Managing Agricultural Resources for Biodiversity Conservation:

Annotated Bibliography

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1 INTRODUCTION

One of the outcomes of the RIO SUMMIT (United Nations Conference On environment and Development) of 1992 was the signing of the Convention on Biological Diversity, which has now been ratified by over 100 countries. By ratifying this convention, countries commit to implementing the agreements and programme of work as it is developed through the "Conferences of Parties", which occur more or less every two years.

When the Convention was originally drafted, agricultural biodiversity was not included as an aspect of biodiversity. But such a clamour has been raised as to the importance of agrobiodiversity, and so much attention has been drawn to such trend as: the precipitous loss of landraces of cultivated crops, and the very large proportion of biodiversity, in general, that occurs in human-dominated landscapes. As a consequence, agricultural biodiversity was included in the scope of the convention, and FAO was given the mandate as overall taskmaster for the subject.

To a large degree, the focus on agrobiodiversity up until now has been on conservation and utilization of plant genetic resources, and its concomitant issues of access to genetic resources (for example, by plant breeders or pharmaceutical researchers) and fair and equitable benefit sharing (with communities or indigenous peoples who have shared or shepherded such resources over time).

However, the Convention on Biological Diversity has recognized its need to liaise thoroughly with the scientific community and through this liaison, with respect to agricultural biodiversity, a number of other thematic focal areas have been established. The present list of areas are:

Pollinators.
Soil biodiversity
Biodiversity that provides mitigation of pests and diseases
Crop genetic resources
Livestock genetic resources
Diversity at the landscape level
Wild biodiversity in agroecosystems

It is now accepted that the "Programme of work" of the Convention on Biological Diversity should include the conservation, sustainable use and benefit sharing of all of these focal areas.

Countries facing the need to now develop strategies to address agrobiodiversity have expressed a number of difficulties. The concept as a whole is very new, even if it may relate to many traditional practices. Bringing a new discipline into the policy arena means exploring relatively uncharted territory. ELCI is undertaking a project, in collaboration with the UNEP/GEF Biodiversity Planning Support Program, to develop guidelines for integrating biodiversity conservation into national agricultural policies. As a first step in this undertaking, we have been reviewing the current literature on the topic, and offer our review here as an annotated bibliography, as a work in progress.

2 ANNOTATED BIBLIOGRAPHY

 # 1 Aarnink, W., S. Bunning, L. Collette and P. Mulvany. (1999). Sustaining Agricultural Biodiversity and Agroecosystem Functions. Opportunities, incentives and approaches for the conservation and sustainable use of agricultural biodiversity in agroecosystems and production systems. Report of an International Workshop, FAO Headquarters, Rome, 2-4 December 1998. Available at: http://www.fao.org/WAICENT/FAOINFO/SUSTDEV/Epdirect /Epre0080.htm

This is a report of an international workshop on agricultural biodiversity from 2-4 December 1998, organized by the Convention on Biological Diversity (CBD) together with the FAO, and with support of the government of Netherlands. Over 60 participants attended from 20 countries and 15 international and regional organizations.

Focusing on agro-ecosystem and production system levels the workshop helped to identify the main elements required in order to provide enabling environments and technical, policy, institutional and legal incentives, from global to local levels, for the conservation and sustainable use of agricultural biodiversity. The aim of the workshop was: -stimulate work at country level and within institutions; -provide expert advice to FAO and the CBD on the assessment of ongoing activities and existing instruments; -assist FAO and the CBD to identify complementary and synergistic activities; and –contribute to the FAO-Netherlands Conference on the Multifunctional Character of Agricultural and Land.

The workshop concluded that four sets of actions for the conservation and sustainable use of all agricultural biodiversity especially at agro-ecosystem levels should be prioritized. The workshop prioritized actions related to: 1 – information, assessment and indicators; 2- research and development; 3-awareness raising and capacity building; and 4-development of policies and instruments.

In the light of the priorities and bearing in mind the opportunities, incentives and approaches discussed in the workshop, the participants made the following recommendations.

- Widening the understanding of agricultural biodiversity by promoting a concept whereby agricultural biodiversity encompasses the variety and variability of animals, plants

and micro organisms which are necessary to sustain key functions of the agroecosystem, its structure and processes for, and in support of, food production and food security.

- Encouraging the maintenance, sustainable use and enhancement of all types and levels of agriculture biodiversity in all types of production systems from diverse to specialized, small-to large scale and intensive to extensive systems.
- Improving integration and coordination of activities and processes for sustaining agricultural biodiversity, productivity and agroecosystem functions. The inclusion of actions plans for the conservation and sustainable use of agricultural biodiversity in national biodiversity, environmental and agricultural policies, strategies, plans and programmes as well as in those of key institutions.
- All organizations in the field of sustainable development need to work further to integrate and mainstream agricultural biodiversity in their policies, programmes and activities.
- Three dimensions of agricultural biodiversity which could be useful for increasing understanding and as a structure for future programmes and plans were identified: - sustainable production of agricultural products improving the conservation, sustainable use and enhancement of the diversity of all genetic resources for food and agriculture; -biological support to production emphasizing conservation, sustainable use enhancement of biological resources; - ecological and social services provided by agroecosystems.

The reports presents in form of annexes – a matrix for analysis and synthesis of relevant ongoing activities and instruments, - Prioritisation of issues and activities for the conservation and sustainable use of agrobiodiversity in agroecosystems and production systems; and –an analysis of required actions for enhancing agrobiodiversity and production in intensive production systems in selected agroecosystems.

Coverage: Global

Case studies or examples from: Brazil, El Salvador, France, Peru, Senegal and Vietnam.

 # 2 AERU. 200. Environmental Management for Agriculture. Agriculture and Environment Research Unit, University of Hertfordshire, UK.

The EMA software runs on Windows 95 (or higher) and is available on

CD for a cost of 35 pounds (+VAT 41.13 pounds) per copy. If you would like to purchase a copy please send your name, address and a cheque made payable to "The University of Hertfordshire" to: Kathy Lewis/John Tzilivakis, Agriculture and the Environment Research Unit, Department of Environmental Sciences, University of Hertfordshire. Hatfield Campus, College Lone, Hatfield, Hertfordshire. AL 10 9 AB United Kingdom. Alternatively, you can order a copy by Tel/Fax: 01707 284548/285258 or Email:
HYPERLINK mailto:ema@herts.ac.uk
ema@herts.ac.uk
and a copy will be sent with n invoice for 35 pounds (+VAAT 41.13 pounds).

Environmental Management for Agriculture (EMA) is computer software that aims to encourage farmers to improve their environmental performance. Its target audience is farmers in the United Kingdom. The approach is based on the principles and philosophy of formal environmental management standards such as ISO 14001, as used by other industrial sectors. These systems use auditing techniques to assess and review the environmental performance of a business. Carried out on a regular basis (e.g. annually) the aim is to establish a cycle of continuous improvement in environmental performance. EMA provides an environment audit (Evaluation System) to help identify the key impacts of the farm, opportunities for improvement and thus environmental objectives. Advisory and Technical systems are available to help the business achieve those objectives by providing useful information and decision support on best practice for the farm.

Topics: environmental audit, on-farm impacts, off-site impacts, decision systems.

 # 3 Allen-Wardell, G.P. Bernhardt, R. Bitner, A. Burquez, S. Buchmann, J. Cane, P.A. Cox, V. Dalton, P. Feinsinger, D. Inouye, M. Ingram, C.E. Jones, K. Kennedy, G.P. Nabham, B. Pavlik, V. Tepedino, P. Torchio and S. Walker. 1998. The potential consequence of pollinator declines on the conservation of biodiversity and stability of food crop yields. Conservation Biology 12: 8-17.

An initial article attempting a valuation of pollination as an ecosystem service, and the impact of its loss on agricultural productivity.

Coverage: primarily North America

Topics: pollination, ecosystem services, valuation

 # 4 Almekinders, C. and W. de Boef. 2000. Encouraging Diversity: Crop Development and Conservation in Plant Genetic Resources. Intermediate Technology Publications, London. 368pp.

This compendium presents case studies of plant genetic resources conservation in many countries. The case studies document the apparent conflict between crop conservation and development, and contribute to an understanding of the new opportunities that are offered by new approaches and activities and perspectives of genebanks, plant breeders, seed programmes and NGOs involved in crop development and conservation, placing them in the context of new approaches in local and global Plant Genetic Resource (PGR) management by both the formal and informal sector.
The last part of the book describes the next step in the debate around PGR management and discusses the implications of integrated and adaptive management approaches in PGR management.

Coverage: Global

Case studies from: Ethiopia, Kenya, Zimbabwe, India, Nepal, Ecuador, Peru

Topics: crop genetic resource conservation, farmer's rights

 # 5 Altieri, M. A. 1999. Multifunctional dimensions of ecologically-based agriculture in Latin America. Department of Environmental Science Policy and Management University of California, Berkeley. Paper prepared for the FAO/Netherlands Conference on the "Multifunctional Character of Agriculture". Sep. 13-17, 1999. http://www.cnr.berkeley.edu/~agfroeco3/multifunctional_dimensions.html

http://www.igc.apc.org/csdngo/agriculture.agr.

Today in Latin America there are still regions with microcosms of traditional farming systems, (i.e., in Mesoamerica, the Andean region, and the Amazon Basin) that have emerged over centuries of cultural and biological evolution and that based on locally available resources and the cultivation of a diversity of crops and varieties in time and space, have allowed traditional farmers to maximize harvest security and the multiple use of the landscape with limited environmental impact. Agro-biodiverse traditional agroecosystems represent a strategy which ensures diverse diets and income sources, stable production, minimum risk, efficient use of land resources, and enhanced ecological integrity. This legacy of traditional agriculture demonstrate that the combination of stable and diverse production, internally generated and maintainable inputs, favorable energy

input/output ratios, and articulation with both subsistence and market needs, comprises an effective approach to achieve food security, income generation, and environmental conservation. Traditional approaches represent multiple use strategies that enhance the multifunctional nature of agriculture, an important feature for the health of rural regions in the next century.

Coverage: Latin America

Topics: farm level management of agrobiodiversity, traditional approaches

 # 6 BAA. 1997. Arable Wildlife: Protecting Non-target Species. British Agro-chemicals Association. Peterborough, UK. 90pp.

(can be ordered from the British Agrochemical Association, 4 Lincoln Court, Lincoln Road, Peterborough PE1 2RP or from British Crop Protection Council, tel. +44 (0) 119 934 2727,

Within agricultural landscapes, wildlife may abound. A few species – in relative terms a tiny minority – have adverse effects on people and agriculture, and must be kept in check. There is a reason for farmers to be concerned about impacts of modern agriculture on non-target species, even beyond the biodiversity implications. Increased mechanization, changed rotations, more efficient weedkillers and pressures to maximize agricultural output to produce cheap food have all imposed changes that have impacted on non-target species. The centers of large fields are beyond the normal range of natural hedge-dwelling predators; fewer hedges mean fewer nesting sites and shelters for birds that may help control pests, larger and heavier machinery means potential damage to soil structure and loss of soil fauna through cultivation, etc.

This booklet provides a set of general guidelines to show farmers and advisors (in the UK, but with principles applicable elsewhere) that given commitment and skill, backed by knowledge and understanding, non-target species can be protected without prejudicing productivity or profitability. The objectives in protecting arable wildlife should be:

- The conservation and enhancement of the diversity of the naturally occurring plants and wildlife of the whole farm and surrounding areas.

- optimisation of the contribution available from natural pest predators by the integration of measures that will encourage the build-up of the whole populations.

- optimization of then contribution that can be made by crop rotations to discourage the build up of pest populations and disease.

 # 7 Bhar, B. and L. Fahrig. 1998. Local vs. landscape effects of woody field borders as barriers to crop pest movement. Conservation Ecology [online] 2(2): 3. Available from the internet. URL: http://www.consecol.org/vol2/iss2/art3

Maintenance of woody borders surrounding crop fields is desirable for biodiversity conservation. However, for crop pest management, the desirability of woody borders depends on the trade-off between their effects at the local field scale and the landscape scale. At the local scale, woody borders can reduce pest populations by increasing predations by providing complementary habits and reducing movement rate of pests out of crop fields. At the regional scale, woody borders reduce pest populations by reducing colonization of newly planted crop fields. Our objective was to develop guidelines for maximizing pest control while maintaining woody borders in the landscape. We wished to determine the conditions under which the regional effect of borders on colonization can outweigh local enhancement effects of borders on pest populations. We built a stochastic, individual-based, spatially implicit simulation model of a specialist insect population in landscape divided into a number of crop fields. We woody borders on local survival. The simulation results suggest that woody borders are most likely to enhance regional control of crop pests if (1) the woody borders are very effective in reducing insect movement from one crop field to another, and (2) crop rotation is on a very short cycle. Based on these results, our preliminary recommendations are that woody borders should contain dense, tall vegetation to reduce on as short a cycle as possible. These conditions should ensure that woody borders can be maintained for their conservation value without enhancing crop pest populations. The results are encouraging because the two most important factors are not sensitive to details of pest habitat use; the recommendations should apply across most pest species.

Topics: conducted simulations to determine the conditions under which woody borders enhanced vs. reduce the regional pest population size. The following factors were considered: landscape fragmentation, crop rotation period, barrier effect of biodiversity that mitigates pest and diseases, landscape level agrobiodiversity.

Coverage: theoretical (simulation model)

 # 8 Boatman, N. (ed.). 1994. Field Margins: Integrating Agriculture and Conservation. Proceedings of a Symposium organized by the British Crop Protection Council in association with the British Ecological Society and the Association of Applied Biologists, held at University of Warwick, Coventry, on 18-20 April 1994. BCPC, Survey, UK. 404pp.

(can be ordered from British Crop Protection Council, tel. +44 (0) 118 934 2727, publications@bpcp.org , http//www.bcpc.org)

Whereas recently field margins were viewed by arable farmers as a source of weeks, pests and diseases, the benefits of marginal habitats as reservoirs of beneficial invertebrates, predators of pest species of crop pollinators are becoming more widely understood. Field margins have amenity values in countryside, in providing migration corridors for organisms, and providing the last haven for wildlife in an otherwise hostile environment created by intensive modern farming.

The role and management of field margins in agriculture has changed in recent years. Many formerly mixed farms have become entirely arable, and hedges have lost their previous purpose. Increased labour costs have led to a decline in the practice of traditional labour-intensive maintenance techniques such as hedge-laying and dry stonewalling. This has been accelerated in stock rearing areas by increased stocking rates, resulting in intensive grazing pressure on hedge bases. Increased use of inorganic fertilizers and pesticides on crops may have effects on the fauna and flora of field edges via drift, surface run off or leaching into drainage ditches.

Yet policies may bring new changes: Commodity surplus have shifted agricultural support policy away from productivity-oriented incentives to production stabilizing mechanisms, with environmental benefits becoming an increasingly prominent factor in policy and spending decisions at national and European levels.

Case studies from: United Kingdom, Netherlands, Germany

Topics: grants and incentive measure, field margins, conservation headlands, arable wildlife.

 # 9 Bohart, G.E. 1972. Management of wild bees for pollination of crops. Annual Review of Entomology 17: 287-312.

Coverage: North America

Topics: pollination

 # 10 Boulouc, G. 1998. Relance de l'Aubrac laitiere. Cooperation fromagiere "jeune montagne". available on old CBD Website: http://216.95.224.231/agro/Casestudies.html

This short notes describes the actions of a dairy cooperative in the straddling the region of mid-Pyrenees, Languedoc and Auverge of Southern France, to revive an local breed of cattle, and by cross-breeding, introduce traits which will promote both milk production and local adaptation. Acknowledging that the objective will be ten or twenty years off, the producers nonetheless are hopeful of reestablishing the quality of their cheese production through use of local agrobiodiversity.

