East, the authors give specific examples of social, economic, and political constraints on aquaculture development, consider the acceptability of aquaculture products for consumption, look at income, production, and technology allocation, contrast fishing and aquaculture activities, and discuss appropriate organization of aquaculture enterprises. The case studies investigate aquaculture planning and projects in Costa Rica, Mexico, Sierra Leone, Botswana, Israel, and Egypt." [from Introduction]

Turnbull, D.A. 1990. Aquaculture development in developing countries: A private sector approach. World Aquaculture 21(3):75-76. [Agrodev Canada, Inc., Ottawa, Canada]

A discussion is presented on the private sector approach to aquaculture development in developing countries, describing a case history from a project being implemented in northeast Thailand with the objective of increasing both production and consumption of fish by the rural poor. The study covers the sociological aspects of the project.

Useem, M.; Setti, L.; Kanchanabucha, K. 1988. Predictors of Success in a Participatory Village Development Project in Thailand. Public Administration and Development 8(3):289-303. [Boston University, Boston, Massachusetts, United States]

"Participatory development strategies are known to mobilize rural resources, but their effectiveness depends on local conditions. This article evaluates the potential importance of three facilitating factors: competing opportunities, development experience, and local leadership. The impact of these factors on project outcome is examined through study of a rural development project undertaken from 1982 to 1985 in southern Thailand. The project used participatory techniques to build self-guided problem-solving groups in 21 poor villages. The village groups launched income-generating, health, education, and related efforts that attracted the participation of large numbers of village residents. Comparison of the village project experiences confirms that participatory strategies are more effective in villages that (1) are relatively isolated from competing urban opportunities (villagers are more prepared to invest their own resources in the community); (2) have prior experience with development efforts and community endeavours (villagers are more open to learning new approaches); (3) hold greater confidence in traditional village leaders and local government agents. When local leadership is not held in great confidence, participatory strategies are found to encourage the emergence of new leadership that can successfully guide project efforts." [Abstract]

Van der Mheen, H. 1991. Aquaculture for local community development program (Zambia). In: Aquaculture Systems Research in Africa. Proc. Workshop, Bouake, Cote d'Ivoire, November 1988. International Development Research Centre, Ottawa, Ontario, Canada

This paper examines the potential of aquaculture in promoting rural development in small communities, outlining some elements required for successful implementation of aquaculture projects and providing some guidelines to those involved in community development activities.

Warren, D.M. 1991. Using indigenous knowledge in agricultural development. World Bank Discussion Papers 127.

World Bank et al. 1991. Tropical Aquaculture Development: Research Needs. World Bank technical paper No. 151, Fisheries series. The World Bank, Washington, D.C., United States. [World Bank, Washington, D.C., United States]

This Working Party report was prepared to provide input into the major multi-donor "Study of International Fishery Research". It discusses "a systems approach for analyzing research needs", examines research capacity in developing countries, and presents an assessment of current research needs in tropical aquaculture, organized by discipline (including economics and social science).

Zweig, R.D. 1985. Freshwater aquaculture in China: ecosystem management for survival. Ambio 14(2):66-74.

"Freshwater fisheries enjoy a long-standing tradition in the People's Republic of China, and the great diversity of aquacultural practices has come to occupy a highly significant role in the country's overall food-production strategy. In recent years, a number of newly devised methodologies and socio-economic incentives have been implemented, some of which are efficient while others require further evaluation." [Abstract]

Chapter 8.
SOCIAL AND ECONOMIC RESEARCH METHODOLOGIES

Anon. 1990. Report of the first seminar on ALCOM's methodology development. Sigtuna, Sweden, March 21-23, 1990. Fish. Dev. Ser. Natl. Swed. Board Fish.; no. 55.

The document describes the topics discussed at the Seminar, which was conducted in order to provide feedback to resource personnel regarding ALCOM's trial and methodological work conducted during the preparatory phase 1987-89, and also to discuss the progress of the programme and give recommendations for the future direction of development work. It covers the following aspects: aquaculture in developing countries; thematic evaluation of aquaculture; introduction to ALCOMs 3 different approaches for surveys; design and testing of the fishfarmer survey; surveying fish and crustacean resources in tropical reservoirs; methods for socio-economic surveys as a tool for planning and introduction of aquaculture; extension methods for rural fishfarming; nutrition and aquaculture; and, genetic broodstock management to prevent inbreeding. Six papers presented at the Seminar are included as appendices.

Baum, K.H.; Schertz, L.P. (editors). 1983. Modelling farm decisions for policy analysis. Westview Press, Boulder, Colorado, United States.

Behnke, R.; Kerven, C. 1983. Farming systems research and the attempt to understand the goal and motivations of farmers. Culture and Agriculture 19:9-16.

Berg, T. 1992. Indigenous knowledge and plant breeding in Tigray, Ethiopia. Forum for Development Studies 1:13-22.

Bernacsek, G.; Powles, H. (editors). 1992. Aquaculture Systems Research in Africa: Proceedings of a Workshop held in Bouake, Ivory Coast, 14-17 November 1988. International Development Research Centre, Ottawa, Ontario, Canada. [IDRC, Ottawa, Canada]

This 426-page workshop proceedings contains 26 papers; several of these are of relevance, notably 3 specifically on socioeconomic topics in aquaculture (for the Ivory Coast, Cameroon and Zambia), ranging from a socioeconomic survey approach to a paper on using aquaculture in community development.

Biggs, S.; Farrington, J. 1991. Agriculture research and the rural poor: a review of social science analysis. International Development Research Centre, Ottawa, Canada.

"This book reviews recent trends in social science analysis of agricultural research (SSAAR), identifying gaps in research and outlining areas of high potential payoff to future

SSAAR. The authors review the major themes treated in the evolution of theory on the generation and diffusion of agricultural technology since the 1950's. They conclude from this review that there has been a preoccupation with studies of the transfer of technology and institutions from international agricultural research centres to national research and extension services. Researchers have neglected a broad range of issues affecting institutions - whether formal, informal, public, or private - that are involved in agricultural research and technology promotion." [Abstract]

Brosius, J.P.; Lovelace, G.W.; Marten, G.G. 1986. Ethnoecology: an approach to understanding traditional agricultural knowledge. In: Marten, G.G. (editor). Traditional agriculture in southeast Asia: a human ecology perspective. Published in cooperation with the East-West Center, Environment and Policy Institute, Honolulu, Hawaii. Westview Press, Boulder, Colorado, United States.

This article begins with an introduction to ethnoecology, defining it as a subset of ethnoscience, and then follows with the basic assumptions of ethnoecology. Four studies from traditional agricultural societies are given describing the sort of topics that ethnoecologists have considered. In conclusion the author discusses ecological relationships and processes, and individual and intra-group variation in agricultural knowledge.

Cancian, F. 1980. Risk and uncertainty in agricultural decision making. In: Barlett, P. (editor). Agricultural Decision Making: Anthropological Contributions to Rural Development. Academic Press, Inc., New York, United States.

"...a number of characteristics of normative economic analysis contribute to making it a misleading beginning point for analysis of human behaviour. This chapter focused on the benefits of replacing the perfect information assumption and related ideas about subjective probability used in normative analysis with a distinction between risk and uncertainty that is productive in analysis of agricultural decision making." [from article]

Carruthers, I.; Chambers, R. 1981. Rapid appraisal for rural development. Agricultural Administration 8:407-422. [Agrarian Development Unit, Wye College, Kent, Great Britain]

"In this introductory paper we wish to broaden the discussion to include more general aspects, key principles, obstacles to improved methods and alternative methods for rapid appraisal." [from article]

Cernea, M.M.; Coulter, J.K.; Russell, J.F.A. (editors). 1985. Research-extension-farmer: a two-way continuum for agricultural development. World Bank, Washington, DC, United States.

"Although agricultural research and agricultural extension obviously have a common ultimate objective, there is often little close collaboration between them. The reasons for this lack are more complex than much of the casual discussion and rhetoric around this topic would

indicate. Seldom are the underlying technical, institutional, sociological, and economic implications of building up such linkages confronted squarely, analyzed in detail, and translated into action programs. Thus, the weak linkages between research and extension persist as a critical constraint on these support services and on the promotion of agricultural development in general.

...To capture the key facets of this theme, the overall subject of research-extension linkages was divided into four main issues;

* Policy and institutional issues in the improvement of research and extension linkages
* Identification of farmers' priority production problems
* The generation of improved technology and its on-farm validation
* The joint identification and formulation of extension messages by extension and research staff."

[from Preface]. Various conceptual and applied articles are presented on these issues.

Cernea, M.M.; Gugenheim, S. 1984. Anthropology, sociology and farming systems research. Agriculture and Rural Development Department, The World Bank, Washington, DC, U.S.

Chambers, R.; Jiggins, J. 1987. Agricultural research for resource-poor farmers. Part 1: transfer of technology and farming systems research. Agricultural Administration and Extension 27:35-52.

"The greatest challenge now facing agricultural science is not how to increase production overall but how to enable resource-poor farmers to produce more.

The transfer-of-technology (TOT) model of agricultural research is part of the normal professionalism of agricultural scientists. In this model, scientists largely determine research priorities, develop technologies in controlled conditions, and then hand them over to agricultural extension to transfer to farmers. Although strong structures and incentives sustain this normal professionalism, many now recognize the challenge of its bad fit with the needs and conditions of hundreds of millions of resource-poor farm (RPF) families. In response to this problem, the TOT model has been adapted and extended through multidisciplinary farming systems research (FSR) and on-farm trials. These responses retain power in the hands of scientists. Information is obtained from farmers and processed and analysed in order to identify what might be good for them. A missing element is methods to encourage and enable resource-poor farmers themselves to meet and work out what they need and want." [Abstract]

Conway, G.R. 1985. Agroecosystem analysis. Agricultural Administration 20:31-55. [Imperial College of Science and Technology, London, United Kingdom]

"In recent years there has been growing demand for more multidisciplinary and holistic content to agricultural research and development. Farming systems research and integrated rural development are two responses to this demand but, in common with other multidisciplinary approaches, they face the problem of trying to encompass a breadth of expertise while at the same time generating a common agreement on worthwhile practical action. The procedure of agroecosystem analysis which is described and illustrated here combines a rigorous framework

with sufficient flexibility to encourage genuine interdisciplinary action. It has been designed and tested in Thailand over the past five years.

The procedure uses a systems analysis approach in a workshop environment. The participants begin by defining the objectives of the analysis and the relevant systems, their boundaries and hierarchic arrangement. This is followed by pattern analysis, the system being analysed by all the participating disciplines in terms of space, time, flows and decisions. Those patterns are important in determining the important system properties of agroecosystems, namely productivity, stability, sustainability and equitability. The outcome of the analyses is a set of agreed key questions for future research or alternatively a set of tentative guidelines for development." [Abstract]

Conway, G.R.; McCracken, J.A. 1990. Rapid rural appraisal and agroecosystem analysis. In: Altieri, M.A.; Hecht, S.B. (editors). Agroecology and small farm development. CRC Press, Boca Raton, Florida, United States.

"In this chapter we briefly review a number of ...methods which fall under the general headings of Rapid Rural Appraisal (RRA) and Agroecosystem Analysis (AA). We begin by describing a number of basic organizing concepts that provide a theoretical framework for these methods. The philosophy, history and techniques of RRA are then introduced, followed by descriptions of the methods of Agroecosystem Analysis and Topical, Participatory and Monitoring RRA. We conclude with suggestions as to how these various methods fit in the design and management of rural development projects." [from Introduction]

den Biggelaar, C. 1991. Farming systems development: synthesizing indigenous and scientific knowledge systems. Agriculture and Human Values 8(1/2):25-36.

"Agricultural development strategies to date were chiefly based on Western technological solutions, with mixed success rates. Farming Systems Research (FSR) was advanced as a way to increase the use of indigenous knowledge of farming to make new technologies more adaptable and appropriate to farming conditions. FSR has enabled researchers to focus attention on people and their knowledge by increasing people's participation in problem identification and new technology validation. In practice, though, FSR continues to be a top-down approach: technologies continue to be developed (in most cases) in the exogenous, Western knowledge system. Little has been done to develop indigenous technology generating and diffusing capacities already present in the rural areas. In this paper, a model adapted from Bell (1979) will be advanced that is based on cooperation and collaboration between the exogenous and indigenous knowledge systems leading to a synthesis of the two. The underlying principle of the model is that the ultimate solution for rural development is not the dumping of more scientists upon rural people (of whatever discipline) to make exogenously-generated technologies more adaptable and in-line with people's problems, but to strengthen, empower, and legitimize indigenous capacities for identifying problems and developing solutions for these problems. The 'empowerment' of the indigenous knowledge/technology system (however difficult that may be politically) so that it has equal footing with Western knowledge may well be the most important step in a strategy of enabling people in the developing countries themselves to alleviate their poverty." [Abstract]

Dewalt, B.R. 1985. Anthropology sociology, and farming systems research. Human Organization 44(2):106-114. [University of Kentucky, Lexington, Kentucky, United States]

This paper is an introduction to a series of papers on farming systems research published in *Human Organization*. This introduction is designed:
"a) to provide a brief introduction to FSR and why it has emerged as such an important perspective in agricultural development circles;
b) to provide an introduction to the different ways in which anthropologists and sociologists have been contributing to FSR and to suggest further directions for research; and
c) to address some of the critical issues that anthropologists and sociologists working in the realm of FSR and agricultural development must face in the years ahead.

The resolution of these issues will determine the future course of both the work of anthropologists and sociologists in agricultural development, as well as the possibilities for the success of the FSR approach." [from article]

Doorman, F. 1990. A social science contribution to applied agricultural research for the small farm sector: the diagnostic case study as a tool for problem identification. Agricultural Systems 32(3):273-290. [Universidad Nacional, Heredia, Costa Rica]

"Currently, the social science methods mostly used in the diagnostic stage of Farming Systems Research are Rapid Rural Appraisal and formal surveys. In this paper it is argued that the sole dependence on these methods may be inefficient to obtain the thorough understanding of small scale farming systems needed to engage successfully in technology development. Therefore, it is suggested to add a more qualitative, in-depth and participatory research method to the FSR tool kit: the diagnostic case study. Research on small scale rice cultivation in the Dominican Republic is used to illustrate how this type of case study can yield a host of valuable information in a relatively short period of time." [Abstract]

FAO. 1990. The community toolbox. FAO Community Forestry Field Manual 2. Food and Agriculture Organization of the United Nations, Rome, Italy.

