Sowing the seeds for sustainability

Agriculture, Biodiversity, Economics and Society

Edited by **Rachel Wiseman** and **Liz Hopkins**

IUCN – European Regional Office (ERO)

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Edited by **Rachel Wiseman** and **Liz Hopkins**

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Contents

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Foreword

Agriculture is one of the most important influences on biological diversity. Conventional agriculture has heavily contributed to reducing the diversity of ecosystems, species and genes, but agriculture has also created new diversity, especially in the cultural landscapes of Central Europe.

The interdependence between nature conservation, agriculture, socio-economy and culture is highly complex. This may be the reason why agriculture has not been in the forefront of IUCN's work. But the fact that about 50% of the European Union's annual budget is used to maintain an unsustainable policy on agriculture illustrates the importance of addressing this subject in the drive towards sustainable development. One of the main topics of the WTO conference is agricultural policy; decisions taken there will have a much greater impact on biological diversity than can be achieved by nature conservation instruments alone.

I am, therefore, very grateful to the European Regional Office of IUCN for having taken up the challenge to strengthen IUCN´s contribution to this policy field, one that will become ever more important in the future. This resulting report is an important contribution to the mission of IUCN – to "influence, encourage and assist societies to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable".

The situation in which nature conservation and agriculture are competitive users of land must change. New models of integrated land management have to be developed to introduce biodiversity conservation into agricultural systems.

One example is to strengthen organic agriculture and its multifunctional benefits for society. I am particularly delighted that the 2nd IUCN World Conservation Congress adopted Resolution 2.32 on organic agriculture and conservation of biodiversity. I hope that through the measures requested from the Council and Director General, agricultural policy will be accorded the importance it deserves in the IUCN Programme.

Finally, I wish to thank not only Liz Hopkins and Rachel Wiseman from the IUCN European Regional Office for their efforts to make this session possible, but also all the contributors and participants for their valuable input.

Professor Hardy Vogtmann
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The German Federal Agency for Nature Conservation
(Bundesamt für Naturschutz)

Setting the Scene: An Introduction to the Session

IUCN and the Amman Congress

The Second IUCN World Conservation Congress, held in Amman during October 2000, brought together more than 2000 representatives of governments, NGOs, institutes and experts from around the world to address pressing issues and challenges in conservation that we are facing in the new millennium.

Two days of the congress were set aside for twelve Interactive Sessions or workshops. Since the relationship between agriculture and biodiversity consititues a major part of the IUCN European Regional Office (ERO) programme, ERO co-ordinated a Session on agriculture entitled "Sowing the Seeds for Sustainability: Agriculture, Biodiversity, Economy and Society".

The Session – sowing the seeds for sustainability

The decision was made in the planning of the Session to broadly cover a spectrum of agricultural issues from around the world and examine the linkages between biodiversity, economy and society. Although this limited the time available for topical discussion, the approach brought forth a wealth of wide-ranging views and opinions from farmers to Non-Governmental Organisations (NGOs) to government officials, leading to heated and fruitful debate which covered both practice and policy. This 'fair' of knowledge, perspectives, case studies and experiences attracted about 300 people from over 100 organisations and institutes, representing over 50 countries.

Participation was not restricted to those attending the Session or making presentations in Amman. Input from others came in the form of e-mailed contributions to a discussion forum, posters on case studies, key papers on a subject, comments on the feedback forms handed out at the Session or in the discussions during the Session.

The Session served as a platform for building and introducing networks of expertise. Many links and partnerships were formed both in the run-up to the Session and as a result of the Session programme, which will prove invaluable for the development of well-informed agriculture projects. IUCN is now beginning a global project to collate the work by IUCN on agriculture across the years and to determine, with the IUCN member networks, gaps and priorities for future work. We look forward to sharing the results and developments of this project with you.

This publication represents the opinions and issues raised by those participating in the Session and is comprised of papers prepared by each of the presenters and posters or web contributions prepared by individuals who were unable to attend the congress in person.