Topics: livestock genetic resources

Coverage: France

Includes cased study from: France

 # 11 Brookfield, H. 2001, Exploring Agrodiversity. Columbia University Press, New York. 347 pp.

The author, lead scientist on the multi-year, multi country people, Land and Environment change project of UNEP GEF, defines agrodiversity as the manner in which farmers use all their available resources. This book is an exploration of the issue, and how it has evolved in the author's conceptualization as he has looked back over his and others' experiences in the field over forty years. As he notes, the dynamic diversity of small farmer's practices has only the most limited formal literature, and that which exists is of uneven geographic overage. The larger literature on human ecology filed research with small farmers is examined and illuminated by the author's own field-work, to understand incremental patterns of agricultural change over time.

In the first section of the book, agrobiodiversity is presented by examples and concept, and as field of study. The place of diversity in agricultural history is discussed, and in a separate chapter, a thesis is drawn concerning anthropogenic influences on soil formation. In the second part, shifting cultivation is examined quite closely over several chapters, including its range of practices and adaptations. The third section of the book looks at trajectories of change, with an emphasis on those periods of intensified change, including but not limited to the green Revolution. The fourth section of the book turns to modern trends and forces in agriculture, with an emphasis on trade and policy influences on the question of sustainability of agrodiversity.

Coverage: Global

Topics: landscape level diversity, human ecology, traditional knowledge of agrobiodiversity.

Case studies or examples from: Borneo, India, Japan, Java, Kenya, Malaysia, Nigeria, Papua New Guinea, Peru, Philippines, Sudan, Zambia.

 # 12 Brookfield, H. and C. Padoch. 1994. Appreciating Agrobiodiversity: A look at the dynamism and diversity of indigenous farming practices. Environment 36(5): 6-11 and 37-44.

This article introduced the "People, Land and Environment Change" project of United Nations University, also introduced the notion that variability on the farm scale may be the source of humanity's best solutions for agriculture and land management in the future. Crop biodiversity is seen as only part of a wider complex of farmers' management practices. This wider framework is called "agrobiodiversity", or the many ways in which farmers use the natural diversity of the environment for production, including not only their choice of crops but also their management of land, water and biota as a whole. There is a close relationship between agrodiversity and managed biodiversity. Because of the diversity of cropping and resource systems that exists, agrodiversity serves as a major means of conserving both structural and species biodiversity.

Farmers vary their practices according to intraseasonal variability, changing them to suit new economic circumstances, new crop and marketing opportunities, and growing population and demand. They use scientific information when available, but even without it, they often adapt with remarkable sensitivity and speed. "The importance question is not which traditional practices, as practiced in the past, are sustainable, nut rather which conditions favour destruction, or overexploitation of local resources."

The paradigm proposed in this paper is applied, as an example, to the issue of land degradation, where it is noted that the question is responsibility for land degradation is a complex issue, not amenable to any simple generalization. Recent studies in Africa show how many smallholders have shown great resilience in adapting their agricultural systems to the larger socioeconomic conditions in the face of high population pressure and unprecedented population growth.

The paper makes some interesting observations on the renewed stress on " traditional knowledge." It notes that the role of the farmers' own knowledge and adaptability has continued to be undervalued until very lately. Now the pendulum appears to be swinging in the opposite direction, with an emphasis on traditional knowledge. The use of

indigenous technical knowledge is somewhat in danger of being treated as a new solution to all problems of development. This is an extreme view and it is more valuable to discuss the problems of using farmers' knowledge in parallel with "scientific" knowledge. More importance is the blending of old with new practices, the ability of farmers to innovate, adapt and adopt. What farmers know is certainly important, but this knowledge changes through time, and this fact is of great importance.

Moreover, there are problems in the use of small farmers' practices and knowledge. Many agricultural scientists and development specialists are reluctant to accent indigenous knowledge, and the management systems based on it, as having scientific value. Indigenous knowledge is often place-specific, and in both structure and cultural context, it is different from that of "rational science". To many scientists, this reasoning has been an insuperable objection to the acceptability of indigenous knowledge in anything but a subordinate role. But the very specificity of indigenous knowledge that has been viewed as a weakness also is its strength. The history and diversity of local circumstances and changes are reflected in that knowledge and in the production systems that incorporate it. The richness of agrodiversity is the result. The paper then addresses how to capture and codify such information, which if recorded, is largely left in the domain of "grey literature" of reports and photocopied papers. The paper makes an argument that there is a compelling need for structured networking among regions, not only to gather information on agrodiversity, but also to demystify an area still dominated by preconceived notions derived from simple theories.

Coverage: Global

Contains examples or case studies from: Peru, Papua, New Guinea, Irian Java, Philippines, Indonesian, Borneo, Kenya

 # 13 Brown, L. 1996. Tough Choices: Facing the Challenges of Food Scarcity. Worldwatch Publications, Washington, D.C. ordering information at: http://www.worldwatch.org

Conservation of agrobiodiversity will have to be achieved in the context of contending with food security.

Food scarcity may be the first major economic manifestation of an environmentally unsustainable global economy. Brown argues that the continually expanding demand for food is colliding with some of the earth's natural limits, including the sustainable yield of oceanic fisheries, the sustainable yield of the aquifers that supply irrigation water, and the physiological limits of crop varieties to use fertilizer.

Tough choices notes that while the growth in production is slowing, the growth in demand may be growing faster than ever before. The world continues to add 90 million people a year, but in addition, the Asian economy, led by China, is growing by 8 percent a year, boosting incomes and the consumption of grain-intensive livestock products at record rates. As the region's 3.1 billion people, more than half the world total, move up the food chain, it puts great pressure on the earth's land and water resources.

Tough choices addresses the choices nations will need to make contending with population growth and consequent natural resources under stress.

Coverage: Global

Agroecosystem focus: General

 # 14 Brush, S.B. (ed). 2000. Genes in the Field: On-farm Conservation of Crop diversity. Lewis Publishers, Boca Raton, US. 288pp.

Only recently has the Worlds' scientific community understood that a vast amount of diversity is being conserved on-farm, by farmers' practices, and that this holds value of global significance. Approximately 1.4 billion people live in farm families that are largely self-reliant and self-provisioning for their seeds and other planting materials. While farmers continue to see advantage in this way of maintaining seed material, or while they have no other alternatives, this form of conservation of resources will continue to exist. Many other forces, however, are impacting on on-farm plant genetic resource conservation.

This edited volume is a collection of papers focusing on agricultural conservation and diversity issues throughout the world. Genetic diversity is important to individual farmers, farming communities and to the agricultural community in general, but there are many different viewpoints on the efficacy of on-farm conservation. This book provides an opportunity for various authors from widely different backgrounds to explore issue raised around in-situ conservation. Recent trends suggest that regional and local farm seed varieties are being lost, as population increase, and modern agricultural technology and trade reach the world's diverse cultures. The chapters discuss both in situ and ex situ conservation strategies, and relevant policy issues.

Coverage: Global

Topics: Plant genetic resource conservation, intellectual property rights

Case studies or examples from: Ethiopia, Fertile Crescent, Mexico, Peru, Zimbabwe.

 # 15 Buchmann, S. L., and G. P. Nabhan. 1996. The Forgotten Pollinators. Island Press, Covelo, CA 292 pp.

The authors, of this popular book, an entomologist and an ethnobotanist and nature writer, illustrate in clear yet proficient language the importance of pollination between insect and plant, which provides the world with one-third of its food source. Using colorful examples-including a moth that rappels down cliffs to pollinate a plant in Hawaii – they also explain how modern developments are threatening this essential process.
The book is aimed at raising awareness about the potential loss of pollinators and their plants, while showing the larger picture of a fragile ecosystem through the eyes of some of its more unnoticed in-habitants.

Coverage: Global

Topics: pollination, ecosystem services

Case studies from: Mexico, United States, New Zealand, Madagascar, Brazil, Malaysia

 # 16 Cane, J.H. 2001. Habitat fragmentation and native bees: a premature verdict? Conservation Ecology 5(1): 3. [online] URL: http://www.consecol.org/vol5/iss1/art3

This very recent article considers what would be required in designing pollination reserves.

Few studies directly address the consequences of habitat fragmentation for communities of pollinating insects, particularly for the key pollinator group, bees (Hymenoptera: Apiformes). Bees typically live in habitats where nesting substrates and bloom are patchily distributed and spatially dissociated. Bee studies have all defined habitat fragments as remnant patches of floral hosts or forests, overlooking the nesting needs of bees. Networks of even small reserves may hold hope for sustaining considerable pollinator diversity and the ecological services pollinators provide.

Coverage: Global

Topics: pollination

Case studies or examples from: Brazil, Argentina, Germany and US.

 # 17 CBD Secretariat. No date. Assessing the Impact of Trade Liberalization on the Conservation and sustainable Use of Agricultural Biological Diversity. Note on an assessment under preparation by the Secretariat.

This note is intended to provide information on an assessment currently being prepared by the Secretariat of the Convention on Biological Diversity on the impact of trade liberalization on the conservation and sustainable use of agricultural biological diversity in consultation with relevant bodies, such as the World Trade Organization (WTO). The study will be submitted to SBSTAA VII under the agenda item on the CBD's programme of work on Agricultural Biodiversity.

The primary focus of this study is to examine the extent to which trade liberalization affects biodiversity, through changes in the farm sector. The agricultural sector is noteworthy for its pervasive, deep and persistent trade restrictions and distortions. Since the 1950s a deepening spiral of protection has occurred, for the most part in industrialized countries, and more recently in some transitional economy countries. In response to this labyrinth of trade restrictions, in the 1990s governments tentatively began a long process towards trade liberalization reforms in the farm sector.

The study looks both at previous and expected future impacts of trade liberalization on price, with an aggregate impact resulting from the simultaneous drop in price-suppressing subsidies and price-increasing tariffs expected to the mixed and ambiguous, but leading on average to an increase in farm output prices.

Impacts of reduced subsidies, which can be expected with trade liberalization may be beneficial to agrobiodiversity, as a reduction in subsidies applied for the most part in developed countries lowers incentives for the over-application of pesticides and fertilizers, lower pressures on the conversion of vulnerable or ecological significant lands into arable production, and lowers other kinds of production pressures, including irrigation withdrawals. However, reduction in subsides may eliminate financial support in the farm sector – including decoupled farm payments – on greenbelt areas, landscaping objectives and land set-aside initiatives and spur farmers towards higher levels of economic and production efficiencies, including concentrating production intensities and altering crop outputs.

Resulting changes in farm production methods are discussed, as production efficiency is enhanced in the agricultural sector. Farm production modernization is often characterized by more intense land

tillage, including tillage of sloping areas; an increased reliance on freshwater inputs, including irrigation, which often exert water quality and quantity effects; the adoption of monoculture crops in specialization objectives; the concentration of livestock operations; and reliance on agro-chemical inputs. Although all farming represents the conversion of natural resources and changes in habitats, technified, concentrated, specialized and large scale farm production tends to push wildlife outside of the farm system. Among the characteristics of industrialized or homogeneous factors of agricultural production is an increased reliance on fertilizer and pesticide inputs. Pesticide and other agro-chemicals, which by intent destroy target species, also by accident disrupt or destroy non-target species. Soil compaction causes water to infiltrate the soil differently, which may increase the risks of runoff and erosion. Nutrient cycles can be significantly altered, as nutrient-based fertilizers bring about changes in soil bacteria and vegetation. A key concern of farm modernization related to a reliance on a narrow range of plant varieties for total food output is higher risks of genetic vulnerability, that is, when a widely planted crop is susceptible to a pest, pathogen or environmental hazard, leading to the possibility of sudden and widespread crop losses.

In addition to these more well understood aspects of trade liberalization, the summary also notes possible impacts of changes in international and domestic transportation on agricultural production systems, which remove natural barriers as policy removes artificial barriers. Concerns related to alien invasive species under new trade regimes are considered, and income and equity effects of liberalization on the rural poor. Mention is made of new developments in relation to increased consumer demand for sustainably produced food products.

 # 18 Clapperton, J. no date. Worm Watch. Submission of the Canadian Government to SBSTTA. Available for download on the CBD website: http://www.biodlv.org/areas/agro/case-studies.asp. More information on website: http://www.cclw.co/ecowatch/wormwatch/

Worm watch is a program that is being initiated by the Canadian government to promote awareness of the diversity of "life beneath our feet" through public participation in a nationwide earthworm census. The census takers will be students, farmers, and producer groups, conservation and naturalist groups, gardeners and interested individuals and families. They will be supplied Warm Watch kit containing background material on earthworm ecology and taxonomy, instructions on how to sample and record their data, datasheets, a photographic key showing the most commonly encountered earthworm species, vials for the preservation of

earthworms that could not be identified, and a list of references, including a wormwatch website and a too-free number. An instructional video demonstrating the various sampling techniques should also be available. Scientists will make use of the data collected to inventory and study the distribution of earthworm species in Canada, including correlations between landuse patterns (including undisturbed vs. disturbed habitats, cropping systems, and tillage practices) ecozones, and earthworm populations and species diversity. The data collected should significantly increase the scientific community's understanding of the biogeography of post glaciation earthworm populations, and the history of their distribution. It can also be used to evaluate the potential of using earthworms as one of a suite of bioindicators of environmentally sustainable land use practices, and the information on species diversity and preferred habitat will be useful when considering policies on introducing earthworms for waste management, integrated pest management, soil improvement, and site reclamation.

Topics: soil biodiversity, public awareness of agrodiversity.

Coverage: Canada

 # 19 Collins, W.W. & C.O. Qualset. 1999. Biodiversity in Agroecosystems. CRC Press, Boca Raton, FL.334pp.

The first three chapters address belowground biodiversity in agroecosystems. Chapter One (Ann C. Kennedy) covers soil microbes in general, chapter Two (Stuart S. Bamforth) focuses on soil protozoa, and chapter Three (Deborah A. Neher & Mary E. Barbercheck) covers mesofauna (medium-sized invertebrates). This portion of the book reviews the function of belowground biodiversity in agroecosystem productivity and quality, and how this diversity is affected by management practices. Soil quality can greatly impact land use, sustainability, and productivity. Soil microbia include bacteria, actinomycetes, fungi, algae, viruses, and protozoa, whereas the mesofauna include the enchytraeids, nematodes, mites, and springtails. These serve as sources and sinks of nutrients in all ecosystems and play crucial roles in soil formation, residue decomposition, nutrient cycling, toxicity removal, and biological control. Agricultural practices such as reducing tillage, using organic fertilizers, and increasing crop diversity (through rotation, polyculture, or intercropping) can restore soil resilience and protect or promote belowground biodiversity. Soil microorganisms are highly sensitive to disturbances, such as those introduced by agriculture, and may therefore serve as early warning indicators of changes in soil quality. However, there is no clear relationship between the diversity of belowground organisms and benefit to a system, although of the

authors (Chapters One and Two) support the notion that community and ecosystem stability is inherent in diversity. These chapters stress, however, that far more information is needed in the fields of taxonomy and species and community function before the interrelationship of belowground biodiversity and soil quality and productivity can be elucidated.

These chapters seek to summarize known information on the interrelationships between underground biodiversity and agricultural productivity by addressing the following questions.

1). What is known about the diversity, abundance, and ecological function of the most important groups of microbes and mesofauna in wild and agricultural soils?
What impacts do various agricultural management practices have on the diversity of soil microbes and mesofauna, and, conversely do management-induced changes in belowground diversity impact soil quality and productivity?
What management practices promote conservation or enhancement of belowground biodiversity?
What are the information gaps that limit our understanding of the interrelationships between belowground diversity and agricultural productivity?