FAO and WCARRD (World Conference on Agrarian Reform and Rural Development). 1988. Ten Years of Follow-Up. Guidelines on socio-economic indicators for monitoring and evaluating agrarian reform and rural development. Food and Agriculture Organization of the United Nations, Rome, Italy.

Section 1 is an introduction outlining the preparation of the guidelines, basic principles and objectives of WCARRD, and the scope of WCARRD socio-economic indicators.

"The ...objectives and the policy and programme areas are discussed in Section 2.1 showing their linkages with a wide range of possible indicators. The indicators actually selected pertaining to particular areas of concern are presented in the lists of primary and supplementary

indicators in Table 1 and Appendix 1, respectively. The explanations of the primary indicators are given in Section 3, and the development of statistical programmes to generate the required data is discussed in Section 4. The final section discusses statistics relating to special population groups including women, the rural landless and the disabled persons." [from Introduction]

Farrington, J.; Martin, A.M. 1988. Farmer participatory research: a review of concepts and recent fieldwork. Agricultural Administration and Extension 29(4):247-264. [Overseas Development Institute, Regent's Park, London, United Kingdom]

"Agricultural production in difficult areas faces multiple constraints, requiring intervention at several levels. It is argued here, on grounds of production and equity, that technology development is an important component of the necessary set of interventions. However, conventional 'technology transfer' strategies of R & D work poorly in complex and highly variable environments. As an alternative, much work has recently been undertaken on participatory, problem-oriented approaches. These innovations and their underlying concepts are reviewed here, and their potential and their constraints highlighted. Participatory research tends to focus initially on small numbers of clients. It is therefore more expensive per client than the technology transfer approach, but much more effective. Two questions need to be addressed in future work: how the costs of research can be spread over a large number of clients without loss of effectiveness, and to what extent flexible, participatory approaches can be incorporated into the work programmes of national agricultural research services." [Abstract]

Finsterbusch, K.; Ingersoll, J.; Llewellyn, L. (editors). 1990. Methods for social analysis in developing countries. Social Impact Assessment Series, No. 17. Westview Press, Boulder, Colorado, United States.

The papers in this book are titled as follows: Introduction: Social Impact Assessment - For Richer and for Poorer; Social Analysis in AID and the World Bank; A New Zealand Issues-Oriented Approach to Social Impact Assessment; The Development Anthropology Approach; Surveys: Avoiding the Common Problems; Demography of the Project Population; Informant Interviewing in International Social Impact Assessment; A Bayesian Perspective on Social Impact Assessment Data Collection; Rapid Rural Appraisal: Social Science as Investigative Journalism; Donor Agency Experience with the Monitoring and Evaluation of Development Projects; Closing the Loops: Workshop Approaches to Evaluating Development Projects; Tropical Deforestation and the Threat to Biodiversity: New Directions in Social Assessment.

Fujisaka, S. 1991. A set of farmer-based diagnostic methods for setting post 'Green Revolution' rice research priorities. Agricultural Systems 36(2):191-206. [International Rice Research Institute, Manila, Philippines]

"Post 'Green Revolution' collaborative research of the International Rice Research Institute and national programs addresses low and declining productivity of rainfed and upland rice environments. Greater complexity and human poverty of these - as compared with irrigated -

systems mean that understanding such systems is the key to designing research. For environments or regions of a country, a sequence of interdisciplinary, farmer-based diagnostic methods is used to identify problems, causes, and research needs. The key method, the diagnostic survey, examines farmer practice and knowledge; combines field observation, ethnographic eliciting, enterprise budgets, and analysis of systems. Research is prioritized by a simple ranking of criteria. A draft report and presentation immediately at the end of fieldwork emphasizes that results are an output of national program efforts. Methods and applications to rice research in Bhutan, Cambodia, Laos, Madagascar, and Nepal are described." [Abstract]

Gladwin, C.H. 1989. Modelling farmers' decisions to change: using cognitive science in the design of agricultural technology. In: Groenfeldt, D.; Moock, J.L. (editors). Social science perspectives on managing agricultural technology. International Irrigation Management Institute, Colombo, Sri Lanka.

The author begins this paper with a short discussion of the role of social scientists and the need for less quantitative data and more understanding of why the farm families do what they do. The bulk of the paper provides examples of farmers' decision rules and strategies that the author elicited in Third World settings.

Gliessman, S.R. (editor). 1990. Agroecology: Researching the ecological basis for sustainable agriculture. Ecological Studies, vol. 78. Springer, New York, United States.

Twenty papers provide a broad and integrated approach to research in agroecology. Part 1 focuses on basic ecological concepts in agroecosystems, specifically discussing examples of natural enemy augmentation; ants as possible candidates of biological control in tropical annual agroecosystems; cropping systems, insect movement, and the spread of insect-transmitted diseases in crops; diversification of agroecosystems for insect pest regulation; reduction of damping-off disease in soils from indigenous Mexican agroecosystems; the role of allelopathy in agroecosystems in Taiwan; nutrient mobility in a shifting cultivation system in Belize, Central America; low-input ideotypes; an ecological approach to reducing external inputs through the use of intercropping; integrating trees into agriculture; the influence of trees in selected agroecosystems in Mexico; the potential for a select microbial inocula in forestry; and variability, stability, and risk in intercropping. Part 2 examines agroecosystem design and management, focusing on indications regarding pre-Hispanic wetland agricultural intensification from contemporary use of a wetland/terra firma boundary zone in central Veracruz; agricultural systems of the northeastern hill region of India; the impact of agrohydrological management on water, nutrients, and fertilizers in the environment of the Netherlands; technological changes in energy use in U.S. agricultural production; energy flow in agroecosystems of northeast China; threats to sustainability in intensified agricultural systems; and quantifying the agroecological component of sustainable agriculture.

Grandin, B.E. 1989. Adding community-level variables to FSR: a research priority. In: Groenfeldt, D.; Moock, J.L. (editors). Social science perspectives on managing agricultural technology. International Irrigation Management Institute, Colombo, Sri Lanka.

"FSR currently focuses its efforts within farm boundaries, thus limiting technology generation to inputs under the complete control of the producers. The initial focus on the farm-family has matured to include a subhousehold focus with particular emphasis on the sexual division of labor and product. The focus, however, remains within the farm. The applicability of FSR is limited by its lack of attention to community-level issues, particularly as they affect communal resource control and organization for community-based development. The IARC's which have been in the forefront of developing FSR, particularly those working in Africa, have an important opportunity to develop and test methods which will assist national programs to incorporate community-level variables and hence expand their scope for technology generation and dissemination." [Summary]

International Development Research Centre (Canada). 1982. Aquaculture economics research in Asia: proceedings of a workshop held in Singapore, 2-5 June 1981. International Development Research Centre, Ottawa, Ontario, Canada.

"Three major subject areas were reviewed during the workshop: microeconomic analysis of existing aquaculture production, microeconomic analysis of experimental aquaculture technology, and social welfare economic considerations for aquaculture development. ...each of the three subject areas is introduced by a paper on economic principles and concepts relevant to aquaculture. Case study presentations of research methodology and economic analysis undertaken in various countries in Asia follow the first two of these introductory papers. ...The final part of the proceedings is a summation of the overall conclusions and recommendations arising from the meeting. Two appendices have also been included: working definitions of economic and statistic terms, and a selected bibliography." [from Introduction]

Methodological contributions are made by the following authors: (a) T. Panayotou, Social welfare economics and aquaculture: issues for policy and research; (b) Y.C. Shang, Microeconomic analysis of experimental aquaculture projects: basic concepts and definitions; and (c) I.R. Smith, Microeconomics of existing aquaculutre production systems: basic concepts and definitions.

Jones, J.R.; Wallace, B.J. (editors) 1986. Social Sciences and Farming Systems Research: Methodological Perspectives on Agricultural Development. Westview Special Studies in Agriculture Science and Policy, Westview Press, Inc., Boulder, Colorado, United States.

"A major goal of Farming Systems Research and Extension is the integration of social and biological disciplines for agricultural development work in interdisciplinary research. This study reports on current FSR projects, highlighting methodological and theoretical advances in the applications of social science research in agricultural improvements. The contributions to this volume demonstrate how social science research has been applied to identify the causes of complex problems in technology change through a mixture of economic, social, and structural

investigations. By providing examples, this research demonstrates how these problems can be identified and resolved within the framework of ongoing projects." [from Summary]

Lightfoot, C.; Minnick, D.R. 1990. Farmer-first qualitative methods: farmer's diagram for improving methods of experimental design integrated farming systems. Paper presented at the 10th annual AFSRE Symposium "The Role of Farmers in FSRE and Sustainable Agriculture", October 14-7, 1990. State University, Michigan, United States.

McCracken, J.A.; Pretty, J.N.; Conway, G.R. 1989. An introduction to rapid rural appraisal for agricultural development. International Institute for Environment and Development, London, United Kingdom.

"This introductory document is neither a detailed exposition nor a 'cookbook'. It is intended rather to supply sufficient information so that development workers can judge the likely usefulness of an RRA approach in their projects and programmes, and select the techniques most appropriate to their needs and resources." [from Preface]

Molnar, J.J.; Duncan, B.L.; Hatch, L.U. 1987. Fish in the Farming System: Applying the FSR Approach to Aquaculture. In: Schwarzweller, H.K. (editor). Research in Rural Sociology and Development - A Research Annual. Volume 3. Third World Contexts. Jai Press Inc., London, United Kingdom.

"The purpose of this paper is to explore the role of aquaculture in the farming system and its relevance for aquacultural development. We will review the origins and fundamental precepts of the farming systems approach. One objective will be to attempt to apply the FSR model to the practice of aquacultural development. Aquacultural technology is examined in terms of indigenous knowledge systems and the unique institutional and infrastructural requirements of fish farming... Finally, we consider the major stages in the FSR process, identifying the special needs and characteristics of fish farming which must be considered in undertaking an FSR approach to aquacultural development." [from article]

Posey, D.A.; Frechione, J.; Eddins, J.; Francelino-Da-Silva, L.; Myers, D.; Case, D.; MacBeath, P. 1984. Ethnoecology as Applied Anthropology in Amazonian Development. Human Organization 43(2):95-107.

"Social and ecological devastation in Amazonia necessitates alternative strategies for sustained, ecologically sound development. The study of indigenous ecological knowledge (ethnoecology) is shown to offer the bases for these new strategies. Six categories of folk knowledge are explored: gathered products, game, aquaculture, agriculture, resource units, and cosmology. A set of recommendations for systematic ethnoecological research is offered, the application of which will not only identify new categories of resources, but also offer alternative

resource management strategies to bring the benefits of development to all residents of Amazonia." [Abstract]

Rocheleau, D.E. 1991. Participatory research in agroforestry: learning from experience and expanding our repertoire. Agroforestry Systems 15(2-3):111-137.

Sands, B.N. 1989. Agricultural Decision-Making under Uncertainty: The Case of the Shanxi Farmers, 1931-1936. Explorations in Economic History 26(3):339-359. [Department of Economics, University of Arizona, Arizona, United States]

"The farmers of Shanxi province in China rapidly adopted cotton as a cash crop in the 1920s, but their material well-being was still considered very poor by observers. Had access to product markets made them worse off by adding another element of risk to that already faced by food producers? Three models of behavior toward risk and net return (maximizing expected utility, safety-first, and acceptable risk) are estimated on annual data for 36 counties in the years 1931-1936 and compared using the Cox-Pesaran-Deaton test. The safety-first model is found to dominate the other two. The implication is that alternative means for risk avoidance were absent in Shanxi province so farmers did not take full advantage of their commercial opportunities." [Abstract]

Shahabuddin, Q.; Mestelman, S.; Feeny, D. 1986. Peasant Behaviour towards Risk and Socio-Economic and Structural Characteristics of Farm Households in Bangladesh. Oxford Economic Papers, N.S. 38(1):122-130.

Sutherland, A. 1987. Sociology in farming systems research. Agricultural Administration Unit Occasional Paper 6. Overseas Development Institute, Regent's College, London, United Kingdom.

This book argues for a systematic incorporation of a sociological perspective into FSR, and offers some guidelines and methodologies as to how this could be achieved.

UNEP. 1986. Environmental Guidelines for Farming Systems Research. UNEP Environmental Management Guidelines, No. 12. United Nations Environment Programme, Nairobi, Kenya.

"[Chapter Two] will briefly describe what FSR is and how it differs from more traditional agricultural research programmes. Chapter Three discusses both the positive and negative potential impacts of FSR upon the environment. Chapter Four provides guidelines for an FSR research programme which emphasizes the positive potential impacts of FSR upon the environment and attempts to identify measures that could minimize the negative." [from Introduction]

Voss, J. 1989. Integrating social science research into the development and testing of new agricultural technology: the case of CIAT's Great Lakes Bean Project. In: Groenfeldt, D.; Moock, J.L. (editors). Social science perspectives on managing agricultural technology. International Irrigation Management Institute, Colombo, Sri Lanka.

"This paper illustrates the effectiveness of integrating social science research into an interdisciplinary project, combining on-farm and on-station research, to enhance bean production in the Great Lakes region of central Africa. Emphasis is placed on the role of on-farm research in general, and social science research in particular, in setting research priorities and devising ways of testing and transferring technologies." [from article]

Wijkstrom, U.N. 1988. A socio-economic survey on fish-farmers in rural communities. Report prepared for the Aquaculture for Local Community Development Programme. FAO/FI/GCP/INT/436/SWE-2. Food and Agriculture Organization of the United Nations, Rome, Italy.

An account is given of the activities conducted during socio-economic surveys of fish farmers in rural communities in Zambia. Recommendations of the project for follow-up are included.

Wijkstrom, U.N.; Aase, H. 1988. Fish-farmers in rural communities: Evaluation of questionnaires and survey routines used during a pilot survey in the northern province of Zambia (October 1987). Report prepared for the Aquaculture for Local Community Development Programme. FAO FI/GCP/INT/ 436/SWE.4. [FAO/UN, Rome, Italy]

An examination is made of the procedures and questionnaires used during a pilot survey conducted in the Northern Province of Zambia in October 1987 to investigate the current status of fish culture in the region. Modifications for improvement are suggested indicating how they can be incorporated into the full scale survey. Recommendations are included in order to ensure that a full scale survey would provide more accurate results than the pilot survey.