Agriculture and Biodiversity: The Challenge for Conservation

Agriculture is the biggest user of land in the world and frequently impacts on or is inextricably bound up with biodiversity. Excluding the polar ice caps, approximately 37% of the earth's land area is utilised as crop and pasture land (WRI website, 2001; FAO website, 2000). In the EU this figure is over 50% (FAO website, 2000) and of the $81 billion EU budget, 47% is allocated to agriculture. Such expenditure on support to agriculture, in the form of subsidies and payments, means that exports are frequently cheaper than they should be. This gives European farmers an unfair competitive edge over farmers from developing countries who do not benefit from such levels of subsidies and subsequently causes a drop in earnings in developing countries. In Latin America it has been estimated that income losses are $3.4 billion annually, as a result of subsidies elsewhere.

Despite the fact that, on average, 24% more food is produced per person than in 1961 (WRI website, 2001), FAO has estimated that more than 800 million people around the world do not have a secure supply of food. With the population growing at a rate of 78 million people per year and global concerns about food security in the 21st century, the production of agricultural goods is expected to increase. At the same time, in many areas of the developing world between 5% and 10% of agricultural land is lost each year through soil degradation, and over 10% of irrigated land is highly salinised, decreasing productivity.

Sustainable agriculture and food security

IUCN and its members are demanding more attention to the conservation of biodiversity through sustainable development. They view agriculture as being both a potentially harmful and a potentially supportive use of land. To maintain productivity in the long-term, it is essential that countries develop policies to move towards integrating food security measures with the conservation of biodiversity and natural resources. The objectives of conserving biodiversity and achieving food security might at first seem to be contradictory. On the contrary, continuing agricultural production relies on the maintenance of resources (such as the soil), the careful use of water supplies, and the conservation of a variety of wild and domestic crop species as a source of resistance to disease.

Historically, nature conservation has concentrated on the management of land preserved for nature, such as the wild plants and animals in these systems. Agricultural crops and domestic livestock have rarely been considered part of the 'natural system' and have frequently been neglected in conservation strategies. Yet, the variety of landscapes and related biodiversity across the world today has been shaped by hundreds, even thousands, of years of farming. For example, traditionally cultivated rice fields constitute one of the most sustainable agro-ecosystems, supporting a huge diversity of life. Their rich array of natural biological control organisms and a diverse soil flora and fauna enhance and maintain soil fertility. Traditional rice fields can actually be perceived as managed wetlands outside natural protected areas (Channa and Edirisinghe, 2000).

Intensification of agriculture

Over the last two decades the area devoted to farming has decreased in countries where agricultural technology has advanced and where intensification has become possible. This has been promoted by some as a positive change since land has been set aside and could possibly be converted back to nature, while high levels of production have been maintained. Others expect biodiversity losses on land that has been abandoned or set-aside by farmers. The Red Book lists 34 species of bird in Ireland, for example, that are dependent upon particular sustainable agricultural practices. In the US, Western Europe and Oceania, "set-aside" schemes have meant that approximately 40 million hectares of land have been taken out of agriculture (WRI website, 2001). However, while the heavy use of fertilisers and other agro-chemicals have

allowed the land to be utilised more intensively, soil quality is declining and chemical run-off into surrounding rivers, water bodies and seas is having a detrimental impact on water quality, ecosystem function and biodiversity.

What is needed is the development of practices that are sustainable both within the agricultural environment and the land surrounding agriculture. These practices must take into account both direct and indirect impacts on biodiversity. When they do not, the consequences can be serious. The development of intensive irrigation systems enables crops to be grown in areas previously deemed infertile. This, however, has commonly resulted in the considerable drainage of wetlands, salination and water pollution. For example, the Diama Dam in Senegal has changed the quality of the water and caused extensive disturbance to the wildlife and natural values of the Djoudj National Park (Arimoro, 2000). The Park is a Ramsar and World Heritage site and its degradation has impacted on the social and economic well being of the surrounding villages.

In Europe the widespread removal of hedgerows has made it easier to use large machinery and obtain economies of scale; but hedgerows are a habitat for many plant and animal species and act as a buffer zone between agricultural land and natural land. The loss of these habitats has resulted in rapid decline in species and population numbers (RSPB website, 2001).