Coverage: Global

Topics: soil biodiversity

The next two chapters focus on the structure and nature of agroecosystems, how they impact the diversity of insects, and how these can be harnessed for pest management. Chapter 4 (Petr Stary and Keith S. Pike) covers the uses of insect natural enemies (parasites and predators) and promotion of their diversity in agroecosystems. Chapter Five (Miguel A. Altieri & Clara I. Nicholls) describes the structure of agroecosystems and its relationship to the patterns and function of insect and plant diversity within them. The authors argue that simplification of biodiversity inherent in agricultural systems promotes pest populations and discourages natural enemies. These conditions can be ameliorated by temporal and spatial crop diversification, conservation of adjacent wild biodiversity (harbouring alternate hosts or prey and nectar and pollen sources), use of repellent, attractant, or trap plants, use of chemical attractants, introduction or adaptation of biocontrol agents, and modification of pesticide use, tillage, and mowing patterns. Some of the constraints to natural enemy use are lack of sufficient taxonomic and ecological information and the need to assess and modify their use under a

daunting array of geographic, climatic, and agroecological conditions.

The chapters attempt to outline the conditions that promote the efficacy of natural enemies in pest management in agroecosystems by focusing on these key questions:

1) How is agroecosystem heterogeneity (diversity in time and space) related to the diversity and function of natural enemies?
2) How do various agricultural practices affect natural pest control?
3) What interventions exist to conserve, promote, and augment natural enemies in agroecosystems?

Coverage: Global

Topics: biodiversity that mitigates pests and diseases as

 # 20 Cordeiro, A. and B. de Mello. N.D. Recovering Local Maize in Brazil, submission of the Brazilian Government to agrobiodiversity case studies, Convention on Biological Diversity. Available on old CBD website: http://216.95.224.234/agro/CaseStudies.html

The loss of genetic diversity in food crops as a serious threat to agricultural development in Brazil. The negative consequences of legislation on patenting life on a community effort to develop farmers' self-sufficient and good quality maize varieties. A project was undertaken to encourage farmer production of maize seed, based on the reintroduction of local varieties, as the NGOs of the Alternative Technologies Project (PTA), had found that a few farmers who were still maintaining local varieties, and getting satisfactory yields despite their poor production conditions. A series of training courses were initiated for technicians of the PTA network to discuss the potential and limitations of promoting the use of local varieties. Valorization of local varieties and farmer's participation were the main principles to guide any search for solutions to the problem of seed dependency. The final objective was that farmers produce their own seed. For this, it was necessary to substitute hybrids with open-pollinated varies. With a greater knowledge about the different varieties and better information about how to work with them, farmers can make their own choices and organize seed production at the community or individual level. Supported by the NGOs of the PTA (Alternative Technologies Project), the experience shed light on the possibility of innovation in plant breeding, in such a way that farmers, technical support people and plant breeders work together.

Topics: plant genetic resources, landraces

Coverage: Brazil

case study from: Brazil

 # 21 Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill. J. Paruelo, R.G. Raskin, P. Sutton, M. Van den Belt. 1997. The value of the world's ecosystem services and natural capital. Nature 387:253-260.

The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet. The paper undertakes to estimate the current economic value of 17 ecosystem services for 16 biomes, based on published studies and a few original calculations. For the entire biosphere, the value (most of which is not yet valued by the market) is estimated to be in the range of US$16-54 trillion per year, with an average of US33 trillion per year, at a minimum. In contrast, gross national product total is around US$18 trillion per year.

The ecosystem goods and services valuated in this publication are (in order of valuation, most to least): nutrient recycling, cultural, waste treatment, disturbance regulation, water supply, food production, gas regulation, water regulation, recreation, raw materials, climate regulation, erosion control and sediment retention, biological control, refugia, pollination, genetic resources, and soil formation.

Coverage: global

Topics: ecosystem services, genetic resources, pollination, biodiversity that mitigates pests and diseases, soil erosion.

 # 22 Crane, E. and P. Walker. 1984. Pollination Directory for World Crops. International Bee Research Association, Bucks, England.

Most pollination research has been devoted to crops grown in temperate zones. The pollination requirements of many tropical crops can often only be guessed at. Few comprehensive books have been published as easy reference material on the pollination of crops, worldwide, and it has not been easy for growers, agronomists or others to find out about crop dependence on pollination. This book and the Free book attempt to fill this gap. This small book provides information on more than 400 crop plants. The entry for each plant provides brief details that will be enough for many users and also gives reference to

200 publications on which material in the directory is based.

Coverage: Global

Topics: pollination.

 # 23 Cromwell, E. 1999. Agriculture, biodiversity and livelihoods: issues and entry points. Overseas Development Institute, London. Available on the Internet at: http://www.ukabc.org/abc.htm

This report was produced for the UK's Department for International Development (DFID), to improve internal understanding and generate a consistent and coherent approach to biodiversity in DFID. The report takes agrobiodiversity to "encompasses the variety and variability of plants, animals and micro-organisms at genetic, species and ecosystem level which are necessary to sustain key functions in the agro-ecosystem, its structures and processes for, and in support of food production and food security". It notes that millions of farmers around the world use, manage and develop agricultural biodiversity on practical, daily basis, while the governance of its conservation, sustainable use and benefit-sharing is determined at an international level by a number of agreements. Of these, the Convention on Biological Diversity, the International Undertaking on Plant Genetic Resources for Food and Agriculture and the WTO/TRIPs agreement are discussed.

Three main functions of agricultural biodiversity are identified: sustainable production of food, biological support to production, and ecological services. The features of agricultural diversity which distinguish it from other components of biodiversity are that: agricultural biodiversity is actively managed by farmers many components of agricultural biodiversity would not survive without this human interference; indigenous knowledge and culture are integral parts of agricultural biodiversity management; and many economically important farming systems are based on 'alien' crop species introduced from elsewhere. This creates a very great interdependence between countries for the genetic resources on which our food systems are based; as regards crop diversity, diversity within species is at least as important as diversity between species; because of the degree of human management of agricultural biodiversity, its conservation in production systems is inherently linked to sustainable use – making preservation through protected areas is of less relevance; but nonetheless in industrial-type agricultural systems, much biodiversity is now held ex-situ in gene banks or breeders' materials rather than on-farm.

Farmers in both more 'traditional' and more 'industrial' agricultural systems rely on using agricultural biodiversity as an integral part of their production strategies. In more industrial systems, crop diversity may be lower on=farm because – IF the necessary supporting infrastructure is in place – it can be stored (in gene banks) and manipulated (by plant breeders) off-farm. Non-crop agricultural biodiversity may remain significant on-farm and very important for biological support and ecological buffering. In more traditional systems, farmers actively manage agricultural biodiversity on-farm in order to improve productivity and maintain sustainability; and adopt to changing needs and circumstances and the need is to enable them to continue to do this. Give that global food security depends significantly on production in more industrial agriculture, it is relevant to note the important contribution of agricultural biodiversity to global food production as well as to sustainable livelihoods in more traditional agricultural systems.

The report notes that for the reasons outlined above, it is inappropriate to promote large-scale abandonment of biodiverse agriculture and to marginalize it in intensive production systems. The challenge is to create a new enabling environment that makes returns to the maintenance o agricultural biodiversity more sustainable and more accurately reflect agricultural biodiversity's true value to the livelihoods of different stakeholders.

The report seeks to identify economic incentives, institutional and policy barriers that currently exist against using agricultural biodiversity sustainably, by correcting the pull in policy, research, and implementation towards the globalisation of the industrial-type agriculture model. Specific interventions on local national and international levels are explored.

Coverage: global

Case studies or examples from: Kenya, Indonesia, Bangladesh, Peru, Vietnam, Philippines, Columbia, Zimbabwe, Mozambique, El Salvador
Topics: incentives measures, agrobiodiversity concepts, traditional agriculture, industrial agriculture, plant genetic resources, ecosystem services, seed fairs, In International Undertaking on Plant Genetic Resources, enabling environments.

 # 24 Crucible II Group. 1999. Seeding Solutions. volume 1. Policy options for genetic resources: People, plants, and Patents revisited. Copublished by: the International Development Research Centre, the International Plant Genetic Resources Institute, and the Dag Hammarskjold Foundation. 121pp.

In 1994, a diverse group of people, drawn from the North and the

South, from private and public sectors and from NGOs began to meet and discuss in issues related to the conservation and enhancement of plant genetic resources. They together published “People Plants and Patents”, a book that summarised the major issues related to ownership conservation and exchange of plant germplasm. The group has continued to meet, as a “highly diverse gathering at individuals who passionately and respectively disagree on intellectual property” and have produced this volume as an update on the range of discussions which have continued over several years. In spit of its diversity, the group has achieved a remarkable degree of consensus on particular recommendations.
This first volume has two sections. The first provides a wider context for understanding the intellectual property and biodiversity debate. The issue of loss of biological and cultural data is outlined, along with increased recognition for the role of farmers and indigenous people in conserving, developing and using biological diversity. It also examines the changing roles of public and private sector agricultural research.

The second section of part one deals with ‘Changes in molecular bioscience’. We know that biological knowledge is expanding rapid, and scientific and technical breakthroughs at the molecular level are not only changing the practice and interpretation of science, they also have profound implications for society. Among the examples highlighted in this section are mammalian cloning, advances in genomics, the engineering of plants that render second generation seeds sterile, advances in drug research and discovery, and artificial human chromosomes.

Part two of the book scrutinises three major areas of discussion: who are the players and what are the for a where biological diversity and IP are being discussed? Over the past five years the international community has seen major conventions and legal agreements enter into force that relate to conservation and use of biological diversity and/or the control, ownership of and access to biological materials. Negotiations on biological diversity and intellectual property are taking place in multiple fora with overlapping and sometimes contradictory objects. However, there is a real danger of losing track of the overarching them and trends amidst the minutiae of international conventions. This section examines the central policy issues in three wide areas: policies related to germplasm access and exchange; policies linked to knowledge conservation and formation; and policies involving innovation management.

Coverage: Global

Topics: plant genetic resources, intellectual property rights, access and benefit sharing

 # 25 Daily, G. C. (ed). 1997. Nature's Services, Societal Dependence on Natural Ecosystems. Island Press, Covelo, California.

This book was written to address the lack of public appreciation of societal dependence on natural ecosystems. If ecosystems do have value such that out livelihoods depends on them, we are surely not appreciating these values: this ignorance is one of the factors responsible for human destruction of biosphere. If policy is to be formulated to appreciate these values, they need to be more clearly specified. In different chapters, this volume addresses the valuation of several ecosystem services as provided by several biomes – grassland, marine, freshwater and forests – are described.

Coverage: Global

Topics: ecosystem services, soil biodiversity, pollination, biodiversity that mitigates pests and diseases.

Case studies from: subsistence economies, Gunnison County, Colorado, South Africa fynbos.

 # 26 Dalpe, Y. no date. Biodiversity of Mycorrhizal Fungi. Submission of the Canadian Government to SBSTTA. Available for download on the CBD website: http://ww.biodiv.org/areas/agro/case-studies.asp

This submission, from the Eastern Cereal and Oilseed Research Centre of Agriculture and Agri-Food Canada, reviews information on the biodiversity of mycorrhizal fungi. It notes that only in the last few decades have botanists and mycologists realised that most terrestrial plants live in symbiosis with soil fungi. Among the types of mycorrizae observed in nature, one which is found on the vast majority of cultivated plants, and 85% of all herbaceous plants, is arbuscular mycorrhiza. This fungi is found under all climates and in all ecosystems, irregardless of the type of soil, vegetation or growing conditions. The symbiotic relationship between the two, in which the fungi provides the plant with greater access to water and soil minerals for its nutrition, while the plant provides the fungi with sugars, amino acids and vitamins essential to its growth, is probably millions of years old.

Given that the majority of cultivated plants used for human and animal food purposes are colonized by mycorrhizae, this symbiosis deserves to be better utilised by agriculture, selecting the best plant-fungus combinations. The fact that colonised plants are better able to obtain their nourishment in the soil and resist environmental stresses gives fungal symbionts a biofertilising and crop protection role. This should lead to healthier cropping systems and to reducing the use of

chemical inputs (pesticides and fertilizers) while ensuring crop profitability and environmental quality. The Eastern Cereal and Oilseed Research Centre of Agriculture and Agri-Food Canada is undertaken an inventory of indigenous and agricultural soils, descriptions of fungi, and computerized taxonomic documents. Their reference collection is the only one in Canada available to industry partners, government agencies, universities, and private producers, and supplies services relating to production and identification of strains and consultation services.

Topics: Soil biodiversity, sustainable agriculture

Coverage: Canada, Senegal, Burkina Faso

 # 27 Dias, B.S.F., A. Raw and V. Imperatri-fonseca. 199. INTERNATIONAL POLINATORS. Report on the Recommendations of the Workshop on the Conservation and Sustainable Use of Pollinators in Agriculture with Emphasis on Bee Conservation. Brazilian Ministry of the Environment, Brasilia.

The emergence of a serious and widespread disease has made it clear that native pollinators need to be protected and sustainably managed for the pollination service they can provide and that agricultural practices be designed to incorporate the protection and sustainable management of bee populations. The pollinator crisis exemplifies the intimate relationship existing between the welfare of natural environments and their biodiversity and the needs of sustainable agriculture. As a contribution to the development of the CBD work program approved by Decision III/11 on the "Conservation and Sustainable Use of Agricultural Biological Diversity", which identified pollinators as one of the initial priorities, the Brazilian Government held an international workshop of experts to propose a framework for an international initiative on pollinators as a key element in this program. The workshop was attended by 61 scientists from 15 countries and four international organizations (CBD secretariat, FAO, IBRA and ICPBR). Six groups of specialists discussed: 1 – Reducing the Taxonomic Impediment on Pollinators, 2- Monitoring the Decline of Pollinators, 3- Identifying the causes of Pollinator Decline, 4 – Quantifying the Economic Value of Pollinators to Agriculture, 5-Conservation of Pollinator Diversity, and 6- Sustainable Use of Pollinators the Recommendations of the Workshop include a proposal that COP5 formally establish an International Pollinators Initiative based on the framework for action contained in this report and request SBSTTA to co-ordinate, with support from the Executive Secretary, the preparation of a first Global Diversity Outlook Report on Pollinators. The Workshop participants also requested that COP5 call for international co-operation to develop the international Pollinators Initiative, and

furthermore, propose the creation of Pollinators Specialist Group within the Species Survival Commission of the IUCN. The recommendations produced by this workshop are intended to help foster support from agencies to enhance initiatives on all continents on pollinator conservation and sustainable use. This should help to mainstream the issue of biodiversity in our society and to direct the conservation movements to promote the maintenance of biodiversity as an essential component to ecosystem functioning.

The workshop participants concluded that there is insufficient reliable data on the reported declines in the numbers of pollinators and their effects on agriculture, but that the necessary expertise to collect such data is available. Furthermore, they agreed that such an effort is viable provided the institutional support is available. However, the difficulties in obtaining reliable identification of pollinators (especially of bees), which are vital for the success of both the monitoring programme and pollination research, was also stressed. They also emphasized that the pollination requirements of relatively few crops are known. The experts spoke of the need to produce manuals and catalog and agreed that the creation of websites with databases of specialists, publications and reports and information on the pollination requirements of crops and on their pollinators is vital and that success of the proposed actions will be greatly enhanced with public awareness of the problem. The spread of successful pollinators for some cultures should be regulated, in order to avoid their introduction in areas outside their natural distribution and avoid competition with local pollinators.

The 43 proposals for action of coming from this workshop are varied, and many are concerned with the collection of reliable information and its dissemination. The predominance of these two subjects demonstrates the participants' desire to have access to standardized extra data. Some of this information already exists but is not really available, while much additional data need to be collected. An international training program was suggested, with standardized methodology and well-defined goals in order to create a worldwide network of experts capable to develop appropriate actions for the conservation and sustainable use of local pollinator diversity.

Topics: pollination

Coverage: Global

 # 28 Dubois. 1998. Promotion of Biodiversity Conservation with Coffee landscapes. available on old CBD website: http://216.95.224.234/agro/CaseStudies.html

This document reports on the perspective of the GEF- funded "EIS Promotion of Biodiversity Conservation with Coffee Landscapes" project. The document notes that coffee production in Latin America evolved from a sun crop to shade-dominated farming system under traditional systems of management. It more recently has been subjected to forces driving it to, again, a sun crop, from donors such as USAID who have been convinced that the new system would reduce the spread of a fungal disease. The greatest rates of adoption of the new system have been in Colombia and Costa Rica.