TECHNICAL APPENDIX:
GENETIC IMPROVEMENT AND CONSERVATION

Aquaculture

Allendorf, F.W.; Phelps, S.R. 1980. Loss of Genetic Variation in a Hatchery Stock of Cutthroat Trout. Transactions of the American Fisheries Society 109:537-543. [Department of Zoology, University of Montana, Missoula, Montana, United States]

"We have detected significant reduction in genetic variation at isozyme loci in a hatchery stock of west-slope cutthroat trout (*Salmo clarki*) in comparison to the wild stock from which it was derived 14 years earlier. This conclusion is supported by (1) a 57% reduction in the proportion of polymorphic loci, (2) a 29% reduction in the average number of alleles per locus, (3) a 21% reduction in the average heterozygosity per individual, and (4) significant changes in allelic frequencies between age-classes. This loss of variation is attributed to both a limited number of founders of the hatchery stock and the effects of genetic drift in the maintenance of the hatchery stock." [Abstract]

Cataudella, S.; Crosetti, D. 1993. Aquaculture and Conservation of Genetic Diversity. In: Ruddle, R.S.V.; Rosenthal, H.; Maclean, J.L. (editors). Environment and Aquaculture in Developing Countries. International Center for Living Aquatic Resources Management, Manila, Philippines. [Biology Department, University of Rome, Rome, Italy]

"The history of aquaculture genetics and the effects of aquaculture on natural aquatic genetic resources are summarized. Modern approaches to fish genetic characterization are discussed. Fish gene pools and genetic impoverishment in fish populations are reviewed with reference to environmental change, the effects of capture fisheries and enhanced fisheries, introduction of exotic species and hybridization. The conservation of fish genetic resources is considered extremely important and approaches to ex situ conservation are discussed, together with examples of international, regional and national efforts." [Abstract]

Chevassus, B.; Coche, A.G. (editors). 1987. Report of the symposium on selection, hybridization and genetic engineering in aquaculture of fish and shellfish for consumption and stocking. Bordeaux, France 27-30 May, 1986. EIFAC Technical Paper 50. Food and Agriculture Organization of the United Nations, Rome, Italy.

"The European Inland Fisheries Advisory Commission (EIFAC) organized a symposium on the new developments in aquaculture genetics of fish and shellfish from 27 to 30 May 1986 in Bordeaux, France.

There were six consecutive technical sessions during which the various topics were introduced and discussed. These topics referred to the genetic bases of species improvements, selective breeding, hybridization, genetic manipulations, and large-scale breeding programmes.

A series of recommendations were made concerning each of the main topics. They included the protection of natural gene pools, further studies of the temporal variability in gene frequencies, the development of better multidimensional techniques and more practical techniques of genetic engineering, the utilization of available means of sex control in the evaluation of exotics, and the incorporation of such methodologies as a component of the introduction protocols now being developed. The available knowledge in aquaculture genetics should be more widely applied to commercial fish farming." [Abstract]

Cross, T.F.; King, J. 1983. Genetic Effects of Hatchery Rearing in Atlantic Salmon. Aquaculture 33:33-40. [Salmon Research Trust of Ireland, Farran Laboratory, Newport, Ireland]

"Six polymorphic enzyme loci were examined electrophoretically in a sample of wild Atlantic salmon smolts from the Burrishoole river in western Ireland and in samples of artificially-reared fry hatched in 1981 and parr hatched in 1979. These hatchery reared fish were the progeny of five generations of artificially reared sea ranched salmon which had originally come from the Burrishoole river. Selection for growth and disease resistance was practised and between ten and 30 females and similar numbers of males were used as parents in each generation. Gene frequencies differed significantly at a number of loci between the wild and the artificially reared samples. Erosion of genetic variability, as measured by mean heterozygosity and mean number of alleles over the six loci, was evident in both hatchery reared samples. It is argued that the observed genetic changes are caused by founder effects and genetic drift rather than selection by some aspects of the artificial rearing regime. The importance of using adequate numbers of parents in hatchery rearing is stressed, since it is shown that differences between wild and reared populations are as great as between natural populations from Irish rivers." [Abstract]

Crozier, W.W. 1994. Maintenance of genetic variation in hatchery stocks of Atlantic salmon, *Salmo salar* L.: experiences from the River Bush, Northern Ireland. Aquaculture and Fisheries Management 25:383-392. [Department of Agriculture for Northern Ireland, Aquatic Sciences Research Division, Fisheries Research Laboratory, Coleraine, Northern Ireland]

"An examination of biochemical-genetic variation at seven polymorphic loci was carried out among five year classes of wild Atlantic salmon, *Salmo salar* L., in the R. Bush and in a hatchery strain derived from the wild population. Within some of the year classes, gene frequencies at several loci differed significantly between wild and artificially reared salmon. Highly significant temporal variation in gene frequencies was detected among successive year classes of the hatchery strain, while this was less significant among the wild salmon. Samples of wild salmon taken as 0+ and 1+ parr in the river showed no significant temporal variability in allelic frequencies. Heterozygosity levels among the wild and hatchery-reared salmon were comparable, averaging 0.185 and 0.176 respectively. The genetic variability of the artificially reared salmon is discussed in relation to numbers of broodstock and breeding regime used at the hatchery." [Abstract]

Das, P.; Jhingran, A.G. (editors). 1989. Fish genetics in India. Proceedings of the Symposium on Conservation and Management of Fish Genetic Resources of India, Allahabad, India. Current Trends in Life Sciences 15.

Doyle, R.; Newkirk, G. 1988. A new net on ancient waters. World Aquaculture 19(3):13-15. [Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada]

Details are given of activities conducted by the International Development Research Centre regarding the genetic improvement of fish stocks. The network links aquaculture projects in Asian countries with each other and also with Dalhousie University in Canada in order to produce strains of fish which grow much faster and which are disease resistant. Progress made in current projects in China, Indonesia, Philippines and Thailand is summarized. Techniques developed at Dalhousie University and their applications to the Asian projects are also outlined briefly.

Doyle, R.W. 1983. An approach to the quantitative analysis of domestication selection in aquaculture. Aquaculture 33:167-185.

"Domestication selection is defined as natural selection on traits which affect survival and reproduction in a human-controlled (domestic) environment. By altering various aspects of the environment, domestication selection can be made to augment or oppose artificial selection on traits of commercial importance. A quantitative, analytical framework based on multiple regression is presented. The analytical techniques are illustrated with five examples of controllable selection in aquaculture environments:
(1) Selection on growth associated with fertility variation in *Salmo trutta* fed at different ration levels.
(2) Selection on growth in *Macrobrachium rosenbergii* associated with variable development rate and age-at-harvest.
(3) Selection on growth as it is influenced by the interaction between fertility and development rate in a continuously re-stocked population (*Gammarus lawrencianus*).
(4) Selection on growth caused by size-selective mortality in juvenile lobsters (*Homarus* spp.).
(5) Selection on growth confounded by phenotypic effects associated with stocking density (stunting) in *Pleuronectes platessa*.

In each of the examples the selection differential is, or can easily be made to be, comparable to the intensity of artificial selection. Although genetic changes classifiable as domestication are known in aquaculture, the selection which causes it has not previously been analyzed quantitatively. It is concluded that management procedures can have strong selective effects and that genetic changes (for good or for ill) may be expected to rapidly if the obvious genetic conditions are met." [Abstract]

Doyle, R.W.; Talbot, A.J. 1986. Effective population size and selection in variable aquaculture stocks. Aquaculture 57:27-35. [Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada]

"Effective population size and inbreeding rates are derived in terms of the variability of brood-stock replacement; the parameters are more useful for extensive aquaculture than the usual formulation. It is shown that response to mass selection may improve if variability in birth date and age is reduced by weight-specific rather than age-specific selection for growth rate. Current studies on domestication selection in Asia suggest that traditional broodstock management may be causing stocks to deteriorate." [Abstract]

Edds, D.R.; Echelle, A.A. 1989. Genetic Comparisons of Hatchery and Natural Stocks of Small Endangered Fishes: Leon Springs Pupfish, Comanche Springs Pupfish, and Pecos Gambusia. Transactions of the American Fisheries Society 118:441-446. [Department of Zoology, Oklahoma State University, Stillwater, Oklahoma, United States]

"We used starch gel electrophoesis to assay 24-28 presumptive gene loci in captive and natural populations of three species of endangered fishes held in the Dexter (New Mexico) National Fish Hatchery. The species included two cyprinodontids, the Leon Springs Pupfish *Cyprinodon bovinus* and Comanche Springs pupfish *C. elegans*, and a poeccc, the Pecos gambusia *Gambusia nobilis.* Hatchery stocks had been founded with 30-80 wild fish and subsequently held in captivity for 6-8 years in 0.1-0.2 hectare ponds where spawning has occurred spontaneously. Heterozygosity and polymorphism of the hatchery stocks were similar to those of the populations from which they were derived. However, the captive populations apparently had lost some rare alleles, probably due to the small sizes of the founding populations. Managers should avoid complacency with small species that spawn spontaneously in hatcheries and, superficially, seem to require little special attention. Minimum requirements for management of such species include initiating captive stocks with hundreds of individuals from natural populations, monitoring genetic status and population size of captive stocks, and, where possible, periodically moculating genetic material from natural populations" [Abstract]

Eknath, A.E. 1990. A review of carp genetic research and possible approaches to genetic improvement of Asian carps. In: Hirano, R.; Hanyu, I. (editors). Proceedings of the Second Asian Fisheries Forum, Tokyo, Japan, 17-22 April 1989. The Asian Fisheries Society, Manila, Philippines. [ICLARM, Manila, Philippines]

"Currently available information on all aspects of genetics relevant to improving the production efficiency of carps under various farming systems is reviewed...With the virtual closure of the life cycle of many of these carps within the culture environments and a rapid increase in artificial propagation, there is a need to monitor scientifically the broodstock management practices and possible genetic changes taking place in the cultured stocks... National breeding and selection programs should start sequentially by first documenting the amount and distribution of genetic variability within the species concerned; identification and estimation of genetic parameters for economically important traits such as growth rate, survival, maturity and disease resistance; identification and proper definition of present and future breeding objectives taking into consideration the anticipated technological developments in culture systems; and then make decisions concerning the choice of appropriate breeding and selection strategies." [Abstract]

Fletcher, G.L.; Davies, P.L. 1991. Transgenic Fish for Aquaculture. In: Setlow, J.K. (editor). Genetic Engineering, Vol. 13. Plenum Press, New York, United States. [Memorial University of Newfoundland, St. John's, Newfoundland, Canada]

"This review focuses on the technology currently being applied to produce transgenic fish, fish containing novel gene constructs that were experimentally introduced into their genome. A number of excellent overviews on this subject have been published in recent years (1-5). Thus rather than repeat what has already been well stated we have, where possible, attempted to examine critically the published results in order to determine the factors that have or have not been established as being important to the efficient production of stable lines of transgenic fish. We hope that this exercise will be useful to researchers currently applying, or contemplating applying, transgenic technology to fish, and that it will assist all of us in the design of experiments that will enable the production of transgenic fish to be as successful as the production of transgenic mice." [from Introduction]

Hallerman, E.M.; Kapuscinski, A.R. 1992. Ecological implications of using transgenic fishes in aquaculture. In: Sindermann, C.; Steinmetz, B.; Hershberger, W. (editors). Introductions and Transfers of Aquatic Species. Selected papers from a Symposium held in Halifax, Nova Scotia, 12-13 June 1990. ICES marine Science Symposium 194:56-66. [Virginia Institute and State University, Blacksburg, Virginia, United States]

"The development of gene transfer as a means of improving cultured fish stocks is progressing rapidly, and use of transgenic fish in aquaculture seems possible within the next decade. It is likely that some transgenic individuals will escape into natural systems; the nature and extent of subsequent impacts upon native stocks and aquatic communities are presently unknown. In this review, we identify likely mechanisms of ecological impacts and key gaps in knowledge needed to predict the extent of ecological risk associated with using transgenic fishes in aquaculture." [from Abstract]

Hew, C.L.; Fletcher, G.L. (editors). 1992. Transgenic Fish. World Scientific Publishing Co. Pte. Ltd., Singapore.

"The monograph is divided into three sessions. The first session on oogenesis, models, gene transfer and detection techniques opens a brief description of the embryology of a model teleost, the desert pupfish. This is followed by two chapters (chapter 2 and 3) on the various approaches in gene transfer which includes direct injection, injection via the microphyle and electroporation. Chapter 4 and to a lesser extent, chapter 10 includes details of polymerase chain reaction strategies used for the detection of transgenesis, a technique which has greatly enhanced the sensitivity and ease of detection. Chapter 5 illustrates the attractive features of the Japanese medaka as a model fish for transgenic studies. Although not included in this monograph, the zebrafish shares many common features with the medaka. The second session focuses on transgene inheritance and expression. Chapters 6 to 10 summarize recent research results from a

wide variety of fish species with major emphasis on growth hormone gene transfer... Chapter 11 is a summary for antifreeze protein gene transfer...