Vertical control

There are further causes for concern. Agro-industries who have no direct interest in local economic, environmental or social welfare tend to control markets around the globe and are gaining greater control of the production chain, from the seeds sold to the products on supermarket shelves. This highlights the issue of free and fair trade. Ironically free trade can generally represent anything but freedom for the people at the bottom of the chain. Take for example bananas. In Latin America where agro-industries control the agricultural land, wage rates are particularly low, social conditions of workers poor and there is little regard for environmental preservation. Not only is this of detriment to the farmers and workers managed by these corporations and to the surrounding landscapes and ecosystems in which these farms exist, but it also threatens the persistence of locally owned farms frequently operating in a more sustainable manner, as they simply cannot compete. Yet the WTO disputes the EU procedure for favouring locally-owned farms in the Caribbean region. On a positive note, certain multinationals such as Unilever (Unilever website, 2001) have developed pilot projects to review more sustainable ways of farming. In Europe, supermarket chains are beginning to respond to consumer demand for more organic food and more recently fairtrade food, which is generally grown in a more environmentally and socially sustainable manner.

Genetically modified organisms (GMOs)

At the cutting edge of the biotechnology revolution and also promoted by particular multinationals, are GMOs. They provide the potential to increase production and reduce fertiliser use. However, genetic modification also provides the opportunity for crops to be grown in areas previously deemed unsuitable for agriculture, raising environmental concerns. In Western Europe, where consumers can afford to be concerned about the possible negative effects of GMOs, labelling of GMO products is obligatory. In poorer countries this is not the case. Concern about being left behind where biotechnological advance is concerned, has meant that the Precautionary Principle is not adhered to and many countries have hastily planted GM crops without making a thorough assessment of the impact on the surrounding environment. It is also feared that limited access to such advanced technologies will compound the negative impacts of global free trade.

Prospects and challenges

One of the biggest challenges over the coming years will be to maintain and develop sustainable agricultural systems which support a high level of wild and agricultural biodiversity. Already this is being increasingly recognised, as illustrated by the integration of agriculture into major environmental agreements such as the Convention on Biological Diversity (CBD) and the incorporation of sustainable measures into regional agriculture policies e.g European Union Common Agriculture Policy (EU CAP). The awareness of extensive linkages between agriculture and the environment is further emphasised by the instigation of IUCN Resolutions on agricultural issues, including those on trade liberalisation, organic agriculture and GMOs.

Since agriculture now represents such an extensive and intensive use of land where biotechnology, globalisation and food security are key issues, conservation at all levels can no longer afford to disregard agriculture.

References

Arimoro, A. (2000). *Desertification, biodiversity and environmental problems in the agricultural and socio-economic development of Nigeria – causes, consequences and recommendations.*

Channa, N.B., Edirisinghe, J.P. 2000. *Role of biodiversity in the conservation and future sustenance of the rice field agroecosystem.*

FAO website. 2000. Http://www.fao.org (Statistical Databases section)

RSPB website. 2001. Http://www.rspb.org.uk/wildlife.asp

Unilever website. 2001. Http://www.unilever.com (Environment and Society section)

WRI website. 2001. Http://www.wri.org/press/goodsoil.html

Results and Recommendations from the Debate

The Session began by examining issues from a biome perspective, assessing the drivers behind the negative impacts and discussing how to promote and implement sustainable practices and livelihoods. Later on the focus moved to 'getting the policy context right'. The issues raised were cross-cutting and emphasised the requirement for linkages between policy and practice, and for co-operation between sectors at the local, national and international level.

Three overarching themes emerged, namely: The Impacts of Modern Agriculture on Biodiversity; Agricultural Business Policy and Trade; and GMOs: Potential Value and Impact. The following outlines the key issues raised in the presentations, members of the audience, together with a summary of the main suggestions and priorities for future work.

The impacts of modern agriculture on biodiversity

Problems

- Exotic species are introduced which may replace natural/indigenous species and lead to a loss of biodiversity associated with indigenous species; examples include rice in South America and European fruits in Indonesia. Exotics may also be maladapted for the environment, such as Merino sheep, which have replaced the indigenous Kalmyk sheep in Kalmykia.
- Cultural and ethical values are diminished.
- Dams and irrigation schemes are often built without sufficient impact assessments, leading to salinity problems as the water table is raised, and flooding and excessive draining of major water sources, as has happened in the Mekong Delta and the Senegal River.
- Intensive use of land, which can lead to degradation of the soil. In arid and semi-arid areas this frequently results in desertification.
- Change from small-holdings to large farming units and agro-industrial developments are frequently the cause of problems including:

  a) The enhanced use of fertilisers and pesticides affecting on-farm and off-farm biodiversity, as reported in Sri Lankan rice plantations.

  b) The plantation of large monoculture crops and therefore a decrease in crop diversity and associated genetic biodiversity.