There are, however, high biodiversity levels of native and migratory bird species in traditional coffee. In El Salvador, it has been noted that only 2% of the forest remains intact, and productive, human-altered landscapes need to contribute to promoting biodiversity. 9% of El Salvador is under coffee cultivation, of which some 95% is under shade cultivation systems. The project proposes to increase the extent of coffee plantations under biodiversity-friendly shade regimes, supports marketing and certification, and to establish a biological corridor of shade coffee plantation between two protected areas. The document reports on outcomes in a series of bullet points, which are difficult to interpret....

Topics: certification and marketing, migration corridors in agricultural land

Coverage: El Salvador

Includes case study from: El Salvador

 # 29 Elliot, L.F. 1997. Microbial Biodiversity and Grass Cropping Systems. Keynote address to the XVIII international Grassland Congress, and case study submission of the Canadian government to the Convention on Biological Diversity. Available on the CBD webpage at: http://www.biodiv.org/areas/agro/case-studies.asp

Grass cropping in a rotation and use of no-till seeding appear to be more important components for developing sustainable cropping systems. Grass cropping and no-till seeding improve soil organic matter content, increase the soil microbial biomass, increase earthworm numbers, likely cause a buildup of fungivorous microarthropods and nematodes, and greatly increases the resistance of soil to erodibility. Grasses in the rotation usually result in a large rotational effect. All of these factors point to beneficial effects on soil biodiversity. It is unlikely that soil biodiversity is increased but more likely that the beneficial portions of the diverse populations are encouraged. Methods for measuring the many components of soil biodiversity on a temporal basis are unavailable. Combinations of microbial biomass,

enzyme activity, genetic probes and markers, measurement of MRNA and more precise methods for separating individual micro and mesofaunal groups are potential approaches. In this manner procedures may be developed to follow key groups as indicators healthy been particularly useful. Earthworm counts appear to be a sensitive indicator to the biodiversity of an agricultural system.

More studies are needed regarding tillage and cropping interactions as they affect the microflora, microfauna, mesofauna and macrofauna. Tillage reduces the soil organic matter content, the microbial biomass content, earthworm numbers, and generally greatly increases soil susceptibility to erosion. Tillage disrupts micro and mesofaunal relationships but results are not clear at this time. It appears that protecting soil from the negative impacts of tillage is essential for preserving soil biodiversity and is an important component of sustainable cropping systems. Being able to define components of soil biodiversity that promote soil health and sustainable cropping systems are very important to users and policymakers. This knowledge will provide a basis for appropriate decisions based on fact.

Topics: sustainable agriculture, soil biodiversity

Coverage: Canada, temperate zones

 # 30 Enriquez, L. 2001. Cuba's New Agricultural revolution: The Transformation of Food Crop Production in Contemporary Cuba. Food First, California, USA. Available at: http://www.foodfirst.org/pubs/devreps/dr14.html

The first half of the1990s witnessed the start of a major transformation of Cuban agriculture, from an emphasis of large state farms to locally based concerns; from export-oriented production to food crop production; from high technology to alternative technologies. This essay takes a look at the transformation that is currently underway in Cuban agriculture and how-and whether a number of dilemmas produced by Cuba's classical model of development are being addressed.

Coverage: Cuba

Agroecosystem focus: General

Topics: alternative technologies

 # 31 Faeth, P., ed. 1993. Agricultural Policy and Sustainability: Case Studies from India, Chile, the Philippines and the United States. World Resources Institute, Washington, DC. 114pp.

As unsustainable agricultural practices continues to be used throughout the world. The symptoms of salinisation, erosion, water pollution, etc, become more evident. At the same time, hunger already a daily reality for the world's poorest, is growing. Conventional economic analysis obscures the degradation of the natural resource base that supports agriculture. Changes in the productivity of natural resources simply are not taken into account. Until now, economic research on agriculture has failed measure sustainability and to reveal how policies biased in favor of conventional farming methods erode the resource base.

This volume is an effort on the part of the World Resources institute to fill this gap by using natural resource accounting methods to get a clearer picture of the relationship between farm policies and sustainability. The book addresses how farm policy affect the production choices that farmers make, and how those choices affect environmental and human health. By quantifying the environmental impacts of various combinations of cropping systems and farm policies. The authors demonstrate that farm policy is stacked against resource-conserving farming methods in all but one of the six areas studies. They find that the real costs of conventional farming methods are miscalculated in both the developing world and the United States.

To encourage the transition to resource-conserving agricultural methods that is in every nation's long term interest, the authors recommend that governments reform their agricultural institutions and policies and improve the tools for monitoring and evaluation policy performance. Three key recommendations were:

- Governments should eliminate subsides that encourage the degradation of depletion of natural resources for instance, the electricity subsides that lead to groundwater depletion in India and the pesticide subsides that make unhealthy practices profitable in the Philippines.

- To reduce both fiscal costs and environmental damages, industrial countries should revise their farm income-support programs, tying support to need and to stewardship of the natural resource base, not to commodity production.

- Governments should revise the agricultural economic indicators reported in official statistics, making them relate the depletion, depreciation and degradation of natural resources.

Coverage: Global

Topics: sustainable agriculture, agricultural policy indicators.

Case studies or examples from: India, Chile, the Philippines and the United States.

 # 32 FAO 2001. The Economics of Soil Productivity in Sub-Sahara Africa. Food and Agriculture Organization of the United Nations. Rome, 2001.

Abstract: The problem of loss of soil productivity is a complex phenomenon yet most ecological studies focus on soil erosion or nutrient depletion in isolation and economic analyses focus on assessments of various conservation technologies or the incentives for fertilizer use. This book highlights how economics can positively impact the problem of degradation of soil productivity (soil structure, water holding capacity, nutrient exchange capacity, and acidity) as, previously. The role of economics in soil productivity at farm, national and international levels has often been over looked.

At the farm level, this book rethinks the factors of soil fertility that account for its sustainable use and the implications of economic analyses of these factors. Until recently, soil degradation focused on erosion and the most appropriate solutions for reducing environmental damage such as physical structures for conservation (e.g. stone lines, terracing, drainage channels). However, poor soil management practice often is cited as the root cause of soil degradation rather than erosion itself. In this case, participatory techniques to transmit information concerning improved soil management would be a more appropriate conservation measure. The effect of the economic analyses of the different approaches can be far-reaching.

Economic considerations that are recommended:

- Economic analysis of risk factors that inhibit input use; improved access t6o off-farm income to finance on-farm investments; and the profitability of various soil conservation techniques;

- Financial and economic analyses of farming cooperatives to establish the attractiveness of collective action to identify perceived net benefits to individual stakeholders. These net benefits weigh the contribution made by individuals to the common effort against their share of the resulting benefits.

Potential economic applications to soil productivity problems:

Assessing farm level incentives; Screening promising techniques through an analysis of incorporating depletion into production costs/farm budgets; Farm level sustainability indicators non-market valuation techniques.

At the macro-economic policy even the following are noted to affect natural resource management (including soil productivity): expansive fiscal and monetary policies (resulting in economic stability and discouraging farm-level investment in improved soil management), high inflation, high interest rates, overvalued exchange rates, high debt service ratios, protectionism (leading to over use of land).

Economic considerations that are recommended:

Sustainable indicators of a more general nature for use at farming, community and catchment levels. A variety of indicators are useful in raising decision-makers' awareness and in promoting improved soil management at all levels. Economic analysis can help screen and evaluate promising farming systems and soil management techniques.

Potential economic applications to soil productivity problems:

Macro-economic policy linkages through an economic analysis of estimating degradation damages; Green accounting; Sustainability indicators.

At the international level, interventions from other countries may hold as long as soil degradation imposes regional or global costs, or as long as there are global benefits from improving soil productivity. Costs at the international level include:

- Loss of crop/livestock production leading to eco-refugee problems and famine;
- Dietary deficiencies and diseases requiring international interventions;
- Flooding, soil transport and transboundary sedimentation problems leading to reduced crop yields
- Loss of significant soil microbe and earthworm biodiversity (e.g. penicillin, streptomycin);
- Waste accumulation of global proportions; greenhouse gas releases and global warming linkage as organic matter is removed.

Economic considerations that are recommended:

- Individual nations will not take into account global benefits stemming from soil management assistance unless they can capture a share of these benefits. International transfers (e.g. carbon credits) can provide countries with incentives to devote more resources to soil productivity.

- A relatively minor deterioration in soil productivity may result in catastrophic events (e.g. famine, eco-refugee displacement). Such a risk provides an incentive for the international community to

apply the precautionary principle, acting sooner rather that later to prevent such an occurrence.

Potential economic applications to soil productivity problems:
International transfers through an economic analysis of extended cost-benefit analysis; use of the precautionary principle.

Coverage: Sub-Saharan Africa (with global examples)

Agroecosystem focus: Sub-Saharan agroecosystems

Contains examples or case studies (in italics) from: Sub-Saharan Africa including as Niger, Nigeria, Sudan, Ghana, Burkina Faso, Lesotho, Kenya, Ethiopia, Madagascar, Malawi, Mali, South Africa, Zimbabwe, Morocco as well as Honduras, Mexico, Nicaragua, Haiti, Costa Rica, Dominican Republic, El Salvador, Guatemala, Panama, Ecuador, Indonesia, Nepal and India.

Topics: farm level, national and global economic considerations for sustainable soil fertility; economic considerations, recommendations.

 # 33 Free, J.B. 1993 Insect Pollination of Crops. 2nd edition, Academic Press New York.

The significance of insect pollinators in maximising the yield of numerous crop plants continues to be of great importance. Our knowledge of this subject has advanced considerably in recent years, and this updated version of Free's 1970 reference is probably the most complete compendium of information on crop pollinators. (Unfortunately, it is presently out of print). In the interim between the two editions, much more work has been carried out in the tropics, which is now included in the second edition.

Crops are presented in alphabetical order of their families, as species with similar flowers often share similar pollination of a crop species varies greatly with locality and with cultivar, and the author has tried to include as much of this localised variability as possible. The author points out that breeders of insect pollinated crops should always assure that the quality and quantity of pollen and nectar produced will attract sufficient pollinators even when competitive sources are nearby.

 # 34 Government of Brazil. N.D. Brazil's fantastic growth in no-till since Eco-92. Submission of the Brazilian Government to agrobiodiversity case studies, Convention on Biological Diversity. available on old CBD website: http://216.95.224.234/agro/CaseStudies.html

This four page brochure describes a farmer-led technological revolution in Brazil, beginning in 1972, to promote no-till farming techniques that have been adopted on over six million hectares. The brochure notes that a significant factor in the transfer of this technology has been the unique system of "Friends of the soil" clubs, joined together in regional associations and a national federation. In their local clubs, farmers swap experiences and hold technical events.

Coverage: Brazil

Topics: conservation tillage

Case studies or examples from: Brazil.

 # 35 Government of Brazil. 1994. Brazil: The Management of Agriculture. Rural Development, and Natural Resources. Document of the World Bank. Report No 11783-Br. In two volumes. (This paper is available at http://www-wds.worldbank.org/

This report presented in two volumes. The first volume is a detailed summary of findings and conclusions of the work on agriculture, rural development and natural resource policy in Brazil. The second volume assembles the background papers prepared as part of the mentioned study. The first volume is meant for policymakers and the second may be of interest to their advisers and to the academic community.

This study surveys and analyses the policies that the government has adopted towards agriculture and natural resources management in Brazil. It covers the following issues:

1. patterns of agricultural growth and recent policy adjustments,
2. foreign trade regime and agricultural price policies;
3. sugar/ethanol policy;
4. public finance;
5. agricultural research and extension;
6. rural credit;
7. land markets and land ownership;
8. small farm agriculture, rural development, and social services for the rural poor;
9. conservation, forestry and biodiversity.

This study recognises the abundance of biodiversity and diverse ecosystems in Brazil, and the ecological benefits of standing forests and of biodiversity. It presents the problems related to land use and resource degradation, and identifies the policy environment as one of the main causes of the agricultural expansion into forest.

This report also recognises that Brazil has undertaken major institutional

and economic reforms many in agricultural and natural resource management and documents a large number of interventions used by the government to manage agriculture, rural development and use of natural resources. However, conservation efforts have been concentrated in certain regions. For instance about 75% of the land in protected areas in Brazil is located in the Amazon region. The study concludes that Brazil must develop a conservation strategy that takes into account all the major biomes of the country.
The strategy should include a research agenda to increase the limited knowledge of plant and animal species and their inches in Brazil's varied ecosystems.

This study addresses policy measures aimed at conserving biodiversity, such as reducing subsidised credits to livestock sector and liberalising trade in agricultural products, thereby increasing the profitability of farming in existing agricultural areas relative to frontier areas. It suggests modifications in policies to achieve vigorous growth in agriculture, reduction in rural poverty and sustainable use of natural resources. It also makes specific recommendation of protected areas, and taxation of land in native forests and cleared areas.

Topics: Agricultural management, Rural development, Natural resources, Poverty mitigation, Governmental policies Trade policies, Natural resource policies, policy reform, Sugar/ethanol policy, land degradation, Land markets, Rural credit.

Coverage: Brazil

 # 36 GTZ. 2000. Support of the Informal Seed Sector. Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH in collaboration with the Centre for Genetic Resources, The Netherlands (CGN).

This small booklet aims to identify the conceptual and strategic background for support to the informal seed sector within the framework of sustainable seed supply systems and development cooperation. It concentrates on the informal seed sector and its complementarity and interface with the formal sector, since this important area has been neglected in the past. The case for the importance of local seed security for food production and sustainable agriculture is made. The vital contribution of the informal seed sector to ensuring food security for the rural population is emphasised. Additionally, the booklet shos that support for the informal seed sector contributes to in situ management of agrobiodiversity, and thereby to the implementation of Agenda 21 of the UN Conference on Environment and Development (UNCED) and of the Convention on Biological Diversity (CBD).

Coverage: global

Topics: agricultural genetic resources

 # 37 IPGRI. 1999. Key questions for decision-makers. Protection of plant varieties under the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights. Decision Tools, October 1999. International Plant Genetic Resources Institute, Rome, Italy.

This small booklet is part of an on-going body of work that IPGRI hopes will assist decision makers with the complex task of discerning the many issues of relevance to the conservation and management of plant genetic resources and devising a coherent and consistent policy and legislative response. The booklet is intended as a tool to help understand implementation options under Article 27.3(b) of the TRIPS agreement and their potential implications for each countries' objectives relevant to plant genetic resources.

Coverage: Global
Topics: agricultural genetic resources

 # 38 Jarvis, D.I.L. Meyer, H. Klemik, L. Guarino, M. Smale, A.H.D. Brown, M. Sadiki, B. Sthapit and T. Hodgkin. 2000. A Training Guide fro In Situ Conservation On-farm. Version 1. International Plant Genetic Resources Institute, Italy. Available from: http://www.ipgri.org/publications

This is a practical manual intended for national programmes interested in supporting in situ conservation of agricultural biodiversity maintained on-farm by farmers. It was written to provide a range of actors, including the Ministries of Agriculture and the Environment, universities, research and extension institutions, non-government organizations (NGOs) and community based groups, with a comprehensive view of factors involved in designing and implementing a programme to support the in-situ conservation of crop genetic diversity on-farm. Recognising the complexity of in-situ conservation, the guide is geared to give national programmes basic technical skills and tolls to build institutional capacity and partnerships to implement an on-farm conservation programme. It discusses the information necessary and the practical steps for the implementation of on-farm conservation, as well as the importance of such an initiative. Seed systems and institutional frameworks for the implementation of on-farm conservation initiatives are described. The importance of participatory approaches and relevant techniques are outlined. The reader is lead through the steps of acquiring information to develop an action plan, and linking actions to benefits for local farmers. The role of policy, and

our present lack of understanding of the effects of policy on-farm conservation, is described.