The farming of transgenic fish has raised many questions concerning their ecological impact due to accidental release. The final two chapters discuss these issues in terms of safety precautions, guidelines and methods of containment. Several approaches to sterilize transgenic fish are suggested." [from Preface]

Hindar, K.; Ryman, N.; Utter, F. 1991. Genetic effects of cultured fish on natural fish populations. Canadian Journal of Fisheries and Aquatic Sciences 48:945-957. [Norwegian Institute for Nature Research, Trondheim, Norway]

"This paper addresses the genetic consequences of aquaculture on natural fish populations. The study is motivated by rapidly increasing numbers of intentionally and accidentally released fish and is based on empirical observations reported in the literature. A wide variety of outcomes, ranging from no detectable effect to complete introgression or displacement, has been observed following releases of cultured fish into natural settings. Where genetic effects on performance traits have been documented, they always appear to be negative in comparison with the unaffected native populations. These findings are consistent with theoretical considerations of the implications of elevated levels of gene flow between cultured and locally adapted natural populations; they raise concerns over the genetic future of many natural populations in the light of increasing numbers of released fish. Strategies for the genetic protection of native populations from the effects of aquaculture are outlined including more secure containment, the use of sterilized fish, and modifying the points of rearing and release. We recommend strong restrictions on gene flow from cultured to wild populations and effective monitoring of such gene flow." [Abstract]

Hynes, J.D.; Brown, Jr., E.H.; Helle, J.H.; Ryman, N.; Webster, D.A. 1981. Guidelines for the Culture of Fish Stocks for Resource Management. Canadian Journal of Fisheries and Aquatic Sciences 38:1867-1876. [Ministry of Natural Resources, Toronto, Ontario, Canada]

"Examples of desired genetic changes produced in fish by selective breeding are contrasted with those of unintentional and often harmful genetic changes resulting from artificial propagation over prolonged periods, e.g. reduced longevity and reduced temperature tolerance. Evidence for undesired effects caused by the hatchery environment on captive fish stocks is also presented. e.g. precocity, inappropriate feeding behavior, and the risks posed by artificial rearing techniques are discussed. Methods for identifying both genetic and environmentally induced changes are outlined along with experimental designs for distinguishing between them. Some practical recommendations are offered for establishing, developing, and maintaining brood stocks in hatcheries and for managing wild fish populations in ways that maximize genetic variability while avoiding the occurrence of undesirable changes. Adherence to the recommended procedures will improve progress in fisheries rehabilitation efforts." [Abstract]

Lannan, J.E.; Gall, G.A.; Thorpe, J.E.; Nash, C.E.; Ballachey, B.E. 1989. Genetic resource management of fish. Genome 31:798-804. [Department of Fisheries and Wildlife, Oregon State University, Hatfield Marine Science Center, Newport, Oregon, United States]

"The diverse global ichthyofauna represents a wealth of genetic resources for adaptive evolution, for the development and harvest of present and future sources of human foods, and for germ plasm for aquaculture. Fish make an important contribution to human nutrition worldwide and the demand for fisheries products is increasing. Several production systems are employed in producing and harvesting fisheries products, including capture fisheries, aquaculture, and culture-based fisheries. There are risks of losing genetic variation inherent in each production system. However, genetic considerations are not widely applied to the management of fisheries. It is imperative that global strategies for the conservation of fish genetic resources be developed and implemented to ensure the richness of diversity for future generations." [Abstract]

Li, S. 1990. Genetic evaluation of Chinese carps. Ambio 19(8):411-415. [Department of Aquaculture, Shanghai Fisheries University, Shanghai, China]

"This paper describes the major results of qualitative and quantitative genetic variation of wild and hatchery populations of Chinese carps (silver carp, bighead and grass carp). There is an obvious intraspecific divergence in morphometric characters among populations of these fishes from major Chinese rivers. Biochemical genetic variations among different populations of silver carp, bighead, and grass carp in the different river systems have been found. The range of average heterozygosity is 0.0484 - 0.0511 for silver carp, 0.1042 - 0.1133 for bighead, and 0.0454 - 0.1076 for grass carp. The range in proportion of polymorphic loci is 11.8 - 23.5% for silver carp, 29.4% for bighead, 20.0 - 33.3% for grass carp. The populations in the south have a higher proportion of polymorphic loci than those in the north. In the same cultivation environment, the growth of silver carp and bighead from the Changjiang River is 5 - 10% faster than those from the Zhujiang River. Similarly, the growth of the wild population of silver carp and bighead is only 5 - 10% higher than those from hatchery populations. The study shows that genetic factors have a great effect on growth variation. In the same cultivation environment, silver carp and bighead from Changjiang and Zhujiang Rivers reach maturity at the same time. Environmental factors have a major effect on their gonadal development and sexual maturity age. The results from this study have formed a guide to genetic conservation, selection and culture of Chinese carps." [Abstract]

MacLean, N.; Penman, D. 1990. The Application of Gene Manipulation to Aquaculture. Aquaculture 85:1-20. [Department of Biology, Southhampton University, Southhampton, United Kingdom]

"Both finfish and shellfish are very suitable types of animals to use in terms of the introduction of novel genes into their genomes (transgenic induction). Genetic manipulations involving gynogenesis, androgenesis, triploidy, and sex reversal are already established, and future applications of DNA manipulations may well include population studies by DNA analysis and genetic tagging prior to release.

Methods for the production of transgenic fish are considered and success to date with rainbow trout, Atlantic salmon, tilapia, channel catfish, medaka, zebrafish, goldfish, carp and loach is discussed. Transgenic induction techniques normally involve injection of cloned copies of the appropriate gene into the cytoplasm of the fertilized egg by microinjection. Ways of assaying for integration, expression and germ line transmission are reviewed.

Candidate genes for transgenic induction in fish include those coding for somatotropin (growth hormone), somatotropin release factor, metallothionein, 'antifreeze' proteins, crystallin, esterases, and disease resistance factors (when available); useful promoter sequences include metallothionein, heat shock and those of other tissue-specific genes. The use of genes and promoters from piscine rather than mammalian sources will probably be advantageous both for effective expression and the market image of the product.

Transgenic fish are also considered as potential expression systems for pharmaceutical products, and problems of containment and planned release are discussed." [Abstract]

Maitland, P.S.; Evans, D. 1986. The role of captive breeding in the conservation of fish species. International Zoology Yearbook 24-25:66-74. [Institute of Terrestrial Ecology, Edinburgh, Scotland]

"The exact number of fish species occurring in the world is uncertain for not only are there many species yet to be discovered but others are undergoing extinction. It is likely that there are about 2500 living species of fishes included in some 450 families - indeed there are probably more fish in the world than all other vertebrates combined. The objective of this paper is to review the need for the conservation of fish species - both freshwater and marine - and discuss the contribution which captive breeding is making or could eventually make to this process." [from article]

McAndrew, B.J.; Rana, K.J.; Pennan, D.J. 1982. Conservation and preservation of genetic variation in aquatic organisms. In: Muir, J.F.; Roberts, R.J. (editors). Recent advances in aquaculture IV. Blackwell Scientific Publications, Oxford, United Kingdom.

"In this paper the recent literature regarding genetic conservation will be reviewed with regard to aquaculture and gene banking. In particular, we will illustrate how recent advances in cryopreservation and genetic manipulation can be used to overcome some of the present problems of genetic conservation. Finally, we discuss the role of genetic manipulation in controlling the contamination of wild stocks by released hatchery products." [from Introduction]

McGregor Reid, G. 1990. Captive breeding for the conservation of cichlid fishes. Journal of Fish Biology 37(Supplement A):157-166. [Natural History Department, Horniman Museum and Public Park Trust, London, United Kingdom]

"Cichlid fishes are by far the largest familial group of endangered vertebrates, especially the haplochromines. This paper concerns the organization and management of captive breeding of haplochromine cichlids. The setting up of a small-scale laboratory programme for the

conservation of endangered species is described in terms of funding, staffing, installation and livestock husbandry. Breeding is discussed in the context of the selection of broodstock, basic reproductive biology, rearing, disease, pathological disorders and the arrangements necessary for the transfer and documentation of progeny. There are already indications in Africa and elsewhere that the dramatic decline and demise of cichlid taxa in Lake Victoria will not be an isolated phenomenon. There is no prospect that the captive breeding of cichlids can alone resolve such large-scale problems in fisheries management and ecology, or prevent the loss of taxa in nature. Nevertheless, captive breeding provides conservation options which are otherwise limited or unavailable regarding the saving of individual 'heritage' species, restocking to the wild, fundamental laboratory research and, finally, public education on the grave issue of actual and prospective mass extinctions of cichilds and other rare fishes." [Abstract]

Moav, R. 1979. Genetic Improvement in Aquaculture Industry. In: Pillay, T.V.R.; Dill, Wm.A. (editors). Advances in Aquaculture: Papers presented at the FAO Technical Conference on Aquaculture, Kyoto, Japan, 26 May - 2 June 1976. Fishing News Books Ltd., Farnham, United Kingdom.

"Selective breeding and supporting genetic research in aquaculture troughout the world are reviewed, including: intra-population selection (including selection for disease resistance and behaviour characters), biometrical analysis of quantitative characters, intraspecific hybridization, inter-specific hybridization including sterile and monosex hybrids, genotype * environment interactions, genetic markers as tools in aquacultural genetic research and breeding, gynogenesis, polyploidy and mutagenesis. This review reveals that adequate genetic studies have not been undertaken, even with the most extensively studies fish such as common carp and trout." [from Abstract]

Morse, D.E. 1983. Biochemical and genetic engineering in marine aquaculture: The role of modern biotechnology in the production of food from the oceans. Proceedings Oceans '83. Effective Use of the Sea: An Update. San Francisco, August 29 - September 1, 1983. Volume 2: Technical papers. Mineral Resources and Energy, Non-Mineral Resources, Transportation.

Intensification of production, modernization of techniques, and improvement of cultivars are needed to increase the economic efficiency of marine aquaculture industries in the United States and many other countries, to make these industries compatible with contemporary economic reality. Recently developed methods of biochemical and genetic engineering can be adapted for control of those biological processes which intrinsically limit the efficiency and yield of aquaculture production, to help achieve these necessary improvements. As illustrated by results obtained with abalones and other commercially valuable marine molluscs described here critical life-cycle stages which thus far have proved amenable to improved control by these methods include: reproduction, larval settlement, metamorphosis, and the acceleration of early growth.

Padhi, B.K.; Mandal, R.K. 1994. Improper fish breeding practices and their impact on aquaculture and fish biodiversity. Current Science 66(9):624-626. [Department of Biochemistry, Rose Institute, Calcutta, India]

"Unfortunately, in India, in lieu of genetic improvement of fish stocks, the faulty breeding practices like mixed spawning, use of low number of spawners for breeding without considering the ratio of male and female breeders are practiced in carp hatcheries. The thoughtless and unjudicious ways of fish breeding are likely to affect the 'gene pools' of these prized food fishes badly. The possible adverse effects of these empirical breeding practices are focused here." [from article]

Philippart, J.C. 1995. Is Captive Breeding an Effective Solution for the Preservation of Endemic Species? Biological Conservation 72:281-295. [Zoological Institute, University of Liege, Liege, Belgium]

"Captive breeding and the release of captive-bred individuals into the wild are among the techniques used for the conservation of rare and endangered fish species. After a brief description of the methods of captive breeding and the establishment of breeding stocks, this paper provides examples of the application of these techniques to endemic fish species of arid regions in south-western USA and examines some current cases and the future possibilities for their use in the Mediterranean region. Special attention is given to the analysis of the strict constraints imposed on fish breeding for conservation purposes, in which the aim is to produce fish with all the morphological, behavioural and genetic characteristics of the taxa to be conserved, and which are capable of effectively adapting to the natural environment when introduced. In terms of genetic management of captive populations, the fundamental problems which are faced involve the categorization of the species-resources to be conserved (identification of cases of inter- and intra-specific introgression), the establishment of founder stocks that contain the maximum genetic diversity depending on the genetic structure of the species (strong intra- or interpopulation variability), and the retention of genetic variability during captive breeding (the need to reduce to the minimum the phenomena of genetic drift, inbreeding and unintentional selection of non-adapted genotypes). Because of these difficulties and risks in terms of genetic conservation, captive breeding should remain a temporary safeguard measure, while awaiting the implementation of measures for protecting species in their restored original habitat or translocation to strictly protected substitute habitats. With this aim in view and in conclusion, the paper suggests methods for organizing a critical plan to safeguard the most endangered species or subspecies in the Mediterranean region by captive breeding." [Abstract]

Ryman, N. 1991. Conservation genetics considerations in fishery management. Journal of Fish Biology 39(Supplement A):211-224. [Division of Population Genetics, Stockholm University, Stockholm, Sweden]

"This paper discusses three aspects of genetic conservation relating to fishery management and fish culture, namely (1) the goal for conservation (what to conserve), (2) a guideline for assessing acceptable levels of gene flow among populations, and (3) the effect on the genetically

effective population size resulting from stock enhancement. *Goal for conservation*: The goal for genetic conservation is to maintain genetic variability between and within populations. It has been suggested recently, as an alternative to that goal, that in the context of fisheries management conservation should strive at maintaining the variance or the distribution of fitness. The characteristics of this model are discussed from the perspective of population genetics. It is concluded that although the fitness approach may appear attractive it is not compatible with the more general objective of maintaining genetic diversity between and within populations. *Acceptable levels of gene flow*: A tension exists between the need for protection of natural fish populations and the rapidly expanding levels of aquaculture causing increased migration into those populations. Guidelines are needed for assessing levels of introgression that are acceptable in the context of genetic conservation. To avoid unrealistically restrictive recommendations it is suggested that acceptable levels of introgression are related to those occurring naturally. It is argued that assessments of acceptable levels of introgression should be made on the basis of spontaneously occurring gene flow estimated from genetic data using parameters such as Fst, or similar ones. *Stock enhancement and effective size*: In the context of genetic conservation previously published recommendations on stocking have focused on the need to identify the genetic structure within the region in question to ensure that the appropriate population is targeted for propagation and release. There is, however, an additional aspect that appears to have been largely unrecognized: the reduction of the genetically effective size of the total population that may result from breeding release programmes aimed at supporting wild stocks. The details of this problem are introduced and discussed." [Abstract]

Saint-Paul, U. 1989. Indigenous species promise increased yields. Naga, The ICLARM Quarterly 12(1):3-5. [Universitat Hamburg, Hamburg, Germany]

In the recent past, aquaculture has gained attention in Latin America as traditional sources of fish become limited. This article presents a discussion of different species suited to farmed production on the basis of biology - adaptations to oxygen depletion, artificial reproduction, and nutrition and growth. In conclusion, the feasibility of this activity is discussed in terms of potential ecological problems and the needs of the people.

Tave, D. 1993. Genetics for Fish Hatchery Managers. An AVI Book, Van Nostrand Reinhold, New York, New York, United States.

"The book is divided into six chapters: an introduction; a brief review about how genes are transmitted from generation to generation, coupled with a brief discussion about sex determination; the genetics and management of qualitative phenotypes, such as body color; the genetics and management of quantitative phenotypes, such as weight; non-traditional genetics, such as the production of sex-reversed broodstock, chromosomal manipulation, and genetic engineering; and a final chapter on how to incorporate the ideas that have been discussed into broodstock management." [from Preface]

Wohlfarth, G.W. 1994. The unexploited potential of tilapia hybrids in aquaculture. Aquaculture and Fisheries Management 25:781-788. [Agricultural Research Organization, Fish and Aquaculture Research Station, Dor D.N. Hof Hacarmel, Israel]

"Hybridization between tilapia species, to produce all-male broods, was at one time considered a promising method to prevent uncontrolled reproduction (Hicking 1963). It has been tested with a number of tilapia species, but most attempts at large-scale hybrid production did not succeed. The major reason for this failure is the instability in production of all-male hybrids. Sooner or later the system broke down, and the females began to appear in increasing proportions among progenies which, up to then, had all been male. It appears that this breakdown is largely due to the infiltration of parental broodstock by individuals of a different genotype, predominantly hybrids between the two species involved, which are difficult to distinguish from their parents. This problem may be solved by a careful examination of the broodstock, often including thousands of individuals, and culling doubtful cases. It requires trained and permanent personnel. Hybridization has been largely superseded by hormonal sex inversion as a method of producing all-male tilapias. In this paper, the two methods are considered as alternatives, if problems of broodstock purity are solved. Establishing a pilot scheme for hybrid tilapia production is recommended." [Abstract]

Wohlfarth, G.W.; Moav, R. 1991. Genetic testing of common carp in cages. 1. Communal versus separate testing. Aquaculture 95(3-4):215-223. [Agricultural Research Organization, Fish and Aquaculture Research Station, Dor D.N. Hof Hacarmel, Israel]

"Relative growth rates of different genetic groups of common carp were tested simultaneously in cages stocked with a given genetic group (separate cages), and in cages stocked communally with samples of different genetic groups. The results of three tests are described. A clear association between relative growth of different progenies, in communal and separate testing, was found in one of these tests. ...We suggest that, in cages, results from the convenient method of communal testing may serve as reliable predictors for relative growth of different genetic groups in separate testing. This should be confirmed in further, similar investigations.