Suggestions

- Management plans for food production and sustainable rural development, including biodiversity conservation and restoration should be prepared, and applied at varying levels of scale, i.e. farm to landscape to country, and to regional and even global. In each case, the level of participation from different stakeholders should be carefully identified if a positive outcome is to be obtained, and plans should respect cultural and ethical values. Specific plans could include:
- Assessment of the multifunctionality of agriculture and its role in supporting sustainable rural development and biodiversity conservation.
- Local activities and field projects to develop indicators and devices for monitoring biodiversity and to test sustainable farming practices.
- Facilitation of networking between agriculturalists, environmentalists, governments and other groups at local, regional and global levels.
- Involving users and polluters of land in restoration.
- Training farmers to apply practices which support the sustainable use of natural resources (e.g. organic farming).

Agricultural business, policy and trade

Problems

- The full costs of agriculture are not paid for by

the producer, such as the impacts of downstream agrochemical run-off.

- The added value (e.g. profit) from agriculture is not put back into the farm or the region.
- In general 'free trade' market prices do not reflect the social and environmental costs and are, therefore, not really free. For example, in the Macanas Reserve in Panama, rice is grown by a multinational corporation. The rice is sold internationally, at a profit to the multinational, and yet the costs such as pollution from pesticides and the loss of natural biodiversity, are felt only by the surrounding communities.
- Farmers are working increasingly under the umbrella of agro-industries. Such direct and indirect control over the production chain (from the seeds sold – and therefore the products produced – to the fertilisers and pesticides required to obtain a good harvest), is decreasing the access farmers have to biodiversity, and practices are commonly unsustainable.
- Subsidies or payments can undermine sustainable rural development and biodiversity. Payments to farmers in the EU has typically lead to intensive production and a high level of pesticide use. In Brazil, deforestation on agricultural land is subsidised.
- Regional and local differences are not respected enough, and turned to advantage far too little.

Suggestions

- Demonstrate the importance of incorporating social, cultural and environmental values into trade rules and policies for long term sustainability. Specific examples of what is taking place on the ground, and the relation this has to policy and trade rules, should be made and disseminated.
- Facilitate dialogue between the public and private sectors to assess the opportunities for sustainable agriculture within the agro-industry sector.
- Improve consumer awareness.
- Assess the 'polluter pays' principle, and at what level the principle should be applied, i.e. at the level of the producer / manufacturer / farmer.
- Assess the role of current incentives and trade policies in providing biodiversity and rural development benefits. Facilitate the development of tools, methods and indicators for the assessment of trade impacts.

GMOs: potential value and impacts

Problems

- The debate on GMOs has become polarised, so it is difficult to determine whether, on balance, GMOs will benefit or harm livelihoods, health and the environment.
- The costs and capacity to test or regulate the release of GMOs are generally lacking, and GMOs are released without adequate assessment of risks.
- The use of GMOs implies that farmers will become further dependent on agro-industries, who control the technology.
- There is a relative lack of public investment in alternative farming methods or funding for research compared to the investment in research on pesticides, fertilisers and GMOs.
- Gene transfer raises ethical and health concerns.

Suggestions

- Identify an independent and neutral convenor of all interest groups for examining the scientific, social and economic evidence for and against GMOs.
- Support and implement capacity building programmes to enable institution to implement the CBD Biosafety Protocol and provide guidelines for the integration of the Protocol into agricultural practice.
- Facilitate the dissemination of balanced information to consumers and to farmers.
- Provide equal support and research funds for alternative farming practices that match those provided for industrialized agriculture.

With thanks to Hardy Vogtmann and Richard Smith for helping to compile these recommendations. Rachel Wiseman.