Topics: on-farm conservation, plant genetic resources

Coverage: global

Case studies or examples from: Bangladesh, Burkina Faso, Columbia, China, Denmark, Ethiopia, Hungary, India, Mexico, Morocco, Nepal, Peru, Philippines, South Africa, Syria, Tanzania, Turkey, Vietnam.

 # 39 Jones, R. and P. Munn, eds. 1999. Hab9tat Management for Bees and Wasps. International Bee Research Association, Cardiff, UK. 38pp. can be ordered from: http:///www.cf.ac.uk/ibra

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This booklet is a guide for those concerned with managing landscapes to conserve bee and wasp populations, or using bees and wasps as bio-indicators. It indicates habitat requirements of British bees and wasps, describes the planning, implementing and reporting of a site survey, and discuss UK priorities and funding for conservation of native bees and wasps.

Coverage: United Kingdom

Topics: pollination, habitat management

 # 40 Kirkwood, R.C. 1997. Biodiversity and Conservation in Agriculture. Proceedings of an International Symposium held at the Stakis Brighton Metropole Hotel 17 November 1997, British Crop Protection Council Symposium Proceedings No. 69.

(can be ordered from British Crop; Protection Council, tel: +44(0) 118 934 2727, publications@bpcp.or http://www.bcpc.org)

This symposium provides a British contribution to the topic of agrobiodiversity conservation. As is presently receiving much recognition, agriculture is important to biodiversity because farmland is such an important habitat. The papers presented in this volume considers the threats attributable to farming practices to mammals, ground beetles, invasive weeds and farmland birds. The effects of biodiversity appear to be most marked within the center of the field with greater biodiversity found around the field margins. Ground beetle diversity in farmland is intermediate between the best and worst of that found in natural habitats, while farmland bird populations appear to decreasing.

Several papers highlight the importance of retaining landscape features, especially hedgerows. Varied cropping patterns, untreated field margins, conservation headlands, and alternatives to pesticide use are advocated. The importance of retaining a mosaic of natural/semi-natural habitats including woodland copses, hedges, ditches, ponds and field corners is emphasised.

Appropriate government policies to benefit farmland wildlife are discussed.

Case studies from: United Kingdom

 # 41 Lesser, W. & S. Kyle. 1996. Policy Considerations along the Interface between Biodiversity and Agriculture Pp. 31-51 in: Srivastava, J., N.J.H. Smith and D. Forno, eds. 1996. Biodiversity and Agricultural Intensification: Partners for Development and Conservation. Environmentally Sustainable Development Studies and Monograph Series No.11. The World Bank, Washington, D.C.

The paper identifies the effect of international agreements and national economic policies on conservation and use of genetic resources in agriculture. It is asserted that an understanding of incentives structures at the local level is essential if biodiversity is to be conserved and managed more wisely. Thus, the emphasis is on understand how national and multinational policies apply at the local level. The paper examines price and land use relationships, macroeconomic policies, input taxes and subsidies, supply restrictions, land us policies on the conservation of biodiversity. Research paradigms such as those that influence the international agricultural research centers, are examined for their potential impacts on biodiversity. The benefits of involvement of local communities in policy development are stressed. Specific policy guides corresponding to the topics above are given.

Sovereign rights to genetic resources are discussed at length, including the FAO International Undertaking on Plant Genetic Resources, access legislation, Farmer's Rights. Specific policy issues and knowledge gaps in relation to genetic resources are identified. International trade agreements in relation to the conservation of biodiversity and other environmental safeguards are dealt with, including the handling of agricultural issues under GATT, NAFTA and the WTO.

Intellectual property rights and other forms of protection of information are considered. The difficulty of applying these to protect traditional knowledge, and the lack of a clear mechanism or link to conservation is discussed. The authors assert that while intellectual property rights and the genetic uniformity demanded by plant breeders' rights may

contribute to the declining use of traditional varieties; they have not been a major factor. The importance of developing a new system of access and rights in relation to tradition varieties and breeds, wild populations, and near-relatives of crops and livestock is stressed.

Coverage: Global

Topics: plant genetic resources, national economic policies, international agreements, incentive structure, price and land use relationships, macroeconomic policies, input taxes and subsidies, supply restrictions, land use policies, agricultural research, local community involvement, access legislation, International Undertaking on Plant Genetic Resources, international trade agreements.

Case studies or examples from: Philippines, Brazil, Costa Rica, Ethiopia.

 # 42 Long, R.F., A. Corbett, C. Lamb, C. Reberg-Horton, J. Chandleer and M. Stimman. 1998. Beneficial insects move from flowering plants to nearby crops. California Agriculture September-October 1998. Pp.23-26.

Marketing studies in California demonstrated that lady beetles, lacewings, syrphid flies and parasitic wasps fed on nectar or pollen provided by borders of flowering plants around farms: many insects moved 250 feet into adjacent field crops. These beneficial insects fed on flowering cover crops in orchard and moved 6 feet high in the tree canopy and 100 feet away from the treated area. The use of nectar or pollen by beneficial insects helps them survive and reproduce. Planting flowering plants and perennial grasses around farms may lead to better biological control in nearby crops.

Coverage: United States

Topics: natural pest control, sustainable agriculture

Case studies or examples from: United States.

 # 43 Matheson, A., ed. 1994. Forage for bees in an agricultural landscape. International Bee Research Association, Cardiff, U.K.

Land use and the conservation of insects are subjects of concern in many areas of the world; not only in the much-discussed tropical rainforests, but also in industrialized countries. In the UK and continental Europe, agriculture dominates much of the landscape, so agricultural practice has a significant effect on habitats for insects, including bees. There are large areas of arable land in Europe, much of which is unfavourable to bees; also the extent of semi-natural

habitats has declined, affecting bee populations.

Current changes in agricultural policy, especially those attempting to address the problem of overproduction of food, stand to have a significant impact on both wild bees and managed honey bees. This volume is intended to stimulate discussion of the need to work for bee conservation, and of the opportunities that have been created by current agricultural policies. It is also important that agriculture industry professionals to consider and adopt land management strategies that will promote the availability of habitats and food sources for bees.

Contributors to this volume looked at the present state of UK and European agricultural policy, especially as it affects set-aside programmes. Then the papers look at what has happened to nectar and pollen sources available to bees in Britain over the last 45 to 50 years, and what the current status is of nectar sources.

Coverage: UK and Europe

Topics: pollination, bee conservation, ecosystem services

 # 44 Matheson, A., A. L. Buchmann. C. O. Toole, P. Westrich and I. H. Williams. 1996. The Conservation of Bees. Academic Press, London, Linnean Society of London and International Bee Research Association – IBRA, 252p. Press, Washington DC.

Bees form a vital part of many natural and farmed landscapes all over the world both as pollinators and as part of the wider insect community. But everywhere bees are under pressure, from the direct impact of pesticides in the environment, as well as the indirect effects of habitat alteration and destruction.

This book focuses on a number of important topics in bee biology and conservation in temperate regions of four continents. The varieties of habitats needed fir bees to thrive, the essential links and interactions between bees and many plant species, and the current state of bee biodiversity and conservation are dealt with by an international group of authors.

Coverage: temperate zone

Topics: pollination

 # 45 McNeely, J.A and S.J. Scheer. 2001. Common Ground, Common Future: How EcoAgriculture Can Help Feed the World and Save Wild Biodiversity. IUCN/Future Harvest, Gland, Switzerland. Available on the internet at: http://www.futureharvest.org.

This report analyses the links between agriculture and biodiversity. It highlights the findings of a study that brings together successful methods from around the world that are being used to increase food production and save wild species. Such innovative farming and land management techniques are the elements of what the authors see as a new type of agriculture: "ecoagriculture". Case studies, brought together from six continents, demonstrate that while agriculture now presents the greatest threat to species diversity, improvements in agriculture through research can reverse this trend and enable agriculture to help conserve wild biodiversity.

The report identifies six key ecoagriculture strategies that can help farmers grow the food they need-without destroying the habitats of the wild species that live on or near their land. These are:

Strategy 1: Reduce habitat destruction by increasing agriculture productivity and sustainability on lands already being farmed.

Strategy 2: Enhance wildlife habitat on farms and establish farmland corridors that link uncultivated species.

Strategy 3: Establish protected areas near farming areas, ranch lands, and fisheries.

Strategy 4: Mimic natural habitats by integrating productive perennial plants.

Strategy 6: Modify resource management practices to enhance habitat quality in and around farmlands.

The research compiled within this report suggests that there are ways of managing the coexistence of wildlife and agriculture, and that previously unrecognized synergies can lead to increased food productivity and conservation gains.

Coverage: global

Topics: Sustainable agriculture, wild biodiversity in agricultural landscapes.

Case studies or examples from: Singapore, United States, China, Philippines, Brazil, Costa Rica, UK, Nepal, Australia, Indonesia, Central America, Vietnam, Zimbabwe, Kenya, Zambia.

 # 46 Mutta, D., Thrupp, L.A. and Simons A. 1998. Integrating Agrobiodiversity Concerns into National Policies, Plans and Strategies

in Eastern Africa. ACTS (African Centre for Technology Studies), WRI (World Resources Institute) and ICRAF (International Centre for Research in Agroforestry).

This paper is one of the documents resulting from the Agrobiodiversity workshop organized by ACTS and WRI during the Second Eastern Africa Sub-regional Forum on Biodiversity, convened November 17-19. 1997 at the International Centre for Research in Agroforestry (ICRAF) Nairobi, Kenya.

The paper is a good review of the socio-economic pressures on natural resources and is discussed in overall trends as well as in separate reviews of each country considered –
Ethiopia, Kenya, Uganda and Tanzania. Appropriate background information is also presented. The paper's topics include:

- A review of the Convention on Biological Diversity's decisions with reference to agrobiodiversity;
- Definition of agrobiodiversity including a brief overview of the general benefits of agrobiodiversity;
- Status of agrobiodiversity in the region with specific discussions of the Eastern Africa centre of origin of crop species (plus a world map of the Vavilov centres of crop genetic diversity with areas and examples of originating crops) and a short section on some of the endemic plants to the region;
- Trends in agriculture and agrobiodiversity based on the factors affecting agrobiodiversity (causes and processes) including demographic pressures, inequality and poverty, perverse food policies, changing food preferences, breakdown of traditional institutions, civil wars and insecurity.

Indications show that modern cash cropping farming systems has limited the use of agrobiodiversity. Traditional farming systems have not been mainstreamed in policy and little information exists concerning traditional knowledge, which further marginalises this farming system. Yet, traditional farming systems perform important functions where the modern agricultural productions fail leading to food insecurity due to drought, pests, loss of income, low quantities and variability of food often leading to malnutrition.

Modern cash cropping systems have been effectively propagated by policies designed to promote the Green Revolution leading to the current state that in all four countries under review, cash cropping highly dominates the economies of the region by factoring approximately 30-50% to GDP, as well as contributing highly to employment and the export crops to total export earnings. However, these practices originally lead to an increase in crop production

especially in two exotic crop varieties – wheat and rice, yet this was done at the expense of diverse traditional agro-ecosystems thus limiting the wealth of agrobiodiversity at the landscape, ecosystem, species and genetic levels. As Eastern Africa losses its genetic base, the potential for self-sufficiency in food production grows limited leading to dependency on food aid.

Although there are some efforts to address the loss of agrobiodiversity within Ethiopia, Kenya, Uganda and Tanzania, these are only implied in policy documents and programs and have only been largely ineffective due to inadequate financial, legal and institutional capacities to design and implement policies that are focused on agrobiodiversity.

Recommendations in this paper to increase agro-biodiversity urge: Awareness raising and training, increased investment in biodiversity management and research, environmental accounting, economic and legal incentives, and local community participation.

Coverage: Eastern Africa, specifically Ethiopia, Kenya, Uganda and Tanzania

Agroecosystem focus: General
Contains examples or case studies from: Ethiopia, Kenya, Uganda and Tanzania

Topics: Country-specific approaches for promoting agrobiodiversity with reference to the Convention on Biological 'Diversity, direct and root causes of loss of agrobiodiversity, recommendations for improving use of agrobiodiversity.

 # 47 OECD. 2001. Environmental Indicators for Agriculture: Methods and Results. Volume 3. OECD, Paris, France. Available on the internet at: http://www.oecd.org/agr/env/indicators.htm

OECD work on Agri-Environmental Indicators is primarily aimed at policy makers and the wider public interested in the development, trends and the use of agri-environmental indicators for policy purposes. The focus of the work is in particular related to indicator definitions, methodologies and calculation of indicators.

Many of the agri-environmental indicators being developed are of importance beyond OECD Member countries, for example, on issues covering soil and water quality, and the use of nutrients, pesticides and water by agriculture.

The general objectives of OECD work on AEIs are intended to:

Provide information on the current state and changes in the conditions of the environment in agriculture. Assist policy makers to better understand the linkages between the causes and impacts of agriculture, agricultural policy reform, trade liberalization and environmental measures on the environment, and help to guide their responses to changes in environmental conditions.
Contribute to monitoring and evaluating the effectiveness of policies addressing agri-environmental concerns and promoting sustainable agriculture, including future looking perspectives of agri-environmental linkages.

OECD work on AEIs covers four main areas:

1. Agriculture in the broader economic, social and environmental context, setting the Ayes in a broader context by considering contextual information and indicators, that is the influence on agri-environmental relationships on economic forces (e.g. farm production, employment), societal preferences (e.g. rural viability), environmental processes (e.g. interaction of agriculture with biophysical conditions) and land use changes (e.g. agricultural land use). One of the key contextual issues concerns farm financial resource and their relation to environmental outcomes in terms of farm level income and public and private agri-environmental expenditure.

2. Farm management and the environment, examining the relationship between different farming practices and systems and their impact on the environment, covering whole farm management practices that encompass overall trends in farming methods, including organic farming, as well as nutrient, pest, soil and irrigation management practices

3. Use of farm inputs and natural resources, tracking trends in the use of farm inputs, covering nutrients (e.g. fertilizers, manure), pesticides (including risks), and water use intensity, efficiency, stress and the price of water paid by farmers relative to other users in the economy.

4. Environmental impacts of agriculture, monitoring the extent of agriculture's impact on the environment covering: soil quality, water quality, land conservation, greenhouse gases, biodiversity, wildlife habitats and landscape.

The OECD, through its various studies and activities, is exploring a range of applications for better using indicators for policy purposes, which are summarized on their web page.

 # 48 Pagiola, S.,J. Kellenberg, L. Vidaeus and J. Srivastava. 1997. Mainstreaming Biodiversity in Agricultural Development: Towards Good Practice. World Bank Environment Paper Number 15. Series: Global Overlays Program. The World Bank Washington, D.C.

Agriculture has played a major role in the decline of biodiversity. Its expansion and intensification are considered to be major contributors to loss of habitat and reductions of biodiversity worldwide. Agricultural landscapes, however, can contain considerable biodiversity. Biodiversity often plays a crucial role in agricultural production by providing services such as genetic information, useful for development of new crop pollination, soil fertility services provided by microorganisms and pest control services provided by insects and wildlife. The value of biodiversity services, however, is not taken into consideration when taking decisions, such as land use, which affect biodiversity. This undervaluation of biodiversity's services is exacerbated by the effects of government policies, including both agriculture specific policies and broader economy policies.

Mainstreaming biodiversity in agricultural developments means addressing strategic elements such as: -recognizing and diagnosing the causes of biodiversity loss, -reforming economy-wide and sectoral policies, -eliminating the market failures causing undervaluation of biodiversity, -improving available technologies to achieve better management of biological resources and promotion of biodiversity-friendly agriculture, this should be accompanied with improvements to extension to ensure that new techniques, inputs and formation emerged reach farmers. Targeted conservation efforts are needed to complement the broader responses. These might include protection of particular important parts of areas being converted to agriculture, preservation of corridors between remaining habitats, ex-situ conservation of particularly variable species and efforts to protect threatened species in situ.