Previous tests in communally and separately stocked ponds generated a similar conclusion. On the other hand, genotype-environment interactions have been demonstrated when the same genetic groups were tested simultaneously in communal ponds and cages. This means that relative pond performance is not a reliable predictor for performance in cages, or vice versa.

Cage culture is presently under consideration as a commercial production method for common carp. The investigations described here indicate that performance testing for choice of genetic stock for cage operations needs to be carried out in cages and not in ponds. Large scale production in cages is carried out, or planned, with several fish species. Genetic testing for these operations is carried out largely in communal cages. The methodology of this testing method has been investigated only in common carp, by simultaneously testing of the same genetic groups in communal and separate cages." [Abstract]

Wu, C. 1990. Retrospects and Prospects of Fish Genetics and Breeding Research in China. Aquaculture 85:61-68. [Institute of Hydrobiology, Academia Sinica, Wuhan, China]

"In this paper, fish genetics and breeding research in China over the last decade are reviewed. It includes acclimatization, hybridization, gynogenesis, artificially induced polyploidy, somatic cell breeding and gene transfer. Two wild species, *Megalobrama amblycephala* and *Plagiognathops microlepis*, were acclimatized. Five carp hybrids of obvious vigour were widely applied to fish culture. After looking through the results of hybridization of distantly related combinations of Chinese freshwater fish, three factors causing incompatibility were determined. By means of artificial gynogenesis and sex reversal, three pure lines of carp were established. Using serial nuclear transplantation techniques, Chinese genetics obtained a 'tube fish'. A number of novel growth hormone gene transgenic fishes, including goldfish, common carp, mirror carp, loach, crucian carp, mud carp and blunt snout bream, have been produced. The novel gene has been clearly detected in adult and second generation samples." [Abstract]

Agriculture

Bezdicek, D.F. 1986. Biotechnology and farming systems: on-farm applications and consequences. Biotechnology in agriculture: implications for sustainability: symposium proceedings, March 1986, Washington, D.C. Institute for Alternative Agriculture, Inc., Greenbelt, Md., United States.

Brush, S.B. 1992. Reconsidering the green revolution: diversity and stability in cradle areas of crop domestication. Human Ecology 20(2):145-168. [Department of Applied Behavioral Sciences, University of California, Davis, California, United States]

"This paper reconsiders two widely held hypotheses about the effects of the green revolution, that it led to biological simplification and instability. The hypothesis of biological simplification (genetic erosion) is tested with evidence from Andean agriculture, where farmers maintain a significant degree of crop diversity even as they adopt modern crop varieties. The hypothesis of increased instability is tested with evidence from Asia where wheat and rice yields show no general pattern of increased instability. Neither of these hypotheses is confirmed. The conventional wisdom about the green revolution should be reconsidered with emphasis on resilience and variation in modernizing farming systems." [Abstract]

Brush, S. 1986. Genetic diversity and conservation in traditional farming systems. Journal of Ethnobiology 6(1):151-167.

Castillo, R.O. 1995. Plant Genetic Resources in the Andes: Impact, Conservation, and Management. Crop Science 35:355-360. [Departamento Nacional de Recursos Fitogeneticos y Biotecnologia, Instituto Nacional de Investigaciones Agropecuarias (INIAP), Quito, Ecuador]

"The Andean region harbors a variety of ecological niches including tropical mountains, Pacific coastal and Amazonian humid lowlands, and many intermediate microclimates. These areas contain a great diversity of crops and their wild relatives. Much of this diversity is

indigenous and much has been selected by man. This genetic diversity includes food plants and their wild relatives, in addition to medicines, condiments, colorants, and spices. Both great empires and small indigenous groups have used various plants over thousands of years. Unfortunately, many landraces and their wild relatives have disappeared and others are near extinction. Although many collecting expeditions and some research projects have been conducted on these plants, more funding is needed for germplasm collection and conservation. National programs of plant genetic resources have been formed in the Andean countries to preserve and maintain this diversity and develop additional research. Both the Andean countries and the whole world win benefit from the discovery and market development of indigenous food, medicine, and industrial crops. These new agricultural products can be an important economic resource in emerging world markets and international trade." [Abstract]

Chang, T.T. 1984. The role and experience of an international crop-specific genetic resources center. In: Conservation of crop germplasm - an international perspective. Crop Science Society of America, Madison, Wisconsin, United States.

Davies, J.C. 1991. Global support and coordination: conserving germplasm of world crop species and their relatives. Biological Journal of the Linnean Society 43(1):61-71.

"The awareness of the importance of plant biodiversity has been considerably raised in both developed and developing countries over the last decade. Some of the debate has not been helpful in fostering collaboration or progress towards a more rational support network. The paper attempts to identify and categorize existing efforts in operation in a wide range of institutions and bodies ranging from essentially environmentally oriented to crop-based organizations. Current funding and training initiatives are discussed." [Abstract]

Harlan, J.R. 1975. Our vanishing genetic resources. Science 188:618-621. [Agronomy Department, University of Illinois, Urbana, Illinois, United States]

This article begins with a discussion of crop evolution, land races and their genetic integrity, and gene centers. A brief historical overview is taken of genetic erosion and the beginnings of genetic resource conservation through plant-breeding programs. Events and actions within the FAO are outlined and national programs within the United States.

Hawkes, J.G. 1990. What are genetic resources and why should they be conserved? Impact of science on society, no. 158; 40(2):97-106. [School of Continuing Studies, University of Birmingham, Birmingham, United Kingdom]

"We are rapidly reaching a point where traditional agriculture will not be able to maintain the world's rapidly increasing population. The key to this problem is not to increase farming and grazing land at the expense of forests and semi-desert areas, but to improve agricultural technology on roughly the same farming areas.

This can be accomplished by better farming methods and by better varieties able to withstand the depredations of pests and diseases and more adapted to stress conditions such as heat, drought, salinity, etc. To produce such varieties plant breeders need genes for better resistance and adaptation. These are being found in conserved ancient farmers' varieties (or 'land-races') and related wild species." [Abstract]

Hindmarsh, R. 1991. The flawed "sustainable" promise of genetic engineering. The Ecologist 21(5):196-205.

"The use of genetic engineering in agriculture is now on the brink of widespread commercial application. The chemical corporations which control the development of the technology claim that genetic engineering will be a linchpin of sustainable agriculture. In fact, not only will it exacerbate the problems of conventional agriculture, but it will also undermine ecological methods of farming. Furthermore, numerous large-scale releases of genetically engineered organisms risk eroding genetic diversity and distorting natural ecological processes. The green movement should be demanding a halt to the research and development of all ecologically unsustainable aspects of genetic engineering." [Abstract]

Hodges, J. 1984. Review of the FAO/UNEP programme on animal genetic resources conservation and management. Animal genetic resource conservation by management: data banks and training. FAO Animal Production and Health Paper 44/1. Food and Agriculture Organization of the United Nations, Rome, Italy.

International Rice Research Institute. 1989. Rice farming systems: New directions. Proceedings of an international symposium 31 January - 3 February 1987, Rice Research and Training Center, Sakha, Egypt. International Rice Research Institute, Manila, Philippines.

Thirty-two papers examine how to improve the productivity, profitability, stability, and sustainability of rice farming systems, particularly in Egypt. Papers discuss Egyptian rice research; rice in Egyptian and global agriculture in 2000; new dimensions for genetic improvement in rice; strategies in rice crop management; new directions for rice farming systems; biotechnology and rice improvement; and postharvest technology and by-product uses for rice. Also examines recent accomplishments in rice research in Egypt.

Nabhan, G.P. 1985. Native crop diversity in Aridoamerica: conservation of regional gene pools. Economic Botany 39(4):387-399. [Office of Arid Lands Studies, University of Arizona, Tucson, Arizona, United States]

"Scholars have seldom considered the native crop diversity in northwest Mexico and the U.S. Southwest as resources of the same cohesive ecological and cultural region. The term Aridoamerica is introduced to describe this overlooked centre of plant domestication and diversification, which is distinct from centres of Mesoamerica and the Mississippi Valley. To

understand why certain of its landraces are unique, the systematic relationships and gene-pool relations of crops found prehistorically and protohistorically in Aridoamerica are reviewed. Significant crop/weed introgression continues where indigenous agriculture persists, but native fields are being rapidly abandoned or converted. In planning *in situ* and *ex situ* conservation efforts to maintain this diversity, both cultural factors and plant population genetics must be considered." [Abstract]

Plucknett, D.L.; Smith, N.J.H.; Williams, J.T.; Anishetty, N.M. 1987. Gene banks and the world's food. Princeton University Press, Princeton, New Jersey, United States.

"The first chapter, 'Gene Banks: A Global Resource,' provides the rationale for gene banks by outlining the dimensions of the world's growing population and the need to further boost agricultural productivity. ...In Chapter 2, 'Seeds in Due Season,' we explore the dynamic nature of modern farming by focusing on the rapid turnover or replacement of varieties...

The history of germplasm preservation and exchange, from botanical gardens to modern cold-storage units, is explored in the third chapter, 'Plant Collectors and Gene Banks'...

Principles guiding the modern collection and utilization of crop germplasm are covered in the fourth chapter, 'Gene Banks'...

In Chapter 5, 'Biotechnology and Genetic Resources', we outline recent advances in recombinant DNA technologies as they apply to agriculture...

The status and locations of gene banks are the focus of Chapter 6, 'Genes in the Bank', where we present the latest available information on germplasm holdings by crop...

...In Chapter 7, 'Gene Bank Dividends', we spotlight specific ways in which scientists draw material from germplasm collections to meet challenges to agricultural productivity, and we give examples of how gene banks have been tapped to upgrade pest and disease resistance and to mold crops to adverse soils and weather.

...The importance of wild species related to cultivated plants is thus highlighted in Chapter 8, 'Wild Species: The Wider Gene Pool'...

Chapter 9, 'A Case Study in Rice Germplasm: IR36', presents a close-up of how plant breeders and other agricultural scientists have collaborated in using rice genetic stocks to produce a successful high-yielding variety, one of a series in the 'green revolution'...

In the final chapter, 'Global Imperatives', we summarize how far germplasm conservation has come, and we outline future tasks..." [from Preface]

Plucknett, J.L.; Smith, N.J.H.; Williams, J.T.; Anishetty, N.M. 1983. Crop germplasm conservation and developing countries. Science 220:163-169. [Consultive Group on International Agricultural Research, The World Bank, Washington, DC, United States]

"Loss of genetic diversity of some of the world's crops has accelerated in recent decades, with many crops becoming increasingly susceptible to diseases, pests, and environmental stresses. A global network of gene banks has therefore been established to provide plant breeders with the genetic resources necessary for developing more resistant crops that will enable farmers to maintain high yields. Most of these gene banks now store the germplasm of only the major crops such as cereals, potatoes, and grain legumes. Cultivated varieties of these crops are conserved as

well as wild species that might otherwise become extinct. Tropical cash crops such as bananas and coconuts are also important food crops in many Third World countries, and more effort needs to be made to conserve the germplasm of these crops as well as of other important plants such as plantation crops, medicinal herbs, and fruit and timber trees." [Summary]

Prescott-Allen, R.; Prescott-Allen, C. 1983. Genes from the wild: using wild genetic resources for food and raw materials. Earthscan Publications Ltd., London, United Kingdom.

Chapter one of this book provides some definitions related to wild genetic resources. Chapter two discusses the contribution of these resources to the production of food and raw materials, giving examples of some of crop and livestock resources. Chapter three discusses the benefits of, the types used, and the future of wild genetic resources. Chapter four discusses where the wild genes are found and who it is that uses them. Chapter five discusses threats to these resources and chapter six discusses their conservation.

Vaughan, D.A.; Chang, T.-T. 1992. In Situ Conservation of Rice Genetic Resources. Economic Botany 46(4):368-383.

"The diversity of rice conserved ex situ is impressive from both cultivated and wild species. However, to ensure the genetic base of one of the world's most important crops, a sound, complementary in situ conservation of rice genepools is necessary. This paper reviews habitat destruction, loss of traditional rice germplasm and limitations to ex situ conservation. Examples of in situ conservation of rice genepools are given based on the literature, herbarium specimens, as well as personal experience of the authors. Proposals for ways to enhance efforts to conserve these genetic resources in situ are given including priority setting, design, management and monitoring in situ conservation sites. The need to harmonize such efforts, particularly with local needs and national priorities in conservation, is stressed." [Abstract]

Villalobos, V.M.; Ferreira, P.; Mora, A. 1991. The use of biotechnology in the conservation of tropical germplasm. Biotechnol. Adv. 9(2):197-215.

The rapid erosion of the genetic diversity of both wild and cultivated plants has recently attracted more and more international concern. As a consequence, germplasm conservation techniques have become accessible to protect the third world's germplasm diversity. Several approaches are used for germplasm conservation and utilization. The evaluation and use of these techniques has to be focused with one important objective; to preserve with as much integrity as possible, the genetic variability of the selected species. Consideration of plant germplasm as a base for genetic improvement has come a long way, but much remains to be done, particularly, with the plant diversity that exists in the tropics. All efforts to conserve and use genetic resources will contribute to the benefit of future human generations.

Wilkes, G. 1991. In situ conservation of agricultural systems. In: Oldfield, M.L.; Alcorn, J.B. (editors). Biodiversity: culture, conservation and ecodevelopment. Westview Press, Boulder, Colorado, United States.