CHAPTER 1

FARMING IN DRYLANDS

Sustainable Development and Desertification in African Drylands – Targeting desertification caused by increased human pressure on dryland resources through community-based development programmes

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Abstract

This paper examines the causes and possible remedies for resource degradation and desertification in African drylands. Agricultural production from traditional farming systems is stagnating or falling, while the population is growing fast. The environmental impacts of population expansion are reduction of fallow periods, soil exhaustion and overexploitation of forest and range areas, leading to degradation and erosion. In many areas of the drylands the result for local populations is increasing poverty and food insecurity. Standard dryland technologies are rarely successful under these conditions. Instead, a community-based integrated approach to natural resource management is proposed, in which a menu of possible treatments form the basis for discussions with local farmers. Major issues in implementing the strategy are: the responsibilities to be entrusted to local communities; interactive planning; common property resources management; the mobilisation of local resources; and the organisation of community activities. A joint task force of African and international institutions concerned with dryland development in Africa may be needed to review the problems, identify development prospects, draw up treatment menus, establish priorities, and follow up the international implications of integrated development and sustainable natural resources management.

Introduction

Recurrent famines and persistent human suffering coupled with resource degradation (desertification) have continued to focus international attention on the problems of dryland management in Africa and the utilisation of the semi-arid and arid parts of sub-Saharan Africa, in particular the Sahel. The result has been an overwhelming flow of initiatives, conferences and studies which have failed to resolve the problem over the last three decades. The purpose of this paper is to examine what is known about the problems, the causes and possible remedies, and reflect on emerging thoughts about a sustainable development strategy. In spite of recent efforts there are considerable uncertainties both in the diagnosis of the problems and the suggested treatments, and the aim is also to identify key areas which require further attention. This paper examines the Sahel (which comprises the 10 countries south of the Sahara from Senegal in the west to Somalia in the east), but the discussion applies to similar semi-arid situations in, for example, Kenya and southern Africa. Problems vary significantly within this broad area, and there is a need to recognise different land management systems (reflecting variations in agro-ecological conditions, vulnerability to degradation and managerial arrangements) and reflect on their sustainability in both the short- and long- term.

The state of African drylands

Physical and biological features

Drylands may be defined as areas with less than 800 mm of annual rainfall. In the eastern part of the Sahel, which includes Djibouti, Ethiopia, Kenya, and Somalia, rainfall is bimodal. But in all cases it is extremely variable, patchy and often of high intensity. IUCN data suggest a natural grouping of countries on the basis of their rainfall deficits during the recent droughts. The most affected countries were in the west and include Senegal, Mauritania, Niger and Mali. Deficits have been less pronounced in the central parts of the Sahel – Burkina Faso, Chad and Sudan.

Soils are mostly light and frequently crust forming. Most soils are of low fertility, particularly poor in phosphates and nitrogen, and structurally fragile with low humus content and water retention capacity. Hydromorphology, hard clay pans, laterisation, and wind and water erosion are common problems. Research and experience over the last 20 years in agriculture and forestry confirm that low fertility and vulnerability to erosion are as important a constraint to plant productivity as variation in climate.

The vegetation of the Sahel is remarkably varied given the generally sparse and impoverished nature of much of the region's vegetative cover. Out of a total area of 9.7 million km^2, predominant vegetation types include 1.3 million km^2 of woodland, 1 million km^2 of wooded grassland/shrubland and 370,000 km^2 of various forms of edaphic grassland (grassland determined primarily by soil factors). In addition, Somalia, Ethiopia and Sudan encompass 850,000 km^2 of another major vegetation type, Somalia-Masai bushland, which extends into Kenya.

Human population and production trends

Population growth in the 10 countries in the Sahel, although somewhat less than for sub-Saharan Africa as a whole (3.1%), has been unprecedented and accelerating at 2.9% annually during the period 1980–95 (WRI 1999). The total population in the area increased from 61 million in 1954 to about 186 million in 1994 and is expected to reach 209 million by 2010. The density of population is still relatively low and varies from 36 people per km^2 in Ethiopia to one person per km^2 in Mauritania. The agricultural population per km^2 of arable land is lowest in Senegal and Sudan (lower than 100) and highest in Mauritania (633). The proportion of the active population employed in agriculture has decreased from 85% in 1970 to 75% in 1994, but the absolute number has decreased by at least 1.5% annually. And although a major part of urban growth has been self-generated, migration of both a permanent and seasonal nature has also contributed. In many cases (usually more than 30%) it has left women in charge of the agricultural operations and has, together with increasing school attendance, created severe labour constraints in farming. A move from low potential to higher potential farm areas is also taking place in West Africa where, in spite of disease problems, such opportunities still exist. In some countries, like Ethiopia and Kenya, where the high potential areas are already overcrowded, migration is in the other direction, toward more marginal farming areas. Family planning (birth spacing) is not well established in the drylands.