Mainstreaming biodiversity in agriculture development is constraint by: -lack of information and a generally poor understanding of the nature of effects, -the traditional focus on sectoral production and institutional barriers to cross-sectoral coordination, which prevent inclusion of biodiversity conservation in agricultural development planning; -lack of proven methods to address biodiversity loss problems.

The Bank is committed to assist developing countries partners in mainstreaming biodiversity in agricultural development. To deliver

on this commitment the Bank needs to integrate biodiversity conservation as an objective into its operations at the levels of country assistance strategy, agricultural sector review and analysis, and project design and implementation.

The paper seeks to help planners in reconciling agricultural production without damaging the biodiversity that forms the basis of sustainable agriculture. This is done by

1) Reviewing current knowledge on the relationship between agriculture and biodiversity
2) Analyzing the factors that have exacerbate the conflict between the two and prevented complementarities from being exploited
3) Proposing ways in which conflicts can be reduced and complementarities enhanced.

The paper addresses four main questions:

1) What impact do agricultural development activities have on biodiversity?
2) How can sustainable uses of biodiversity enhance agricultural development?
3) How can economy-wide and agriculture policies and programmes be modified to reduce biodiversity losses?
4) What factors constraint policy adjustments and institutional reforms?
5) What are the tradeoffs between agricultural development objectives and biodiversity conservation, and how can they be evaluated?

Topics: agricultural economy, agrobiodiversity conservation, agricultural development, biodiversity in the World Bank Portfolios.

Coverage: Global

Contains examples or case studies from Bangladesh, Borneo, Brazil, Costa Rica, Ecuador, India, Indonesia, Mexico, Nepal, Sri Lanka, Sudan, Sumatra and Uruguay.

 # 49 Pimental, D., T. W. Culliney, I.W. Buttler, D.J. Reinemann and K.B. Beckman. 1989. Ecological Resource management for a Productive, Sustainable Agriculture. pp. 301-323 In: Food and Natural Resources. Academic Press, New York.

This older article is still relevant, in that it points out that many economies can be made in the transition to sustainable agriculture.

High production costs in United States agriculture are due in part to environmental degradation, and in part to the costly inputs of fertilizers, pesticides and fossil fuel. The authors propose that by employing various alternative practices that improve the environment and the use of reduced, as they show in two models of the corn (maize) production system. A wide array of soil and water conservation technologies exist that could help reduce pesticide inputs. The approach is needed now, as economic problems and growing environmental concerns plus the challenges of producing more world food are encouraging agriculture to look to improved resource management practices.

Coverage: United States

Topics: Soil management, natural pest control, sustainable agriculture

Case studies or examples from: United States.

 # 50 Pimentel, D., C. Harvey, P. Resosudarmo, K. Sinclair, D. Kurz, M. McNair, S. Crist, L. Shpritz, L. Fitton, R. Saffouri, R. Blair. 1995. Environmental and Economic Cost of Soil Erosion and Conservation Benefits. Science 267: 1117-1122.

Soil erosion is a major environmental threat to the sustainability and productive capacity of the earth. During the last 40 years, this analyses estimates that nearly one-third of the world's arable land has been eroded and continues to be lost at a rate of more than 10 million hectares per year. With the addition of a quarter of a million people each day, the world population's food demand is increasing at a time when per capita food productivity is beginning to decline.

The authors estimate that it would take an investment of $6.4 billion per year ($40 per hectare) to reduce US erosion rates from about 17 tons/ha/yr to a sustainable rate of 1 ton/ha/yr on most cropland. To reduce erosion on pastureland, the United States would have to spend an additional $2.0 billion per year ($5 per hectare for conservation). The total investment for US erosion control would be about $8.4 billion per year. Given that erosion causes about $4.4 billion in damages each year, it would seem that this is a small price to pay.

When the economic costs of soil loss and degradation and off-site effects are conservatively estimated into the cost/benefit analysis of agriculture, it makes sound economic sense to invest in programs that are effective in the control of widespread erosion. Human survival and prosperity depend on adequate supplies of food, land, water, energy and biodiversity. Infertile, poor-quality land will not sustain food production at the levels required by the growing world population.

Coverage: United States

Topics: ecosystem services, soil erosion

 # 51 Pimental, D., U. Stachow, D.A. Takacs, H.W. Brubaker, A.R. Drumas, J.J. Meaney, J.A.S. O'Neil, D.E. and D.B. Corzilius. 1992. Conserving Biological Diversity in Agricultural/Forestry Systems. Biosciences 42(5): 354-362.

This paper discusses a misallocation of attention to biodiversity in protected areas, versus the abundance and threats to biodiversity in human dominated landscapes. Humans manipulate 70% of the temperature and tropical ecosystems to harvest 98% of their food and all of their wood products. Approximately 50% of the terrestrial area is devoted to agriculture, approximately 20% to commercial forests, and another 25% is occupied by human settlements, which include cities, towns and villages. Thus, most species are located in the area that is managed for agriculture, forestry and human settlements. For example, in West Germany only 35 to 40% of the total 30,000 species are found in protected areas; the remaining species live in human-managed ecosystems. In addition to protecting the integrity of parks, the conservation efforts of biological diversity in agricultural, forest, and other managed ecosystems must be expanded. To date, humans have destroyed approximately 44% of the world's tropical forests. Approximately 80% of the total 20 million ha/yr of deforestation is due to the conversion of forests to agricultural lands. The deterioration of current agricultural land, combined with the increasing population, results in approximately 15 million ha of new agricultural land being needed each year to satisfy human food needs.

Techniques of agricultural and forest production which both conserve biodiversity and promote productivity are mentioned, including use of crop residues to restore soil fertility, cover crops, multispecies forests and gardens, shelterbelts and hedgerows, intercrops, soil and water conservation, crop rotations, strip cropping, contour planting, terracing, ridge planting, no-till, use of livestock manure, habitat diversity on farm, agroforestry, mixed forest, pasture management, stable ecosystems with protected microenvironments, and reduction of pesticide use.

The needs and activities of escalating numbers of humans are changing natural ecosystems at rapid rates. Millions of species live and carry out vital functions in the biosphere and are essential to society. Yet, the importance of most species of animals and plants, -the small organisms that make up more that 95% of all species-is being overlooked. Because the organisms are small, the benefits to

agriculture and forestry of these less-conspicuous organisms, such as arthropods and fungi, are often not recognized. During the past decades, focus has been on saving the relatively low number of large animals. Setting aside parks for the species has heightened public awareness and benefited the fight to save these often beautiful creatures. However, preserving the greater diversity of all species of organisms should be the aim of conservation projects.

The following policies are recommended to enhance the conservation of biological diversity:

- Develop more accurate measures for assessing the value that small and large organisms have for protecting the quality of the environment and work to disseminate this information to scientists, farmers foresters, policy makers and all concerned citizens.
- Encourage ecologically sound and sustainable management practices in agriculture and forestry.
- Adopt biological controls for pests and encourage greater use of biological resources for agriculture and forestry systems to replace pesticides, fertilizers, and other chemicals.

- Encourage society to dedicate itself to protecting biological diversity to provide a quality environment for every one and to have a productive, sustainable agriculture and forestry. Concern should not be for one species or one factor, but for the integrated management of the earth's natural resources as a whole.

Coverage; global

Topics: wild biodiversity in agricultural landscapes

Case studies or examples from: United States, Kenya, Russia, Japan, United Kingdom, Hungary, China, India.

 # 52 Pimentel, D., C. Wilson, C. McCullum, R. Huang, P. Owen, J. Flack, Q. Tran, T. Saltman and B. Cliff. 1997. Economics and Environmental Benefits of Biodiversity. BioScience 47(11): 747-757.

The vital services provided by biodiversity to humans and the environment are analysed in this paper. This assessment of the environmental and economic benefits of biodiversity will assist the development of strategies and policies to enhance the conservation of biological diversity.

The analysis concludes that most of the services provided by the

diverse plant and animal species, including pollination, waste degradation, and biological pest control, cannot be provided by any human technology either known today or projected for the future. Biodiversity itself helps preserve the functioning of a healthy ecosystem. These services are jeopardised and fail to work adequately when human pollute or deplete resources on which such services are based. The estimated economic and environmental benefits of biodiversity in the United States and the world are $316 billion, and $3,150 billion per year, respectively. These appraised economic benefits are estimates at best, but they enlarge out understanding of the many essential services that diverse species provide humans. Practical policies and programs that will protect biodiversity for human society to maintain a productive, healthy environment must be given high priority.

Among the specific services which are appraised and costed within the paper are: decomposition of waste material, soil formation, nitrogen fixation, bioremediation of chemical pollution, genetic engineering, crop and animal genetic resources, biological control, of pests, how plant resistance and pest control, pollination, values of wild animals and plants, harvest of food and drugs from wild biota, and carbon sequestration.

 # 53 Pretty, J.N. 1995. Regenerating Agricuture: Politics and Practice for Sustainability and Self-Reliance. London, Earthscan Publications.

Regenerating Agriculture looks at the scale of the challenge facing agriculture today and details the concepts and characteristics of alternativie, sustainable agricultural practices. The author draws together new empirical evidence from a diverse range of agroecological and community settings to show the impacts of more sustainable practices. Using twenty detailed case-studies and field and community-level data from more than 50 projects and programmes in 28 countries, he identifies the common elements of success in implementing sustainable practices and shows how to replicate them. In addition, the book looks at the existing policy frameworks and institutional processes, and sets out 25 alternative policies which are known to work to support the shift to greater self-reliance and sustainability in agriculture.

Coverage: Global

Topics: sustainable agriculture, policy

Contains examples or case studies from: Philippines, China, Mexico, USA, Africa, Japan, Indonesia, Tanzania, Bali, India, Sri Lanka, Botswana, Nepal, Burkina Faso, Australia, United Kingdom, Brazil, Honduras, Kenya, Lesotho, Mali, Peru,

 # 54 Pretty, J. and R. Hine. 2000. Feeding the World with Sustainable Agriculture: A summary of New Evidence. Final Report for the "SAFE-World" (The Potential of Sustainable Agriculture to Feed the World) Research Project, University of Essex.

Over the past 40 years, per capita food production has grown by 25%, and food prices in real terms have fallen by40%. Yet the world still faces a fundamental food security challenge, due to population growth. The conventional wisdom is that, in order to double food supply as needed, we need to redouble efforts to modernize agriculture. But there are doubts about the capacity of such systems to reduce food poverty. The poor and hungry need low-cost and readily available technologies and practices to increase local food production. Moreover, the success of modern agriculture has often masked significant externalities, affecting both natural capital and human health, as well as agriculture itself. In this document, the options of a more sustainable agriculture are explored, and some tentative conclusions are drawn about the value of increasing food production based on locally available resources in developing countries.

The aim of the SAFE-World research project was to audit and database recent worldwide progress towards sustainable agriculture, an assess the degree to which such projects/initiatives could be ramped up to a larger scale. As of October 2000, the database contained information on 208 cases from 52 countries. In these projects/initiatives, some 8.98 million farmers have adopted sustainable agriculture practices on 28.92 million hectares. Of improvements which have been instituted to improve sustainable agriculture, the majority have been "on-farm and in-community". The document notes that little attention, as yet, has gone to finding ways to link farmers to markets and consumers, and to add value to produce.

While the 208 projects show clear increased in food production over 29 million hectares, these increases are not yet making a significant mark on national statistics. The authors attribute this to a significant elasticity of consumption in many rural households-, which are consuming the increased food surplus, or selling it within national statistics.

The authors conclude that sustainable agriculture can deliver increases in food production at relatively low cost, plus contribute to other important functions. Were these approaches to be widely adopted, they would make a significant impact on rural people's livelihoods, as well as on local and regional food security.

Coverage: Global

Topics: Sustainable agriculture

Case studies or examples from: India, Uganda, Kenya, Tanzania, China, Philippines, Malawi, Honduras, Peru, Brazil, Mexico, Burkina Faso, Ethiopia, Bangladesh.

 # 55 Roling, N.G. and M.A.E. Wagemakers. 1998. Facilitating Sustainable Agriculture. Participatory learning and adaptive management in times of environmental uncertainty. Cambridge, Cambridge University Press.

A move towards more flexible, sustainable agricultural practices is being seen increasingly as the way to address or avoid environmental and economic problems associated with existing, predominantly intensive, farming systems. This book examines the implications of adopting more ecologically sound agricultural practices, both at the level of individual farmers and at the level of larger-scale agro-ecosystems such as water catchments. The emphasis of the book is on human and social aspects, rather than on agronomic or economic considerations, focusing on the learning processes necessary for change to be implemented at, in turn, on the facilitation of that learning through participatory approaches and appropriate institutional support and policy structure.

Coverage: global

Topics: sustainable agriculture

Contains examples or case studies from: Switzerland, Greece, Netherlands, Germany, Indonesia, Australia, USA

 # 56 Roodman, D.M. 1998. The Natural Wealth of Nations: Harnessing the Market for the Environment. Worldwatch Publications, Washington, D.C.

The Natural Wealth of Nations offers concrete solutions to environmental problems by removing harmful subsides, and using the power of the market to protecting natural wealth and human health. Among the sectors which are currently heavily subsidised, and discussed in this book is the agricultural sector.

Coverage: Global

Agroecosystem focus: General

Topics: environmental economics, perverse incentives, subsidies,

market mechanisms, environmental taxes.

 # 57 Roubik, D. W. 1995a. Pollination of cultivated plants in the tropics. Food and Agriculture Organization, Rome. FAO Agricultural Services Bulletin 118, 196pp.

This extremely useful book is intended as a guide for development of pollination resources in the tropics. It first introduces the reader to various aspects of natural and insect pollination. Topics in the first part include the pollinators; the ecological and economic importance of pollination; applied pollination in temperate area, tropical oceanic islands and mainland tropics; and alternative to artificial pollinator populations. Prospects for the future are also discussed. The second part considers successful pollination with pollinator populations; the evaluation of pollinators; floral biology and research techniques; the behaviour of pollinators and plant phenology and various case studies on the preparation of pollinators for use in tropical agriculture. An appendix is provided on cultivated and semi-cultivated plants in the tropics, pollination contracts, and levels of safety of pesticides for bees and other pollinators.

Coverage: Global

Topics: Pollination

 # 58 Ruiz, M. and R. Poona. 2000. Going Home: A manual on the Repatriation of Information from Ex-situ Conservation and Research Institutions to Countries of Origin. Royal Botanic Gardens, Kew, UK.

This manual seeks to provide readers with basic information on what repatriation is and how it takes place. Using examples and a step-by-step approach it hopes to offer clear guidelines for both the development of wider repatriation strategies and more focused, specific initiatives.

The manual concerns itself primarily with botanic gardens and herbaria. However, much of the methodology outlined could equally be applied to other institutions such as zoos, zoological museums and collections of microorganisms.

The procedures outlined may be particularly relevant to national programs to inventory and conserve soil microorganisms, pollinators, and natural pest control agents, as the richest collections of these are often held in developed country institutions. The manual is highly relevant to national biodiversity planning.

Coverage: Global

Topics: repatriation, inventories, taxonomy

Case studies or examples from: Brazil

 # 59 Smith, N.J. H.1996. Effects of Land Use Systems on the Use and Conservation of Biodiversity. Pp. 52-79 in: Srivastava, J., N.J.H. Smith and D. Forno,eds. 1996. Biodiversity and Agricultural Intensification: Partners for Development and Conservation. Environmentally Sustainable Development Studies and Monograph Series No.11. The World Bank, Washington, D.C.

The paper seeks to establish a conceptual framework to guide analysis of the interrelationships between biodiversity and agricultural production systems. Then, it seeks to focus on the following policy-related questions: How do agricultural production systems and agricultural sector policies, institutions and programs including technology choices affect biodiversity? How does the conservation of biodiversity help improve the sustainability of agriculture? How can agricultural development policies enhance biodiversity?