This article begins with an examination of the three levels on which biological conservation can occur - conservation of entire biomes, *in situ* conservation, or *ex situ* conservation. It then carries on with an elaboration of *in situ* management, arguing that different levels of management are appropriate for different classes of genetic resources. Various country examples are provided.

Williams, J.T. 1990. Vavilov's centres of diversity and the conservation of genetic resources. Biological Journal of the Linnean Society 39(1):89-93.

"Attention is drawn to Vavilov's agro-ecotype concept of cultivated plant adaptation, and genotype/environment interactions in crops. Vavilov developed an ecological classification of cultivated plants and stressed the need for national and international evaluation of collections and breeding lines, based on materials collected in areas of great genetic diversity. A discussion of Vavilov's centres of diversity highlights the importance of land races and wild crop relatives to breeders in Vavilov's day, and even more so at present.

This if followed by a brief description of the work of the International Board of Plant Genetic Resources (IBPGR) in relation to Vavilov's philosophy, in its efforts to conserve the genetic diversity of crops and especially old land races, which have developed resistances to diseases and pests, and adaptation to a wide range of environmental conditions. Related wild species are also of great importance here, and one of IBPGR's tasks is to see that all these materials are evaluated with a view to building useful characters into new and better crop varieties." [Abstract]

Wood, D.; Lenne, J.M. 1997. The conservation of agrobiodiversity on-farm: questioning the emerging paradigm. Biodiversity and Conservation 6:109-129. [IGA, Milnthorpe, Cumbria, United Kingdom]

"The genetic diversity of traditional varieties of crops is the most economically valuable part of global biodiversity and is of paramount importance for future world crop production. The Biodiversity Convention has given a clear mandate for on-farm conservation. However, very little formal research has been done and no agreed set of scientific principles yet exists for on-farm conservation of genetic resources. This lack of scientific knowledge has not prevented an explosion of recommendations on how to conserve agrobiodiversity on-farm and it is possible to identify an emerging paradigm. Through a review of some of the assumptions on which this paradigm is based, we clearly show that if attempts to conserve agrobiodiversity on-farm are based on these misconceptions, they are likely to fail. By assessing the present activities of farmers, we propose a research agenda to increase the diversity available to farmers and to enhance farmers capacity to manage this diversity dynamically. Increasing genetic diversification, combined with farmers experimental abilities, and underpinned by the formal system, will ensure greater on-farm conservation of more useful genetic resources." [Abstract]

Woodruff, D.S.; Gall, G.A.E. 1992. Genetics and conservation. Agriculture, Ecosystems and Environment 42(1-2):53-74.

"The basic sciences of genetics and ecology have long played a vital role in agriculture. New technologies spawning a gene revolution promise to revolutionize agricultural genetics. The opportunities to utilize these new techniques, along with standard methods of animal and plant breeding, are great for agriculture, conservation biology, and their synergism. Biological diversity is inextricably linked to human welfare. Genetic engineering is viewed as having both promise and risk to agricultural and natural biological systems, suggesting that its application must be evaluated on a case-by-case basis. In order to adequately manage genetic resources, patterns of genetic variation must be documented and their relationship to the life-histories of species and the functioning of ecosystems understood. To achieve this goal, species to receive attention must be prioritized, possibly based on their usefulness as indicator species in defining genetic management strategies for biological groups of species. Particular attention should be given to invasive species, to the phenotypic plasticity of species, and the organizational complexity of populations, communities, and ecosystems. A return to greater scientific emphasis at the organismal and ecosystem level obviously is essential." [Abstract]

Natural Aquatic Systems

Allendorf, F.W. 1991. Ecological and genetic effects of fish introductions: Synthesis and recommendations. Canadian Journal of Fisheries and Aquatic Sciences 48(supplement 1):178-181. [Division of Biological Sciences, University of Montana, Missoula, Montana, United States]

"The papers resulting from this symposium review the ecological and genetic effects of fish introductions throughout the world. Purposeful introductions rarely have achieved their objectives. Moreover, both intentional and unintentional introductions usually have been harmful to native fishes and other taxa through predation, competition, hybridization, and the introduction of diseases. We must learn from the past in order to avoid mistakes in the future. Introductions should not be used as a management tool without sufficient prior information and understanding to predict their effects. Introductions are often made or permitted because of the demands of certain interest groups (e.g., anglers or aquaculturists). Education of the public to the potential dangers and costs of such introductions is essential. Cooperation among management agencies is necessary to regulate and control both the purposeful and accidental introductions of fishes." [Abstract]

Arthington, A.H. 1991. Ecological and genetic impacts of introduced and translocated freshwater fishes in Australia. Canadian Journal of Fisheries and Aquatic Sciences 48(supplement 1):33-43.

"The inland waters of Australia have been colonized successfully by 20 species of freshwater fishes introduced to the continent, including 6 poeciliids, 3 salmonids, 4 cyprinids, 5 cichlids, 1 percid and 1 cobitid, all of which reproduce there in the wild. The ecological and genetic consequences of fish introductions and translocations have concerned scientists and water

authorities since the late 1960's, although the earliest introductions of salmonids for sport were made towards the end of the 19th century. Impacts of introduced fishes, including hybridization problems, habitat and water quality alterations, competition for space and food, predation and the introduction of exotic parasites and diseases are reviewed." [Abstract]

Cloud, J.G.; Thorgaard, G.H. (editors). 1993. Genetic Conservation of Salmonids. NATO ASI Series, Series A, Life Sciences Vol. 248. Proceedings of a NATO Advanced Study Institute on Genetic Conservation of Salmonid Fishes, June 23-July 5, 1991, Moscow, Idaho, and Pullman, Washington. Plenum Press, New York, New York, United States.

Papers include: (1) Methods to Describe Fish Stocks; (2) Spatial Organization of Pacific Salmon: What to Conserve?; (3) Status of Biodiversity of Taxa and Nontaxa of Salmonid Fishes: Contemporary Problems of Classification and Conservation; (4) Requirements for Genetic Data on Adaptations to Environment and Habitats of Salmonids; (5) Impacts of Fishing on Genetic Structure of Salmonid Populations; (6) Genetic Change in Hatchery Populations; (7) Potential Impacts of Transgenic and Genetically Manipulated Fish on Natural Populations: Addressing the Uncertainties through Field Testing; (8) The Reproductive Containment of Genetically Altered Salmonids; (9) Germplasm Repositories for Plants; (10) Advances in the Cryopreservation of Embryos and Prospects for Application to the Conservation of Salmonid Fishes; (11) Genetic Resource Banks and Reproductive Technology for Wildlife Conservation; (12) Cryopreservation of Fish Spermatozoa; (13) The Norwegian Gene Bank Programme for Atlantic Salmon *(Salmo salar)*; (14) Reconstitution of Genetic Strains of Salmonids Using Biotechnical Approaches; (15) Genetic Components in Life History Traits Contribute to Population Structure; (16) Status and Plight of the Searum Cutthroat Trout; (17) Status of Genetic Conservation in Salmonid Populations from Asturian Rivers (North of Spain); (18) Genetic Status of Atlantic Salmon (*S. salar*) in Asturian Rivers (Northern Spain); (19) Genetic Management of Natural Fish Populations; (20) Genetics of Salmonids in Czechoslovakia: Current Status of Knowledge; (21) Occurrence, Distribution, and Potential Future of Yugoslavian Salmonids; (22) Genetic Differentiation and Relationship within and between Natural and Cultured Populations of *Oncorhynchus masou* Complex in Japan; (23) Data Base for Trout Brood Stocks; (24) The Use of Supplementation to Aid in Natural Stock Restoration; (25) Status of Genetic Resources of Pacific Rim Salmon; (26) Status of the Atlantic Salmon, *Salmo salar* L, Its Distribution and the Threats to Natural Populations; (27) Selective Breeding and Domestication.

Das, P.; Mahanta, P.C.; Kapoor, D.; Pandit, P.K.; Bhaumik, U. 1987. Fish germplasm conservation and genetic stock improvement. Symposium on the Impact of Current Land Use Pattern and Water Resources Development on Riverine Fisheries, April 25-27 1987.

Destruction of fish habitat in India, by man-made interference of river systems, overfishing, pollution and domestic discharges has already brought both qualitative and quantitative changes that are reflected in dwindling fisheries of different ecosystems. Management measures such as judicious exploitation, improvement and conservation of natural fish resources are urgently needed. The conservation approach may be through preservation within nature/man-made ecosystems in which they occur or through perpetuating sample

population in genetic resource centre/gene pools of gamete storage, germplasm bank or through entire biomass preservation.

Fernando, C.H. 1991. Impacts of fish introductions in tropical Asia and America. Canadian Journal of Fisheries and Aquatic Sciences 48(supplement 1):24-32. [Department of Biology, University of Waterloo, Waterloo, Ontario, Canada]

"Biotas are constantly being reshaped by invasions. Introduction is now an added route to invaders. Impacts must be viewed against the background of massive changes in type, extent and quality of freshwater habitats globally and in that freshwater fishes are almost living fossils. Also old lakes and lacustrine fishes are highly restricted geographically. Lakes are young while rivers are old. Riverine, marsh and pond fishes are not well adapted to lacustrine conditions now widespread due to reservoir construction. Some Clupeidae and Cichlidae are lacustrine-adapted and highly productive. They have therefore made major impacts on fish yields in lakes and reservoirs. In tropical Asia and America, there have been a series of overlapping waves of fish introductions during that past 150 years, culminating in the tilapias from Africa. These fishes now dominate capture and culture fisheries in many countries. Fish introductions are a fait accompli and will continue. They must be realistically assessed and carefully monitored. Contrary to some predictions, introductions have not caused severe damage to indigenous species except when piscivores were used. Yields of indigenous fishes have apparently been enhanced in some instances. Parasites pose a serious threat and only an effective quarantine will ensure their exclusion." [Abstract]

Gregory, R.S. 1988. A framework for managing the risks of deliberate releases of genetic material into aquatic ecosystems. Journal of Shellfish Resources 7(3):557.

Releases of genetically-altered organisms into the environment constitute a concern because of their potential for adverse consequences to human health and the natural environment. There is a need for a rational, consistent program to assess the risks of genetic releases to the aquatic environment and to structure a meaningful dialogue with the public about this information. Risk assessments focusing on the expected physical damages of technologies have become commonplace, and much of this structure may be relevant for assessments of deliberate genetic releases to aquatic ecosystems. However, this transfer is likely to be only partial, for several reasons. This paper will examine these questions from the perspective of a potential regulator, emphasizing the use of risk assessments in developing a rational decision-making framework for evaluating the net social benefits of deliberate releases of genetic material to the aquatic environment.

Kapuscinski, A.R.; Hallerman, E.M. 1991. Implications of introduction of transgenic fish into natural ecosystems. Canadian Journal of Fisheries and Aquatic Sciences 48(supplement 1):99-107. [Department of Fisheries and Wildlife, University of Minnesota, Minnesota, United States]

"Production of transgenic fish has increased in scope, aimed at improving performance traits in economically important species or at creating model systems for basic biological problems. A variety of transgenic phenotypes will become possible as more genes are cloned and characterized. Categories of altered phenotypes include modified: metabolic rates; tolerance of physical factors; behavior; resource or substrate use; and resistance to disease, parasitism, or predation. Ecological impacts of transgenic fishes are uncertain but will depend primarily on their altered phenotypes and secondarily on the scale and frequency of their introduction into ecosystems. Production of ecologically noxious transgenic types is possible, because many fish varieties readily disperse and persist in aquatic ecosystems, are fit in natural settings, interact substantially with other organisms, and play a role in ecosystem processes. Releases of transgenic fishes may impact aspects of fisheries management. Because future uses of transgenic fish in commercial aquaculture or in stocking of natural waters are contemplated, interdisciplinary teams of fisheries biologists, ecologists, and resource managers must develop integrated approaches to assessing risks of ecological impacts. The current situation of uncertainty demands caution in expecting 'safe' uses of transgenic fishes." [Abstract]

Kapuscinski, A.R.; Hallerman, E.M. 1990. Transgenic fish and public policy: Anticipating environmental impacts of transgenic fish. Fisheries 15(1):2-11.

Transfer of novel genes into fishes introduces a number of contentious issues into public policy debate among fisheries scientists and regulatory authorities. In the context of the technical status of development of transgenic strains of fishes, we discuss anticipated ecological impacts of releasing such fishes into natural environments. The major determinant of ecological impacts of transgenic fishes will be the phenotypic effect of the inserted genes. Three conceptual classes of phenotypic changes are anticipated, including changes in physiological rates, behavior, or tolerance of physical factors. We identify major research needs for formulation of quantitative risk analysis protocols and suggest items to include in a position statement on transgenic fishes for adoption by the American Fisheries Society.

Krueger, C.C.; Gharrett, A.J.; Dehring, T.R.; Allendorf, F.W. 1981. Genetic Aspects of Fisheries Rehabilitation Programs. Canadian Journal of Fisheries and Aquatic Sciences 38:1877-1881. [Department of Entomology, Fisheries, and Wildlife, University of Minnesota, St. Paul, Minnesota, United States]

"The stocking of indigenous or exotic fish species is often a desirable aspect of fisheries rehabilitation programs. Two strategies are proposed for the choice of fish for stocking. The first plan involves making separate collections of fish from each of several genetically different populations, performing all possible crosses between the different sources, and then stocking the progeny. In contrast to selective breeding programs, this strategy maximizes genetic variability and then relies on the environment for the selection of the most appropriate genotypes. The second plan is to sample populations from waters environmentally similar to those being rehabilitated that may contain preadapted genotypes. Application of this strategy should consider the use of gene banks or natural refugia as a source of preadapted genetic variability. When gene flow may occur between stocked fish and local populations, the second strategy should be used in favor of the first to minimize the impact on native gene pools. When choosing fish to implement

either strategy, it is important to know the distribution of genetic variability within and between populations to sample adequately the variability present." [Abstract]

Leberg, P.L. 1990. Influence of genetic variability on population growth: Implications for conservation. Journal of Fish Biology 37(supplement A):193-195. [Savannah River Ecology Laboratory, Aiken, South Carolina, United States]

Conservation biologists often assume that the genetic variation of a population may affect its short-term viability. This assumption is largely based on noting that individuals that have lost heterozygosity due to inbreeding, generally exhibit a depression of fitness traits, such as growth, survival and fecundity. An experiment was conducted to evaluate how a reduction in genetic variation affects characteristics of fish populations under field conditions. The eastern mosquitofish, Gambusia holbrooki, was used.