Although reliable statistics on agricultural production are lacking, available information seems to show increases in production over the last three decades. In the western Sahel (Senegal, Mauritania, Niger, Mali) and eastern Sahel (Ethiopia, Somalia, Djibouti) the World Bank reported growth in the period 1980–1988 to be of the order of 35%, while in the central part (Burkina Faso, Chad, Sudan) growth has been more than double that. Population growth over the same period amounted to approximately 70%. In the western part most of this increase was due to area expansion, while in other regions yield increases were also reported. Fertiliser use is very low but has increased from approximately one to five kilograms per hectare. Agricultural production per capita has decreased significantly in this period, except in the central region where it has remained stagnant. All states in the region have changed from being net food exporters to major importers.

Land use trends

The main farming systems include pastoral livestock rearing, agro-pastoral systems (in which part of the family grow crops while livestock are still herded on communal rangelands, although ranging less widely), and settled farming with or without livestock. Groundwater for irrigation is scarce and often saline.

Agro-pastoralism

Under the low and unreliable rainfall conditions of the drylands, farmers adopt various practices to minimise risks. Adjustments may be made before (ex ante), during (interactive) and after (ex post) the growing season. Among the ex ante practices to reduce risks are diversification, i.e. the growing of crops that perform differently under varying rainfall situations, and intercropping, i.e. growing a combination of crops that draw moisture and

nutrients from different parts of the soil profile; if one crop fails the other may take over. Farmers may also select varieties with different maturation rates, stagger the planting and select varieties with good storage properties to allow stocks to be carried over from good to bad years. They will attempt to find at least a smaller plot of bottom land with better moisture retention properties, and may originally plant a relatively large area, part of which may have to be abandoned in a year of good rainfall. The combination of crops and livestock provides further stability of income and subsistence flows. Depending on how the season progresses (improved weather forecasting may become an important tool), farmers may decide to use fertiliser, or re-seed some area, with short duration varieties or crops, or adjust the plant density (sequential decision making). If the crop fails, farmers may try to supplement their income through outside employment, trading or craftwork, sale of livestock, or food aid.

Pastoralism

Livestock grazing is a productive land use in areas unsuited to agricultural cropping. It is generally practised in arid or semi-arid lands, where rainfall is sparse and unpredictable in time and space. Extensive livestock production, particularly pastoralism, is an appropriate and sustainable form of land use that is much less risky than cropping. Grazing and rangeland vegetation are co-adapted; both undergrazing and overgrazing result in the growth of woody plants and large, unpalatable grasses which reduce the productive potential of an area. Dung from the livestock helps to maintain soil fertility and physical soil characteristics, and the germination of certain plants is enhanced or made possible when seed is passed through the digestive tract of animals.

Livestock production, therefore, represents a system of land management that can maximise food production in marginal areas with minimal input, while maintaining the productivity of the ecosystem. Negative environmental impacts of livestock grazing arise from excessive concentration around water points and settlements. Nomadism is a biological necessity for survival in areas with scant rainfall, and pastoralists have also diversified their livelihoods through the keeping of mixed herds of livestock like cattle, sheep, goats and donkeys.

Institutional trends

Drylands face a number of institutional and political constraints. As part of nation-building efforts, central governments have taken over the ownership of natural resources (land, trees and water) which were formerly under local community control. Usufructuary rights are granted to individual cultivators, and although traditional management practices continue to prevail in many rangeland areas they are denied legitimacy if there are any conflicts of interest. Central governments have not been able to establish any effective alternative management systems, and different users therefore tend to have open access to such common property for grazing, water and fuelwood. Governments find it difficult, even in forest reserves, to protect against encroachment, and influential people close to the decision-making powers are frequently able to obtain rights in, and encroach upon, the common lands.

Traditional society has undergone other fundamental changes as well. Leaders have been co-opted by the state for administration, tax collection and law enforcement, and may now be more aligned with national powers and associated individual benefits than with local interests. As a result of these centralisation policies, local motivation and initiatives have been sharply reduced and replaced by a dependency on central government. The virtue of decentralisation is being extolled by many governments, but so far, with the possible exception of Kenya, there has been little real action; the fear of reinforcing tribal divisions may possibly act as a deterrent. The distribution of wealth (e.g. livestock) seems to have become more skewed, which will tend to further erode local cohesion.