Four perspective underlie the analysis: cultural landscapes (virtually all ecosystems on earth have been modified by humans); land-use dynamic (shifts in the mix of agricultural production systems in a given area enhance or destroy biodiversity; driving forces. Those forces such as shifts in market opportunities or fiscal incentives that influence land use change) and the intensification/resiliency relationship.

Policy implication of specific land use systems are examined, including intensive cropping, shifting agriculture, agropastoralist system, agroforestry, and plantation systems.

Overriding policy issues are then brought out, including the need for a new agricultural research and development policy, the importance of socioeconomic infrasructure and property rights. It is proposed that agricultural development projects always include biodiversity performance indicators, and that rapid agrobiodiversity surveys are undertaken before a rural development project is started.

As well, more biodiversity conservation projects should be focused on conservation of agrobiodiversity and wild relatives of useful species

Coverage: Global

Topics: land-use systems and biodiversity, policy issues

Contains examples or case studies from: Brazil, Columbia, Peru, Mexico, UK, Malaysia.

 # 60 Srivastava, J., N.J.H. Smith & D. Forno. 1996. Biodiversity and Agriculture: Implications for Conservation and Development. The World Bank, Washington, D.C. World Bank Technical Paper 321.

For too long the agriculture and environmental communities have been at odds with each other over biodiversity when in fact they share many concerns. Agriculture is often cast as a homogenization agent on the landscape, obliterating much of the biodiversity to make room fro crops and livestock. Some agricultural practices also trigger downstream impacts on biodiversity, such as water pollution with agrochemicals. While it is true that agriculture has caused harm to the environment, agriculture is the key to saving biodiversity and farming and livestock practices can be honed to minimize environmental damage. Agriculture and biodiversity are inter-linked. Without biodiversity, agriculture cannot progress. Biodiversity in both wild and managed habitats is a vital resource for crop and livestock improvement. And without improved agriculture, most of the remaining habitats for wildlife will be destroyed to make room for farms, plantations, and ranches. Biodiversity is thus much more than the preservation of habitats for unique and interesting plants and animals. People in rural, and even urban, areas are intimately involved in using biodiversity to supply their needs. Most of the earth's surface has been transformed by human activities and how biological resources are treated in cultural landscapes will largely determine how much biodiversity survives in the next century. Both indigenous knowledge and scientific research are needed to meet the challenge of intensifying agriculture in an environment-friendly manner and understanding how the landscape mosaic of cultural habitats could contribute to conservation of biodiversity.

The paper seeks to identify the critical issues surrounding agricultural development and biodiversity such as:

1) what are the fundamental relationships between the use of agricultural resources and loss of biodiversity, both on and off farm?
2) How do agricultural policies and development programs, including technology choices, impact biodiversity both on and off farm?
3) How could such policies and practices b modified to harmonise biodiversity conservation with agricultural development?
4) What are the constraints (technical, institutional, financial, social and botanical) that inhibit such modification?

The paper does not offer answers; rather it proposes in-depth reviews and in-country studies for a better understanding of the questions raised above.

Coverage: Global

Topics: conflicts and compatibilities between agriculture and biodiversity. Impacts of agriculture in different land use systems. Biodiversity in the World Bank portfolios.

Contains examples or case studies from: West Africa, Indonesia

 # 61 Srivastava, J., N.J.H. Smith and D. Forno, eds, 1996. Biodiversity and Agricultural Intensification: Partners for Development and Conservation. Environmental Sustainable Development Studies and Monograph Series No. 11. The World Bank, Washington, D.C.

This volume of papers on biodiversity and agricultural intensification argues that biodiversity must be better managed and conserved if the twin challenges of improving living standards and enhancing the environment for all of humanity are to be met. Examples are given of how agrobiodiversity is being tapped to intensify agriculture in a sustainable manner.

 # 62 Srivastava, J., N.J.H. Smith and D. Forno. 1996. Agriculture as Friend and Foe of Biodiversity. Pp. 1-10 in: Srivastava, J.,N.H. Smith and D. Forno, eds, 1996. Biodiversity and Agricultural Intensification: Partners for Development and Conservation. Environmentally Sustainable Development Studies and Monograph Series No. 11. The World Bank, Washington, D.C.

Agricultural intensification is usually defined as more purchased inputs such as fertilizers, pesticides, herbicides and machinery. The paper investigates how society might provide incentives to make agricultural intensification more sustainable and ecological, such as through rational use of nutrients, space, and energy in all land-use systems, greater recycling of nutrients, better use of biological resources to raise yields, greater appreciation of indigenous knowledge and neglected crops, more effective measures for soil and water conservation, and deployment of environment corridors in agricultural landscapes. The authors' concern is not with tailoring practices to be more "environment-friendly" but more with centrally incorporating greater biodiversity within agricultural production systems. They assert that benign policies and practices that enhance agricultural productivity as well as biodiversity conservation are possible. Biodiversity is defined as genetic, species, and habitat diversity. The focus in this and the

subsequent papers in this volume is not on safeguarding natural habitats, which may contain elements of agrobiodiversity, but on wisely managing habitats that have been modified for human use, such as farmland. Within this, there is a stress on the "off-site" effects of land-use systems, including reduction or elimination of agricultural pollutants in groundwater and in run-off, and greater emphasis on integrated pest management strategies.

Coverage: Global

Topics: agricultural intensification, mainstreaming biodiversity into agricultural policy, off-site effects, natural enemy conservation.

Contains examples or case studies from: Amazon, Latin America, West Java, Costa Rica.

 # 63 Srivastava, J.P., smith, N.J.H. and Forno, D.A. 1999. Integrating Biodiversity in Agricultural Intensification: Toward Sound Practices. Environmentally and Socially Sustainable Development. Rural Development. The World Bank. (Work in progress for Public discussion).

This report underlines the critical role of agrobiodiversity in intensifying agriculture. It also emphasizes that biodiversity will be safeguarded only if contributes in a perceptible way to human welfare and if essential needs are being met from areas already in production. It highlights ways in which agrobiodiversity can be utilized more effectively to boost productivity. It presents case studies in which modern and traditional agriculture have been successfully transformed to enhance biodiversity without sacrificing yield. Practical ways are identified to better manage and conserve the biological resources that support crop and livestock production.

Lessons learned from this review help to identify sound practices for designing and monitoring agricultural projects so that they improve rural incomes while safeguarding biodiversity. The main challenges are to boost productivity of traditional systems while maintaining their environmental friendly characteristics, and to transform modern agriculture so that environmental damage is reduced or eliminated as yields increase. A great deal of diversity is found in managed landscapes. A better management of these biological resources would help to meet the challenge. However, as the report emphasizes, technological 'solutions' alone will neither sustain greater agricultural productivity nor enhance biodiversity in the long run. The successful protection of biodiversity depends on a favourable policy environment and on agricultural research and extension activities that stress farmer participation and greater sensitivity to the off-site impact of agriculture. Thus, suggestions for sound practices include

modifications of the policy environment and ways to strengthen research institutions and extension services in such a way that agriculture can be intensified while better protecting and managing biological resources.

In many agricultural research programmes not enough consideration is being given to ways to better harmonise biodiversity conservation and agricultural development. To address this the report highlights policy, institutional, and technological issues to improve agricultural projects designed to boost crop and livestock yields while incorporating greater biodiversity and reducing pressure on wildlife habitats.

The paper also stresses the importance of local participation by farmers and their communities, as major stakeholders in biodiversity management. It states that a blend of indigenous knowledge and scientific research will be needed to further the transformation of agricultural systems so that they are more biodiversity friendly and achieve higher productivity.

The report analyses the role of the World Bank as a leader in providing ideas and approaches to development rather than merely as a financial source. The role of governments and international development institutions is to identify and help remove constraints to the better use and safeguarding of biodiversity. It presents various instruments at the disposal of the bank to influence the way in which biodiversity is mainstreamed into agricultural development.

It concludes that follow-up work is needed to visit apparently successful cases where biodiversity has been mainstreamed in agricultural development so that more data can be obtained to back-up policy recommendations. This would also provide opportunity to interact with stakeholders in borrower countries in order to arrive at realistic recommendation for sound practices.

Coverage: Global

Topics: Agrobiodiversity conservation, agricultural intensification, agricultural development, and agricultural development projects.

Case studies or examples from: Bangladesh, Brazil, Costa Rica, India, Malaysia, Mexico, Nigeria, Turkey, Uruguay.

 # 64 Swaminathan, M.S. (ed.) 1996. Agrobiodiversity and Farmers' Rights. The Swaminathan Foundation, New Delhi, India. Xvi, 303 p.

This volume considers the term agrobiodiversity to refer to genetic variability in plants, animals and microorganisms of economic value.

As such, it provides the feedstock for the breeding and biotechnology enterprises. The future of food and healthy security depends on the conservation and sustainable use of such diversity. This book deals with the equity part of the utilization of agrobiodiversity. Today, the traditional conservers live in poverty, while the utilisers experience prosperity. How can the equity provisions of CBD and the concept of farmers' rights developed in the Forum of FAO, i.e., the rights of tribal and rural women and men who have not only conserved genetic variability but also enriched them through selection and information and thereby deserve to be recognized and rewarded, be converted into reality? The volume proposes concrete ways forward.

Contents: Background paper. Inaugural session. 1. The national and international context. 2. Plant variety protection and the convention on biodiversity. 3. Viewpoint of the plant breeding industry. 4. Viewpoint of public sector plant breeding institutions. 5. Tribal and rural farmer-conservers. 6. Role of the mass media. Recommendations of participants. Annexure 1:Financial arrangements for the realization of farmers' rights. Appendix: 1 Plant variety protection and farmers' rights Act. 2. National income accounts. Annexure: 2. Uncommon opportunities for achieving sustainable food and nutrition security.

Coverage: Global

Topics: Farmers' Rights, intellectual property rights, plant variety protection, crop genetic resources.

 # 65 Thies, E. 2000. Incentive Measures Appropriate to Enhance the Conservation and Sustainable Use of Agrobiodiversity. GTZ, Eschborn, Germany.

This study analyzes whether incentive measures designed for the promotion of conservation and sustainable use of natural resources are transferable to agrobiodiversity and if so, which ones. For this purpose, existing activities that apply incentive measures in development cooperation have been evaluated with regard to their design, implementation and impact. Since measures are political instruments aiming to encourage politically desirable ways of acting and to discourage undesirable ones, key problems and adverse incentives have to be identified before entering the process of design. They are linked to the valuation of natural resources, in particular biodiversity, which is a complex subject, characterized by numerous interdependencies, ignorance of details and uncertainty about probable management impacts. Valuation therefore is difficult, due to the lack of scientific knowledge and objective valuation criteria. In addition, private short-term economic interests quite often determine

the valuation, leaving little space for the manifestation of public values and long-term sustainability considerations. Market prices do not reflect the real value of biological resources and their services because of a failure to internalize external costs. Genetic resources represent above all option and quasi-option values, and specific incentive measures for their realization are not common. One possibility in this context is to apply the precautionary principle in general policy-making. The challenge is to allocate values to both, the private and the public functions of biodiversity. These values have to be transparent and easily understandable and must be translated into incentive measures and action. Several types of incentive measures exist, and the most appropriate are often a mix.

With the exception of wild relatives, agrobiodiversity is not an "open access common," such as are many forests or wildlife. It is managed privately or in communities, either for subsistence or commercial purpose. The more it is managed fro commercial purposes, the more high-yielding crops and breeds are used, and the less important is the traditional minimization of risks through the use of a high diversity of varieties, typical of subsistence farming. Agrobiodiversity is threatened because most commercial production focuses on a few major crops and breeds, often already introduced during colonial time and sometimes still propagated by national policy and development projects. A multitude of traditional breeds and crops are considered low-performing varieties. This however leads to the irreversible loss of genetic diversity essential for genetic improvement, which is decisive for current and future food security.

Consequently, agrobiodiversity is threatened because it is not used and not because it is overused, as is the case with many wildlife or tree species. Sustainable use of agrobiodiversity therefore often means "increased use" instead of restriction. Consequently, in-situ management of agrobiodiversity therefore often means "increased use" instead of restriction. Consequently, in situ management of agrobiodiversity is a very active process, as is ex-situ conservation. Since traditional, neglected and under-utilized breeds and crops have their present characteristics only because they have been actively selected, conserving them means more than just shielding them.

Particular "agrobiodiversity criteria" fro the transferability of incentive measures follow from the afore-mentioned considerations. However, it is the framework conditions in particular which the author judges to be decisive for the success of incentives. These may be multilateral or bilateral agreements, good governance, the legislative framework and enforcement, national and regional economy, research activities, traditional knowledge or the uniqueness of certain agrobiological resources. Agriculture is often an intensively subsidized economic

sector. Therefore most prices are distorted and do not reflect the real cost of production. In addition, food-for-work programs or long-term free food supply may strongly influence local and national markets. The combination of these factors may result in an adverse incentive with regard to the sustainability of agriculture and the conservation and sustainable use of plant and animal genetic resources. The removal of these adverse incentives may already have a considerable impact.

In most OECD countries, the government's steering function is much stronger than in developing countries. In developing countries, it is therefore often the donor community that assumes the role of the government in designing and implementing incentives.

As such, a development project can be regarded as a series of incentives. Therefore, project-initiated incentives have to take into account the framework conditions to increase the probability of success, i.e., a sustainable change in valuation and resulting management priorities. On the other hand, framework conditions, such as the ratification of the convention for biological Diversity or a national strategy to implement the Global Plan of Action for plant genetic resources, can facilitate decision-making and design, implementation and monitoring of incentives.

Besides the general activities dedicated to capacity-building and information exchange, the following types of incentive measures seem to be the most promising:

- Removal of adverse subsidies
- Environmental funds and public financing
- Benefit-sharing agreements
- Intellectual Property Rights
- Market creation and support for commercialization
- Access to and use of information about available genetic resources.

Many experiences concerning incentives for the conservation and sustainable use of agrobiodiversity are related to plant genetic resources. Therefore, approaches should be analyzed to determine whether any of them are transferable to animal genetic resources and if so, which ones.

Coverage: Global

Topics: incentive measures.

 # 66 Thrupp, L.A. 1998. Cultivating Diversity: Agrobiodiversity and Food Security. World Resources Institute, Washington, D.C.

Agrobiodiversity is increasingly recognised as the fundamental basis of agricultural production and food security. Yet, this diversity is being rapidly lost throughout the world. Although the policies of the Green-Revolution – that of promoting monocultural systems, uniform crop varieties and agrochemical inputs, have contributed to aggregate increases in production in many areas, these patterns have also eroded agricultural biodiversity and degraded other natural resources, contributing to serious economic loss and human suffering.

Internationally, mandates have been made to assure food security. However these agreements are inefficient and have not produced long-term effects on food production. And, although the Convention on Biological Diversity provides the framework for protecting intellectual property rights, this is in conflict with other such agreements such as those of the World Trade Organization, which establishes private regimes over intellectual property, and does not adequately value local peoples' rights. What is required is effective action that can overcome conflicts and change conventional agricultural practices and economic policies.

This book reviews the relationship between ecology, and social and economic aspects of sustainable development through reviewing the benefits of agrobiodiversity and causes of biodiversity loss within the agricultural sector – both proximate and ultimate causes. Incorporating agrobiodiversity into farming practices is outlined through a discussion of strategies, examples and case studies.

Through addressing root problems of policies, paradigms and protection rights, the author outlines priorities and principles to enhance agrobiodiversity. Noted are the most crucial changes that are required for the elimination of policies that erode agrobiodiversity (such as subsidies that erode agrobiodiversity (such as subsidies and incentives for agro-chemicals and high-yield varieties) and the adoption of market and trade policies that incorporate ecological concerns. Laws and other measures also require implementation to ensure ethical business practices by agricultural technology companies and to prevent their unfair control over plant genetic resources.

Coverage: Global

Case studies or examples from: global examples and case studies, with regional priorities given for East Africa.

Topics: benefits and causes of biodiversity. Best practices that enhance agrobiodiversity. International policy and recommendations.