Meffe, G.K. 1987. Conserving fish genomes: Philosophies and practices. Environmental Biology of Fishes 18(1):3-9. [University of Georgia's Savannah River Ecology Lab, Aiken, South Carolina, United States]

This essay focuses on the philosophical and practical aspects of the challenges of conserving fish genomes. Massive habitat change, introduction of exotic species careless disposal of toxin and anthropogenic pollutants have placed many species in potential or immediate danger of extinction. Conservation of genetic diversity and species diversity are considered.

Meffe, G.K. 1986. Conservation genetics and the management of endangered fishes. Fisheries 11(1):14-23. [University of Georgia's Savannah River Ecology Lab, Aiken, South Carolina, United States]

"The emerging field of endangered fishes management has yet to fully incorporate conservation genetics into recovery programs. Genetic aspects of small populations must be considered at the outset of management programs in order to maximize probability of their long-term survival and continued adaptability. Total genetic variance of a species consists of within population genetic diversity, and the differences found among populations; both types of variance should be maintained to maximize adaptive flexibility of endangered fishes. Forces that erode genetic variation include small population size, population bottlenecks, genetic drift, inbreeding depression, artificial selection in captivity, and mixing of distinct genetic stocks. These can lead to increased homozygosity, loss of quantitative variation, and exposure of deleterious recessive alleles, all of which may reduce fitness. Suggestions for genetically sound management of endangered fishes include genetic monitoring of natural and captive populations, use of large numbers for captive breeding where feasible, selective mating to avoid inbreeding where necessary, minimization of time in captivity, and separate maintenance of distinct stocks." [Abstract]

Mork, J. 1991. One-generation effects of farmed fish immigration on the genetic differentiation of wild Atlantic salmon in Norway. Aquaculture 98:267-276. [Biological Station, Trondheim, Norway]

"One-generation effects of various amounts of farmed fish immigration on the genetic differentiation among wild salmon stocks in Norway were examined. Known allele frequencies at three electrophoretic loci and population sizes of five Norwegian salmon stocks and one farmed fish strain were input in formulae for gene flow, and the results measured as reduction in *G-st* at electrophoretic loci.

In general, a raised immigration rate from a common source will reduce the existing genetic differentiation between stocks. In absolute terms, the reduction in wild stock *G-st* will be the largest in the first generation, because the genetic differences between immigrant and recipient are largest then. Both the magnitude and pattern of immigration effects are substantially influenced by whether immigrant number is equal in all rivers (model I) or proportional to local population size (model II). Assuming equal fitness of immigrants and recipients, the currently reported farmed fish proportion among spawners of about 30% (the mean value in 50 Norwegian rivers as reported for 1989) was estimated to reduce existing genetic differentiation (measured as *G-st*) between the wild stocks involved by almost 70% in one generation under model I, and by more than 50% under model II. Each of the wild stocks will take on the genetic characteristics of farmed fish at corresponding rates. First-generation effects on *G-st* of burst immigrations in connection with rearing pen wrecks may be used to estimate farmed fish fitness in nature." [Abstract]

Moyle, P.B.; Leidy, R.A. 1992. Loss of biodiversity in aquatic ecosystems: Evidence from fish faunas. In: Fiedler, P.L.; Jain, S.K. (editors). Conservation Biology: The Theory and Practice of Nature Conservation, Preservation, and Management. Chapman and Hall, an imprint of Routledge, Chapman & Hall, Inc., New York, New York, United States.

"Fishes are appropriate indicators of trends in aquatic biodiversity because their enormous variety reflects a wide range of environmental conditions. Fish also have a major impact on the distribution and abundance of other organisms in waters they inhabit. Examination of trends in freshwater fish faunas from different parts of the world indicate that most faunas are in serious decline and in need of immediate protection. Species most likely to be threatened with immediate extinction are either specialized for life in large rivers or are endemic species with very small distributions. We conservatively estimate that 20% of the freshwater fish species of the world (ca. 1800 species) are already extinct or in serious decline. Evidence for serious declines in marine fishes is limited largely to estuarine fishes, reflecting their dependence on freshwater inflows, or to fishes in inland seas." [from Abstract]

Nelson, K.; Soule, M. 1987. Genetical conservation of exploited fishes. In: Ryman, N.; Utter, F. (editors). Population Genetics and Fishery Management. Washington Sea Grant Program. Distributed by University of Washington Press, Seattle, Washington, United States.

An examination is made of the evidence for genetic changes in fish populations resulting from man's exploitative activities. Succession in intensive fisheries, undirected genetic erosion within stocks, changes resulting from selection, and hybridization and introduction are considered. Preventive and remedial measures suggested by quantitative and population genetics are discussed.

Nyman, L. 1991. Conservation of freshwater fish: Protection of biodiversity and genetic variability in aquatic ecosystems. Fisheries Development Series 56. National Swedish Board of Fisheries, Goeteborg, Sweden. [Institute of Freshwater Research, Drottingholm, Sweden]

"This is an overview of the status of conservation of freshwater fishes in the context of the World Conservation Strategy launched jointly by WWF, IUCN and UNEP. This strategy aims to preserve genetic diversity, to maintain ecological processes and to ensure the sustainable use of species and ecosystems...

This report sets out to explain why there is a need to protect freshwater fishes and their habitat, what has been achieved so far in the field of fish conservation and what types of threats fish are subjected to. The subject of conservation biology in a fish context is explained in some detail. Definitions of the basic scientific terms currently in use are provided, also with emphasis on the specific characteristics of fish taxa. After these introductory chapters follows a section on recommendations and guidelines how to protect fish. General considerations emphasize the challenge of conserving biodiversity rather than individual fish species, and to ensure the long-term viability of the aquatic communities of which fishes are vital components. In the concluding part of the report recommendations on theoretical and practical management of fish populations - wild and cultured - are given. They address different levels of decision making and various user groups, but all bear on the wish to standardize and improve conservation of the world's genetic resources of freshwater fish." [from Summary]

Ogutu-Ohwayo, R.; Hecky, R.E. 1991. Fish Introductions in Africa and Some of Their Implications. Canadian Journal of Fisheries and Aquatic Sciences 48(supplement 1):8-12. [Uganda Freshwater Fisheries Research Organization, Jinja, Uganda]

"Fish introductions in Africa have been made at various spatial scales from small fish ponds to the largest lakes, primarily to sustain or increase production, though some were to develop sport fisheries and to control unwanted organisms. Some introductions have fulfilled their objective in the short term, but several 'successful' introductions have created uncertainties about their long-term sustainability. *Lates niloticus, Oreochromis niloticus, O. leucostictus, Tilapia melanopleura, and T. zilli* were introduced into Lake Victoria and Kyoga in 1950's and early 1960's; by the 1980's *L. niloticus* and *O. niloticus* dominated the fisheries, having virtually eliminated a number of endemic species. In Lake Victoria, the loss of genetic diversity has been accompanied by a loss of trophic diversity; the transformation of the fish community coincided with profound eutrophication (algal blooms, fish kills, hypolimnetic anoxia) which might be related to alterations of the lake's food-web structure. By contrast, the introduction of a planktivore, *Limnothrissa miodon* into Lake Kivu and the Kariba reservoir has established highly successful fisheries with little effect on the pre-existing fish community or trophic ecology. The endemic species-rich African Great Lakes may be particularly sensitive to introductions. Species

extinctions, introgressive hybridization and ecosystem alterations may occur following introductions." [Abstract]

Rab, P. 1989. Genetic aspects of the conservation of fish gene resources. Pr. Vurh Vodany/Pap. Rifh Vodany (18):9-14.

Management of endangered as well as commercial fishes is a new field that requires incorporation into the conservation programmes - if such programmes are elaborated - all pertinent genetic knowledge concerning gene pool conservation and use of the genetic aspects in the current practice of stocking open waters with the important commercial fishes. The total genetic variability consists of intra- and inter-population (components); both are necessary to keep the fixed adapting abilities. The processes that "erode" the width of genetic variability include, in particular, the low population size, sudden reduction of population size, genetic drift, inbred depression, artificial selection, and mixing of genetically different units within a species.

Scudder, G.G.E. 1989. The adaptive significance of marginal populations: A general perspective. In: Levings, C.D.; Holtby, L.B.; Henderson, M.A. (editors). Proceedings of the National Workshop on Effects of Habitat Alteration on Salmonid Stocks. Canadian Special Publication of Fisheries and Aquatic Sciences 105. Department of Fisheries and Oceans, Ottawa, Canada.

"Populations of a species normally undergo successive expansions into less favourable, 'hard', marginal habitats, alternating with contractions into more favourable, central 'soft' refuges. These expansions and contractions are the inevitable consequences of density fluctuations. The 'hard', ecologically marginal habitats are characteristically spatially diverse and temporarily unstable. Selection in these is for colonization ability and adaptation to a diverse array of density-independent factors. Centripetal gene flow from these marginal areas at times of contraction increases the genetic diversity of the central population, wherein selection usually favors density-dependent factors. Thus, central genetic diversity is found in the most ecologically versatile species. Studies of diverse organisms show that the greatest genetic diversity is found in the most ecologically versatile species. Marginal populations have a high adaptive significance to the species as a whole, and marginal habitat conservation, preservation and management is one of the 'best' ways to conserve the genetic diversity and resources of fish species. Marginal habitats are an essential prerequisite for the maintenance of this diversity and versatility." [Abstract]

Smith, P.J. 1994. Genetic diversity of marine fisheries resources: Possible impacts of fishing. FAO Fisheries Technical Paper 344. Food and Agriculture Organization, United Nations, Rome, Italy. [Fisheries Research Center, Ministry of Agriculture and Fisheries, Wellington, New Zealand]

"This report reviews the evidence for the genetic impact of fishing on marine fisheries resources. The most widely used method for measuring genetic diversity in natural populations has been protein electrophoresis; marine teleosts have levels of genetic diversity ranging from 0.0 to 18% and marine invertebrates from 0.4 to 32%. Genetic studies have shown that populations of

marine species are less differentiated than freshwater species, experience temporal genetic changes, can be changed locally by pollution, and contain cryptic species.

Genetic changes in populations occur through selection or drift. In natural populations fishing is a major source of mortality and is non random with respect to age and size of individuals. A common observation in heavily exploited teleost fisheries has been a decline in the age and/or size at sexual maturity. Size selective fishing would favor early maturity. However, growth rate in some fishes is density dependent and increases when the stock is reduced; faster growth rates leads to a reduction in the age or size at onset of sexual maturity. Thus it is not possible to determine if the observed changes are genetic or compensatory in response to reduced stock density.

Genetic drift is unlikely to be a major factor influencing levels of genetic diversity in many marine fisheries, except for some populations, e.g. giant clams, which have been reduced to near extinction levels. Some rare and endangered freshwater fishes show low levels of genetic diversity. There is no evidence for loss of genetic diversity in collapsed stocks of pelagic species. While the stocks have collapsed from a commercial perspective most have maintained large population sizes at their lowest rate.

The use of hatcheries to produce seed for aquaculture and enhancement could lead to loss of genetic diversity in natural populations through escape of farm stock or inappropriate choice of broodstock.

Experimental studies are required to determine the heritability and the response to selection of life history characters of exploited species, and to determine if relaxation of fishing pressure allows the recovery of 'fast growing' and 'late maturing' genes or gene complexes in populations. Also it would be desirable to monitor levels of genetic diversity in recently exploited or highly exploited species. A combination of experimental and field studies would permit a more rigorous testing of genetic changes in exploited populations.

If genetic changes are demonstrated in exploited species then changes to management would be needed to conserve natural levels of diversity." [Abstract]

Stahl, G. 1983. Differences in the Amount and Distribution of Genetic Variation Between Natural Populations and Hatchery Stocks of Atlantic Salmon. Aquaculture 33:23-32. [Department of Genetics, University of Stockholm, Stockholm, Sweden]

"Tissue samples from a total of 1643 Atlantic salmon collected from naturally reproducing populations and hatchery stocks representing nine major river systems draining into the Baltic Sea were electrophoretically analyzed for 37 enzyme loci. Pronounced spatial genetic heterogeneity was generally observed among samples within as well as between different river systems. Samples representing hatchery stocks exhibit a significantly lower amount of genetic variability than natural populations. This is displayed as both a reduced variation within hatchery stocks and a lower amount of genetic divergence between them." [Abstract]

Utter, F.; Hindar, K.; Ryman, N. 1993. Genetic Effects of Aquaculture on Natural Salmonid Populations. In: Heen, K.; Monahan, R.L.; Utter, F. (editors). Salmon Aquaculture. Fishing News Books, Oxford, United Kingdom.

"This chapter addresses concerns about genetic dangers to wild populations from aquaculture activities (see Fig. 5.1). We are particularly concerned about the dangers of indiscriminate accidental or intentional releases of cultured organisms into the natural environment. We maintain that the above noted tendency to react only after extensive damage has become apparent is a particularly inappropriate response to these problems. Our concerns are heightened for this specific issue because the genetic effects are irreversible, and by the time they are detected, the damage has already occurred. Therefore, our message is based on a goal of prevention as the only viable strategy to minimize losses of valuable and irreplaceable genetic resources." [from Introduction]

Waples, R.S.; Winans, G.A.; Utter, F.M.; Mahnken, C. 1990. Genetic Approaches to the Management of Pacific Salmon. Fisheries 15(5):19-25. [Coastal Zone and Estuarine Studies (CZES) Division, Northwest Fisheries Center, National Marine Fisheries Service, Seattle, Washington, United States]

"The complex problems involved in managing Pacific salmon *(Oncorhynchtis* spp.) are largely a consequence of the unusual life history features of these species. The strong homing instinct leads to the formation of discrete, locally adapted spawning populations, each of which has the potential to evolve as an independent evolutionary unit. It is important, therefore, that the genetic consequences of different management policies be carefully evaluated. If current management goals (e.g., doubling the abundance of anadromous salmonids in the Columbia River basin through increased hatchery production and supplementation of natural populations) are realized, genetic issues will assume even greater importance in the future. To date, however, genetic concerns have not been adequately incorporated into the management process. We identify three genetic approaches, primarily based on easily obtained electrophoretic data, that can provide valuable information on which to base management decisions: (1) Using the Genetic Stock Identification method for identifying stocks contributing to oceanic, mixed-stock fisheries. Genetic Stock Identification has several advantages over traditional tagging methods, including cost-effectiveness and easy access to wild as well as hatchery stocks. (2) Monitoring genetic changes in hatchery stocks. Analysis of the nature and magnitude of such changes is the best means of identifying stocks in which potentially dangerous levels of inbreeding may be occurring. (3) Detecting mixtures of gene pools. The ability to detect hybridization and introgression is necessary for an evaluation of the genetic consequences of releasing artificially propagated fish into the wild." [Abstract]

Other Systems and General Studies

Ashton, P.S. no date. Factors affecting the development and conservation of tree genetic resources in South-east Asia. Tropical Trees, Variation, Breeding and Conservation (2):189-198.