Given the low population densities, large distances and poor road conditions, government services are relatively weak and, in pastoral situations, difficult to deliver. Research has mainly emphasised high potential areas and provides little guidance for dryland development. Public interventions in water supply have proven very difficult to sustain in the absence of effective cost recovery, trained technicians and the absence of spare parts, which have to be imported. IUCN reports some 4,500 development projects in the Sahel supported by 180 different donors. Despite such impressive numbers, though, successes are relatively few, scattered and difficult to generalise. In addition, war and internal unrest have caused major setbacks in development efforts in several countries.

Poverty and resource degradation

The present crisis in large areas of sub-Saharan Africa can be related to four mutually reinforcing trends: explosive population growth, stagnating agriculture, degrading natural resources and

increasing poverty and food insecurity. Prophylactic health care has greatly increased infant survival and prolonged life. However, so far there is little adjustment of family size as children are considered as an asset in the struggle for survival and as a security during their parents' old age. Agricultural growth is still mainly based on area expansion; intensification through the application of new technology, cash inputs, or adjustments in farming systems is low. The environmental consequences of population expansion thus tend to be a reduction of fallow periods and soil exhaustion, cultivation of shallow soils and steep slopes, followed by accelerating erosion, over-exploitation of forest and range areas around settlements, consequent denudation and erosion and worsening prospects for future agricultural growth.

The failure of agriculture to keep pace with population growth, in a situation in which the non-farm sector is only able to absorb a fraction of the added labour force, has resulted in decreased per capita income and in some areas chronic food insecurity. This in turn may imply less interest in family planning measures. In large parts of the drylands the population now faces a situation where the per capita access to resources in the form of land and livestock is dwindling. The exploitation of more marginal areas also implies that the risk of crop failure is enhanced and food relief is required with increasing frequency.

Livestock numbers

Livestock numbers are commonly reported to greatly exceed the carrying capacity of the rangelands. Under the pressure of such overgrazing, vegetation is expected to deteriorate in quality and quantity. As the population increases the average herd size is diminishing, and pastoralists find it difficult to maintain a living purely on livestock production. Some families take up crop production if they have the opportunity, while others attempt to sell livestock in exchange for grain. The desire for schooling and other social amenities reinforces the move towards agro-pastoralism. Although availability of feed remains an overall constraint to the number of livestock that can be carried, the continuous grazing of areas around settlements may result in degradation. The loss of mobility appears to have made agro-pastoralism more vulnerable during a drought.

Water resources

Obviously, lack of water is also a limiting factor, which prevents the use of certain areas during the dry season. The amount of labour available for manual watering restricts livestock numbers where water has to be drawn from dug wells. Public intervention to relieve such restrictions are the subject of much concern and a reputed source of excessive concentration of livestock and of associated degradation. Apart from the difficulties of sustaining these interventions, do additional water points spread destruction or increase production? By removing the labour constraint or opening-up areas for dry season grazing, livestock numbers will tend to increase. More serious degradation often occurs around settlements where the demand for fodder and fuelwood or charcoal may lead to denudation of vegetative coverage. Such depletion in ancient Ethiopia forced a relocation of settlements which could be avoided only after the development of individual plantations of fast growing eucalyptus species.

Agricultural expansion

Clearing of land for crop production can be expected to result in higher biomass and production value in the short-term and, with appropriate precautions, it may often be possible to prevent soil degradation and gradual loss of productivity. But appropriate technology is frequently missing or has not found favour with farmers. There is little traditional experience of maintenance of soil fertility where fallow periods have to be shortened, or of soil conservation where more marginal and arid areas are brought under cultivation. Problems of erosion (wind and water), nutrient depletion, acidity and deteriorating soil structure (compaction, crust formation, laterisation) may be encountered and require new approaches. Some of these problems are obvious even to the casual observer, while others will require careful analysis. There is very little scientific work on what is happening to the soil, the extent of damage, the impact on yields, and the effectiveness of possible treatments.