 # 67 Thrupp, L.A. 1996. New Partnerships for Sustainable Agriculture. World Resources Institute, Washington D.C.

What works to develop sustainable agriculture practices? From rice paddies in Bangladesh to cornfields in lowa, innovative people and organizations are working together and making progress to replace chemical-intensive farming methods with alternative approaches. The nine case studies featured in this report from Asia, Africa and Latin America and north America show how ecologically-oriented integrated pest and crop management practices can maintain or increase yields, increase soil quality and resilience, reduce agrochemical inputs and costs, and achieve other benefits. Though representing distinct farming systems, different geographical zones and scales, and varied cultures, the cases highlight common elements of success as well as constraints that must be overcome to implement and maintain sustainable and profitable production practices.

Coverage: Global

Topics: Sustainable production practices

Case studies or examples from: Bangladesh, Philippines; Cuba, Nicaragua, Senegal, Kenya; BIOS, and USA.

 # 68 Thrupp, L.A. 1989. Legitimizing Local knowledge: from Displacement to Empowerment for Third World People. Agriculture and Human Values 6(3): 13-24.

 # 69 Thrupp, L.A., B. Cabarle, and A. Zazueta. 1994. Participatory methods in planning and political processes: linking the grassroots and policies for sustainable Development. Agriculture and Human Values 11(2-3): 77-84.

These two publications discuss ways in which traditional knowledge systems are critical to the sustainability of farming and natural resource management. Local people have evolved with their environments and have acquired considerable knowledge about the locations and appropriate sources. The integrity of cultural systems that have adapted to the numerous habitats on earth is therefore an essential part of biodiversity conservation. How and why rural people conserve, enhance and use biodiversity has rarely been taken into account when designing management interventions and devising policy for agricultural development and natural resource management. The active participation of farmers, ranchers and pastoralists – and especially resource- poor operators is essential in designing and carrying out biodiversity and agricultural development projects.

Incorporating indigenous knowledge is thus an integral part of the new paradigm for agricultural research and development that is emerging.

Coverage: Global

Agroecosystem focus: General

Topics: participatory methods, sustainable development, natural resource policy.

 # 70 Thrupp, L.A. with N. Megateli. 1999. Critical Links: Food security and the environment in the Greater Horn of Africa. WRI Project Report. World Resources Institute, Washington DC and International Livestock Research Institute, Nairobi, Kenya. 110pp.

The challenges of overcoming hunger, conflict, entrenched poverty and environmental deterioration in the Greater Horn of Africa region remain daunting. Responses, up until now have been largely through food aid and other emergency programs. However, these short-term measures do not account for sustainable solutions. An important general strategy to address this challenge is to integrate environmental concerns into efforts to achieve food security, as environmental and food security are closely line. Sound management of natural resources particularly the use of sustainable agricultural practices is needed for food production, secure access to food, and hunger alleviation. It can also reduce environmental stress and related social conflict. This report provides a synthesis of major challenges and opportunities in the food security- environmental nexus**, to help clarify the linkages. The analysis concludes with the key strategic principles that are needed to reverse the downward spiral of hunger, resource degradation, poverty and conflict.

Coverage: Sudan, Eritrea, Ethiopia, Djibouti, Somalia, Kenya, Uganda, Tanzania, Rwanda, and Burundi.

Topics: sustainable agriculture, agricultural policy, food security

Case studies or examples from: Ethiopia, Tanzania, and Sudan

 # 71 Tilman, D. 1998. The greening of the green revolution. Nature Vol. 396:211-212.

In comparison with conventional, high-intensity agricultural methods, 'organic' alternatives can improve soil fertility and have fewer detrimental effects on the environment. These alternatives can also produce equivalent crop yields to conventional methods.

The article discusses an experiment in which two alternative, organic practices for growing maize (with manure and legume crops) were compared with intensive systems of applying pesticides and mineral nitrogen fertilizers. Ten-year average maize yields differed by less than 1% among the three cropping systems, which were equally profitable.

The intensification of agriculture has broken what was once the tight, local recycling of nutrients on individual farms. A greener revolution is needed, a revolution is needed, a revolution that incorporates accumulated knowledge of ecological processes and feedbacks, disease dynamics, soil processes and microbial ecology.

Coverage: global

Topics: environmental impacts of agriculture, sustainable agriculture.

 # 72 Tilman, D. 1998. Global environmental impacts of agricultural expansion: The need for sustainable and efficient practices. Paper was presented at the National Academy of Sciences colloquium "Plants and Population: Is There Time?" held December 5-6, 1998, at the Arnold and Mabel Beckman Center in Irvine, CA. Available online at http://www.pnas.org/cgi/content/full/96/11/5995

The recent intensification of agriculture, and the prospects of future intensification, will have major detrimental impacts on the non-agricultural terrestrial and aquatic ecosystems of the world. The doubling of agricultural food production during the past35 years was associated with a 6.87-fold increase in nitrogen fertilization, a 3.48-fold increase in phosphorus fertilization, a 1.1-fold increase in land in cultivation. Based on a simple linear extension of past trends, the anticipated next doubling of global food production would be associated with approximately 3-fold increases in nitrogen and phosphorus fertilization rates, a doubling of the irrigated land area, and an 18% increase in cropland. These projected changes would have dramatic impacts on the diversity, composition, and functioning of the remaining natural ecosystems of the world, and on their ability to provide society with a variety of essential ecosystem services. The largest impacts would be on freshwater and marine ecosystems, which would be greatly eutrophied by high rates and phosphorus release from agricultural fields. Aquatic nutrient eutrophication can lead to loss of biodiversity, outbreaks of nuisance species, shifts in the structure of food chains, and impairment of fisheries. Because of aerial redistribution of various forms of nitrogen, agricultural intensification also would atrophy many natural terrestrial ecosystems and contribute to atmospheric accumulation of greenhouse gases. These detrimental environmental impacts of agriculture can be minimized only if there is

much more efficient use and recycling of nitrogen and phosphorus in agroecosystems.

Coverage: global

Topics: environmental impacts of agriculture, sustainable agriculture.

Case studies or examples from: United States

 # 73 UNEP and FAO. 200 Our land, Our future: A new approach to land use planning and management, pdf document available for download at http://www.fao.org.

This highly illustrated document seeks to raise public awareness around current land management challenges of population growth, hunger and poverty, social and political conflicts, mass migrations and land degradation. The document calls for a strategy, which can permit both development and conservation, starting with the land itself. It notes that everyone has a stake in sustainable land use, but the aims and activities of stakeholders are often in conflict. The root cause of the conflict, and of land degradation, is people's inability to develop effective institutional frameworks for conflict resolution and efficient and sustainable land use. The document then defines conflict resolution as "Negotiated agreement using mechanisms and institutions that accurately reflect the view of all stakeholders" and illustrates the steps of identifying the stakeholders, educating and informing, creating forums for negotiation, agreeing on the rules, and empowering the people. Four incentives, to conserve are also illustrated: security of tenure, productive land conservation techniques, people's participation, and charges and sanctions. A blueprint for a practical program for sustainable land use is proposed.

Topics: sustainable land management incentive measures for agrobiodiversity conservation.

Coverage: Global

 # 74 UPWARD. 1998. Conservation and Change: Farmer management of Agricultural Biodiversity in the Context of Development. UPWARD (Users' Perspectives with Agricultural Research and Development), Los Banos, Laguna, Philippines, 267pp. ISBN 971-614-015-0. Available from: UPWARD, Los Banos Luguna, P.O. Box 3127, Makati Central Post Office 1271, Makati City, Philippines . Fax (63-49) 536 16 62, e-mail: CIP-Maniola@cgiar.org

Includes an overview of local maintenance of crop biodiversity in the Philippines, among other interesting approaches related to agricultural

management of biodiversity in different regions of this country.

Coverage: Philippines

Agroecosystem focus: rice agroecosystem

Topics: farm level management of agrobiodiversity

Contains examples or case studies from: Philippines.

 # 75 Vietmeyer, N. 1996. Harmonising Biodiversity Conservation and Agricultural Development. Pp. 11-30 in: Srivastava, J.,N.J.H. Smith and D. Forno, ends. 1996. Biodiversity and Agricultural Intensification: Partners for Development and conservation. Environmentally Sustainable Development Studies and Monograph Series No.11. The World Bank, Washington, D.C.

Genetic uniformity raises the danger that crop and livestock resources could succumb to diseases or pests. The ability of agricultural and pastoral systems to adjust to change and meet ever-increasing demands for food and other agricultural products thus hinges on the availability of a broad range of plant and animal resources. Only when the integrity of this genetic safety net is assured can agriculture remain productive and resilient in the face of unexpected shocks. Gives examples from history of catastrophic crop collapses, including wheat, potato, and cassava, and the genetic solutions that have been provided by wild relatives of crops. Mention is made of new uses for unconsidered plants, such as in wastewater treatment and soil restoration. Wild biodiversity has a role to play both in pest control, and in sometimes turning from being a pest to a new and valued resource, as with quelea in Zimbabwe. Wild animals continue to provide an important source of protein, and many species are finding increased value as new domestications, such as iguana in Costa Rica. Heirloom seed saver and rare breed organizations are providing an important role in rescuing vulnerable genetic stock. Pockets of diverse agricultural production systems, in for example the Amazon, Rwanda, or Syria, are gaining increased recognition and respect as new models of biodiversity-friendly agriculture are sought.

Farming of endangered species, such as crocodiles in Papua New Guinea and within endangered habitats (butterfly farms in threatened forests, for example) are highlighted, with the point made that “any species that can prove its worth to people can stake a stronger claim to survival”.

It is proposed that “World Heritage Gene Sites” be developed, to ensure protected area coverage for primitive ancestors and wild

relatives of major food crops. The importance of assessing impacts of development projects on agrobiodiversity is stressed, and special venture capital fund that recognizes the needs of biodiverse farming is proposed.

Coverage: Global

Topics: use of nontraditional species, the role of wild species conservation in plant breeding, underutilized food crops.

Case studies or examples from: Kalahari Desert –Botswana, Namibia and South Africa, United States, Costa Rica, Papua New guinea, Africa, United Kingdom, Malaysia.

 # 76 Vorley, W. and D. Keeney, eds. 1998. Bugs in the System: Redesigning the Pesticide Industry for Sustainable Agriculture. London, Earthscan Publications.

This book is an important contribution to the "greening" of both business and agriculture, as it looks at one of the most environmentally controversial industries – the chemical pesticide industry. Lofty intentions of the industry around the 1992 Earth Summit appear to have become derailed in a competitive business climate of mergers and market shares. Business and scientific trends have turned the pesticide industry's focus to biotechnology and seed engineering. These developments suggest that what is needed is a deeper restructuring, a "redesign" of the industry to exploit new business opportunities servicing a regenerative agricultural system.

Coverage: global

Topics: sustainable agriculture, pest control

 # 77 Wood, D. and J.M. Lenné (eds.). 1999. Agrobiodiversity: Characterization, utilization and management. CABI Publishing, Wallingford. 490 pp.

This book brings together the collective knowledge of contributors from a wide diversity of geographical and disciplinary backgrounds, and provides a broad view of current thought on the composition, management, conservation, and utilization of agrobiodiversity through improved farming practices.

Three themes emerge throughout the book. One encompasses the current concept and usage of the word agrobiodiversity and its relation to biodiversity. Another, the large part of the book, expounds on the components of agrobiodiversity, their interactions, their impact

on agricultural production, and how to best manage them for sustained food production. The third theme is an examination of whether the extensive knowledge of the management of agrobiodiversity can provide models and practices for the wider management of biodiversity. This theme, it is pointed out, runs contrary to the mainstream emphasis of ecological and biodiversity practice providing models for agriculture.

A summary of the 18 chapters is presented in the first chapter, and is further condensed as follows:

Chapters 1 - 2 define agrobiodiversity and review its historical dimensions. They describe the development of agriculture and the importance of agrobiodiversity as the largest source of human food. Delving into international policy setting, the chapters also point out perceived yet erroneous conflict between conservationists of wild biodiversity and agricultural biodiversity.

Chapters 3 – 7 examine the nature, role and function of the various important components of agrobiodiversity. Genetic diversity between and within crop species, and its distribution, assessment and organization into agroecosystems is discussed, along with two case studies that demonstrate how natural and human-directed evolutionary forces determine the genetic boundaries of crop diversity. The character and erosion of the diversity of domesticated animals is treated, along with the need for development of information systems that will promote successful management of domesticated animal biodiversity. An examination of the regulation and function of soil biodiversity is provided, especially how they are affected by various agricultural practices, and how below-ground biodiversity relates to crop productivity. Lastly, the evolution of disease diversity in agroecosystems and its generally harmful impact is contrasted with the overall positive impact of insect diversity in agriculture. An appraisal is given for the consequences of pathogen diversity for effective management of diseases in agroecosystems, and theoretical and practical considerations, including case studies, are provided for optimizing insect diversity.

Chapter 8 introduces the management of agrobiodiversity in the broader environment, through a consideration of the agroecosystem in the landscape. The differences between agroecosystems and other ecosystems from an ecological context are examined under the concept of the habitat template, the patterns of disturbance and habitat adversity (or quality), and landscape structure. Two case studies in contrasting systems are presented to assess how much diversity can be supported in an agroecosystem, and to provide a

foundation for a discussion of the effects of intensification in agroecosystems.
Chapters 9 – 13 are devoted to agrobiodiversity management issues. Traditional farming systems are shown to have remarkable parallels across crops, livestock, cultures, and continents, and the need for continued farmer management of agrobiodiversity is stressed. How crop diversity is measured and the effects of plant breeding on crop genetic diversity are reviewed, with consideration of the potential impact of modern plant breeding techniques on agrobiodiversity. The importance of insect pests, weeds, and pathogens in agroecosystems are considered, and a review is presented of the effects of pest management practices by chemical, biological, cultural, and genetic techniques on various components of agrobiodiversity. The effects of conventional modern tillage and alternative tillage methods on agrobiodiversity are also presented, and some general conclusions are drawn. The last management issue addressed is the relationship between seed management systems and genetic diversity, and traditional farmer-managed systems are compared with modern commercial systems within a framework of food production and sustainability.

Chapters 14 and 15 consider various aspects of the conservation of agrobiodiversity. The evolution of conservation approaches and recent arguments for its conservation are presented, and the policy and technology of conservation is addressed using the role of IPGRI as an example of an international approach for conservation of plant genetic resources. The complementarity of conservation methods is discussed in the context of agroecosystem conservation. Next, a conceptual framework (for discussion and testing) is provided for valuing crop genetic resources on-farm, and for supporting strategic decisions about how to choose crops for conservation in particular places.

Chapters 16 – 18 wind up the book by exploring regulatory issues, by debating whether analogues exist in natural and agricultural ecosystems, and by summarizing other key issues. The standard practices used by governments to regulate inputs (seeds and pesticides) to agricultural production are considered, and issues are identified where input regulation can have a significant impact on agrobiodiversity. Changes in common regulatory practices that may be beneficial to agrobiodiversity are examined. The evolving debate over how diversity, stability, and ecosystem functioning is related to agrobiodiversity is reviewed. Contrary to the mainstream line of reasoning, the question is posed whether knowledge of traditional and modern management of agrobiodiversity can throw light on problems of natural resource conservation. Finally, ways of optimizing

agrobiodiversity for productive agricultural development are suggested.

Questions addressed: The book provides a comprehensive review of agrobiodiversity issues, addressing such questions as:

1. What is meant by agrobiodiversity, why is it important, how did it evolve, and what are its components, their functions, and interactions?

2. How are agrobiodiversity and general biodiversity alike or different, and how are they interrelated? Can knowledge of one be applied toward the conservation of the other?

3. What are traditional and modern agrobiodiversity management practices, how do they affect ecosystem functions and productivity, and how well do government policy and regulation support best practices in light of current knowledge?

4. By what methods can agrobiodiversity be conserved?

Coverage: Global.