Brown, A.H.D. 1992. Human impact on plant gene pools and sampling for their conservation. OIKOS 63(1):109-118. [CSIRO, Canberra, Australia]

"Many human activities distort the sample of genes that pass from one generation to the next of a plant population. These activities affect genetic structure either by markedly altering - usually decreasing - the level of genetic diversity, or by causing large changes in specific allele frequencies. The former changes are due to such stochastic evolutionary forces as reduced population size, increased migration and recombination, and the latter changes are due to systematic selection pressure. The leading examples of each are habitat destruction and environmental degradation. Interaction between stochastic and deterministic evolution is well displayed by introduced colonizing weeds. To combat unwanted evolutionary changes in plant population genetic structure, conservation measures - both in situ and ex situ - should employ sampling strategies that meet both stochastic and systematic needs." [Abstract]

Chambers, S.M. 1983. Genetic principles for managers. In: Schonewald-Cox, C.M.; Chambers, S.M.; MacBryde, B.; Thomas, W.L. (editors). Genetics and conservation: a reference guide for managing wild animals and plant populations. The Benjamin / Cummings Publishing Company, Inc., Advanced Book Program, California, United States.

This chapter provides an introduction to genetic principles such as heritability, chromosomes and cells, cellular reproduction, sex chromosomes and sex determination, molecular genetics, mutations, evolution by natural selection, population genetics, and evolutionary genetics and population management.

Cohen, J.I.; Bertram, R. 1989. Plant genetic resource initiatives in international development. In: Knutson, L.; Stoner, A.K. (editors). Biotic diversity and germplasm preservation, global imperatives. Kluwer Academic Publishers, Boston, Massachusetts, United States.

Cohen, J.I.; Williams, J.T.; Plucknett, D.L.; Shands, H. 1991. Ex situ conservation of plant genetic resources: global development and environmental concerns. Science 253(5022):866-872.

Conservation of plant genetic resources is achieved by protection of populations in nature (in situ) or by preservation of samples in gene banks (ex situ). The latter are essential for users of germplasm who need ready access. Ex situ conservation also acts as a back-up for certain segments of diversity that might otherwise be lost in nature and in human-dominated ecosystems. The two methods are complementary, yet better understanding of this interrelation and the role of ex situ conservation in global environmental considerations is needed. Inclusion of ex situ conservation efforts within current environmental policies conserving global diversity would focus greater international attention on the safeguarding of these efforts.

Cook, L.M. 1992. Genetic and ecological diversity. The sport of nature. Chapman and Hall, New York, New York, United States.

This book examines species diversity and the genetic diversity of species within populations of animals, discussing the factors generating the diversity. The ideas developed by

ecologists and population geneticists have tended to remain separate, and one aim of this book is to bring together these two vital areas. The book has grown out of the author's years of experience in teaching evolution and population genetics.

Crozier, R.H. 1992. Genetic diversity and the agony of choice. Biological Conservation 61(1):11-15.

"Vane-Wright *et al.* (Biol. Conserv., 55, 1991) correctly stress the importance of using the evolutionary distinctiveness of taxa when assigning them priorities for preservation - 'the agony of choice'. In the absence of other information, the crucial quantity is the preservation of genetic diversity. The method of Vane-Wright *et al.* uses exclusively the topology of the inferred phylogeny of the group. This cladistic method will err on occasion because it does not take into account the accumulation of genetic divergence along branches of the evolutionary tree, and because it relies on the three being rooted. When available, the use of reliable genetic data following tree construction is preferable. The species with the highest priority for conservation is then that with the highest overall probability of having unique character states. If there is a linear relationship between distance and the probability of character state change, the relative probability of uniqueness of a taxon may be estimated by the product of its genetic distances to other taxa along the branches of the dendrogram. Habitats or reserve systems can be ranked according either to the priorities assigned to their constituent species, or their preservation of biodiversity estimated by using a simple product rule applied to the lengths of the branches conserved." [Abstract]

Day, P.R. 1989. The impact of biotechnology on conventional germplasm conservation and use. In: Knuston, L.; Stoner, A.K. (editors). Biotic diversity and germplasm preservation, global imperatives. Kluwer Academic Publishers, Boston, Massachusetts, United States.

Fiedler, P.L.; Jain, S.K. (editors). 1992. Conservation biology. The theory and practice of nature conservation preservation and management. Chapman and Hall, an imprint of Routledge, Chapman & Hall, Inc., New York, New York, United States.

The editors assembled a collection of papers dealing with many issues in the theory and application of conservation biology in the early 1990s. The book is divided into four main parts: the natural order of the biological world; processes and patterns of change; population biology and genetics; and the practice of conservation, preservation, and management. Thirteen chapters focus on the following topics: plant community species richness; vascular plant rarity; Latin American crop genetic resources; Holocene reptile extinctions; fish biodiversity loss; invertebrate biodiversity threats; forest fragmentation and biodiversity conservation; plant extinction stochastic modeling; inbreeding and minimum viable populations; Asian primate conservation; sensitive natural area management; park protection and public roads; and protecting plant diversity. Five essays consider conservation biology in relation to: higher taxonomic levels; scale; genetic and demographic issues for rare plants; the role of ecological restoration; and why humans should conserve species and wildlands.

Ford-Lloyd, B.V.; Jackson, M.T. 1991. Biotechnology and methods of conservation of plant genetic resources. Journal of Biotechnology 17(3):247-256.

Frankel, O.H. 1988. Genetic resources: evolutionary and social responsibilities. In: Kloppenburg, J.R.Jr. (editor). Seeds and sovereignty : the use and control of plant genetic resources. Duke University Press, Durham, North Carolina, United States.

This chapter attempts to provide an overview of the genetic resources system and its biological basis. It examines the biological justification for claims involved with the politicization of genetic resources, as well as the biological and social consequences.

Frankel, O.H. 1970. Genetic conservation in perspective. In: Frankel, O.H.; Bennet, E. (editors). Genetic resources in plants: their exploration and conservation. International Biological Programme, London, and Blackwell Scientific Publications, Oxford, United Kingdom.

"The need for conservation of genetic resources is widely recognized. But there has been little discussion on what one might call the strategy of conservation, i.e. its objectives and perspectives. This chapter is intended as a contribution to this discussion." [from article]

Goodman, M.M. 1990. Genetic and Germ Plasm Stocks Worth Conserving. Journal of Heredity 81:11-16. [Department of Crop Science, North Carolina State University, Raleigh, North Carolina, United States]

"The relative costs and benefits of genetic stock collections and germ plasm collections are discussed. The status of national and international collections is compared with the needs of plant breeders and geneticists. There is an international need for germ plasm systems that emphasize the use and employment of materials rather than acquisition and storage. For base collections to function, they must provide for regeneration, characterization, documentation, and evaluation of their materials. The quality of a germ plasm system should be judged on the basis of the quality of the materials available to scientists. Adequate quantities of high-quality seed that are of known provenience, spanning the range of known genetic diversity, promptly delivered, and well described constitute the minimum that should be expected. All too often such minimal requirements are not met." [Abstract]

Gregorius, H-R. 1991. Gene Conservation and the Preservation of Adaptability. In: Seitz, A.; Loeschcke, V. (editors). Species Conservation: A Population-Biological Approach. Birkhauser Verlag, Basel, Switzerland.

"Preservation of the adaptability of a resource population is emphasized as an indispensable objective of gene conservation. Therefore, methods of dynamic conservation deserve priority. Adaptability requires the existence of genetic variation that is either adaptively

inferior or neutral under the respectively prevailing environmental conditions. On this basis, the significance of genetic load and environmental heterogeneity for the maintenance of genetic variation in gene resource populations is discussed, and some elementary principles to be considered in gene conservation are pointed out. It is suggested that criteria for the determination of resource population sizes be oriented at the loss of genetic variation that can be tolerated over a specified number of generations as a consequence of random genetic drift. A model taking account of this aspect is presented, and the population sizes resulting for different systems of reproduction are computed. The relationships between dynamical gene conservation and population (species) protection are emphasized, and the necessity for ecosystem protection is argued." [Abstract]

Lacy, R.C. 1987. Loss of genetic diversity from managed populations: interacting effects of drift, mutation, immigration, selection, and population subdivision. Conservation Biology 1(2):143-158. [Department of Conservation Biology, Chicago Zoological Society, Brookfield, Illinois, U.S.]

"A computer simulation program was used to examine interacting effects of genetic drift, mutation, immigration from outside populations, directional and balancing selection, and population subdivision on the loss of genetic variability from small, managed populations..." [from Abstract]

Lleras, E. 1991. Conservation of genetic resources in situ. Diversity 7(1/2):72-74. [CENARGEN, Brazilian Enterprise for Agricultural Research, Brasilia, Brazil]

This article defines *in situ* conservation and outlines various types. An integrated program for conservation is proposed and the activities of CENARGEN, Brazil's National Center for Research in Genetic Resources and Biotechnology are outlined.

McCusker, A. 1991. The global genetic resources dilemma: What to nurture and What to abandon. Diversity 7(3):36-37. [International Board for Plant Genetic Resources, Rome, Italy]

This article discusses the debate that exists among scientists on the approach to conserve genetic resources - one global network or networks based on national programs.

Mlot, C. 1989. Blueprint for conserving plant diversity. Bioscience 39:364-368.

This article discusses how to maximize genetic diversity among rare and endangered plants. Plants have on average twice the genetic variation of animals, and many are listed as threatened species. This combined with changing climate patterns makes the need for conservation a priority. Tools for assessing variation are given and methods of conservation, like seed collections and botanical gardens, are discussed.

Orton, T.J. 1988. New technologies and the enhancement of plant germplasm diversity. In: Kloppenburg, J.R.Jr. (editor). Seeds and sovereignty: the use and control of plant genetic resources. Duke University Press, Durham, North Carolina, United States.

"This chapter presents an assessment of the potential impact of discrete biotechnological approaches on the total pool of biological diversity." [from article]

Rojas, M. 1992. The species problem and conservation: what are we protecting? Conservation Biology 6(2):170-178. [Fundacion Natura, Bogota, Colombia]

"Although conservation biologists base most of their activities on species taxa, they have participated little in the debate of systematists and evolutionary biologists about the recognition and nature of species. It is clear from this debate that there is no agreement on what species are, how they should be delimited, or what they represent. But in conservation science, and particularly in selection, design and management of protected areas, species are either treated as types or evolutionary units. A typological view of species may lead to a failure to protect the real diversity of life in the long term, if conservation priorities are set on the basis of species numbers or on circumscriptions of endangered, threatened, or endemic species taxa that result from the use of different species concepts. Considering species as typological entities may also lead workers to disregard geographic variation and to neglect the problem of which level of variability to protect. It may even affect the goal of maintaining the evolutionary potential of organisms, if the focus is placed on the preservation of a sample of the existing types in populations that will persist little changed as possible. When species are considered evolutionary units, attention is shifted from the level of species to that of populations and metapopulations. Problems may still arise if these populations are considered in the context of species taxa, particularly if their composition is managed or if indicator species are used. A closer interaction between systematists and conservation biologists is suggested. Although the pressures of time and the difficulties faced by conservation biologists cannot be denied, considering the species problem more critically may result in recognizing the limitations of the taxonomic information used; it may also contribute to the refinement of the concepts and methods involved in their activities, making them more congruent with the nature of biological diversity." [Abstract]

Schonewald-Cox, C.M.; Chambers, S.M.; MacBryde, B.; Thomas, W.L. (editors). 1983. Genetics and conservation: a reference guide for managing wild animals and plant populations. The Benjamin/Cummings Publishing Company, Inc., Advanced Book Program, Menlo Park, California, United States.

The chapters of this book are as follows: 1) The Place of Management in Conservation; 2) Genetic Principles for Managers; 3) Isolation, Gene Flow, and Genetic Differentiation among Populations; 4) Isolation by Distance: Relationship to the Management of Genetic Resources; 5) The Differentiation of Populations over Short Distances; 6) Sibling Species; 7) What Do We Really Know about Extinction?; 8) Extinction, Survival, and Genetic Variation; 9) Genetics and the Extinction of Butterfly Populations; 10) Extinction: Lessons from Zoos; 11) The Genetics of

the Founder Effect; 12) Evolutionary Consequences of Inbreeding; 13) The Founding of Plant Populations; 14) Molecular Approaches to Studying Founder Effects; 15) The Elimination of Inbreeding Depression in a Captive Herd of Speke's Gazelle; 16) Some Merging of Plant Populations; 17) Sea Turtles and the Problem of Hybridization; 18) Hybridization and Gene Exchange among Birds in Relation to Conservation; 19) Preserving Natural Diversity; 20) The Distribution of Genetic Variation within and among Natural Plant Populations; 21) Systematics, Conservation and the Measurement of Genetic Diversity; 22) Interspecific Interactions and the Maintenance of Genetic Diversity; 23) The Relevance of Captive Populations to the Conservation of Biotic Diversity; 24) The Impact of Research on the Propagation of Endangered Species in Zoos; 25) Conclusions: Guidelines to Management: A Beginning Attempt.

Templeton, A.R. 1991. Genetics and conservation biology. In: Seitz, A.; Loeschcke, V. (editors). Species conservation: a population-biological approach. Birkhauser Verlag, Basel, Switzerland. [Department of Biology, Washington University, St. Louis, Missouri, United States]

"Genetics can be applied to many problems in the area of conservation biology, and four such uses will be illustrated in this paper. First is conservation forensics in which genetic techniques are used to aid the enforcement of laws concerning endangered species. ...A second application is in systematics. ...a third application of genetics in conservation [is] the detection and monitoring of hybridization. ...The final area is genetic management of natural and captive populations of endangered species." [from Abstract]

Widrlechner, M.P.; Clark, R.L.; Roath, W.W.; Wilson, R.L. 1992. An analysis of the literature of ex situ germplasm preservation. Plant Genetics Resource Newsletter 88/89:31-36.

Witt, S.C. 1985. Biotechnology and genetic diversity. BriefBook. California Agricultural Lands Project, San Francisco, California, United States.

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