Some possible causes of the current crisis

Several reasons for the failure to speed up agricultural production, reduce population growth and prevent land degradation may be noted:

- Lack of confidence in the political system due to continued tribalism and unrest (incomplete nation-building);
- Power frequently being abused to promote personal rather than national interests;
- A dual-value legal structure (traditional and Western) which allows much room for manipulation;
- Limited accountability (both in the political

system and in the civil service) and a consequent low level of performance, and leaks;

- Insufficient government attention to land degradation, agricultural development and subsistence farming;
- Deficient infrastructure, which slows adjustments and prevents specialisation;
- Insufficient adaptation of recommendations to the large agro-ecological variability over time and space, and deficiencies with respect to proven technology, extension, input distribution, credit, etc. outside the more promising situation;
- Inefficiencies arising from institutional weaknesses and particularly the over-emphasis of the public sector and centralised decision making;
- Central ownership of natural resources in conjunction with the breakdown of traditional leadership and consequent lack of security for individuals using fallow land; open access to range and woodlands; inability to protect and manage public forest reserves and parks;
- Inappropriate development strategies, including:
  - i) a prescriptive rather than interactive approach with insufficient understanding of the problems, priorities, resources situations and strategies of individual producers; insufficient understanding of village dynamics (i.e. interactions among farmers and landless, cultivators and herders, men and women, wealthy and destitute)
  - ii) dealing with population, agriculture (crop, livestock and forestry) and conservation issues in isolation; pursuing complex problems with single factor treatments and projects
  - iii) an uncoordinated approach in which government strategy is frequently insufficiently articulated, donors pursue their own objectives and approaches, and there is little institutional memory or learning from experience;

Drought is often blamed for increasing poverty and desertification. It is clear that countries in the western and central parts of the Sahel in particular have over the last 20 years experienced an unprecedented series of below average rainfall years, while the other countries have suffered from shorter periods of severe drought. To what extent these facts represent a worsening climatic trend or a cyclical event and whether they have been influenced by human abuse of the environment will require a much longer series of observations to determine. What is important here is to establish the effects on production, income and natural resources. That drought can have an adverse impact on production is not disputed, although this label is often used to hide the failure of government policy to create an incentive framework which allows production to keep pace with population growth. Such man-made 'drought' occurs with increasing frequency even in average rainfall years.

Among the inhibiting factors, much attention has already been given to the importance of incentives and efficient marketing, credit, and input distribution. Instead, this paper concentrates on technology issues and the need for a community-based integrated approach to the conservation and development of natural resources, which has been perceived in many recent programmes and projects (Tropical Forestry Action Plan, social forestry, watershed development, wildlife conservation, natural resource management). To what extent could such a strategy accelerate adjustment and achieve or retain sustainability? How effective would it be in improving management of rangelands and forests; in improving the planning and the adjustment of recommendations to the local agro-ecological situation, the resources and the priorities of different segments of the community; in reducing the dependency on government and promoting local initiatives and increasing self-reliance; in integrating development efforts, particularly those concerning conservation and investment in crop range and forest lands; and in improving accountability in the use of local and central funds? What government and donor support would be needed and how could it be organised? A few thoughts on non-farm opportunities and some dryland specific policy issues are presented.

Development prospects

Technology

Dryland technologies

The success of any development effort will depend largely on the availability of attractive interventions. Any attempt to take stock of available technology will need to distinguish agro-ecological variations and the associated constraints in the form of moisture stress, nutrient deficiencies, soil structure and erosion, and weed, pest and disease problems. It will also need to review the different

land management systems (e.g. pastoral, agro-pastoral, settled crop production, with or without livestock), and the interrelation between different enterprises, seasonal labour shortages, and risk aversion strategies that characterise each system. Such stocktaking would need to assess not only the technical but also the financial and risk implications of each intervention, and how it fits into the existing farming system.

There has, of course, been a fair amount of success in different parts of the world, with an essentially top-down approach to generating and disseminating technology. The emphasis has been on production and good results have emerged, particularly in relatively homogenous high-potential areas. Results have been less spectacular in areas of large variability, and where integrated production systems and risk management have a higher profile. In the drylands there are few practices which can be taken off the shelf and prescribed to farmers. There are a number of successes of a scattered nature from which it is hard to generalise – by no means surprising under the diverse conditions of the drylands. Some practices will simply not be applicable until a certain stage in the development process has been reached. For example, intensification may not become feasible until land is considered the constraining resource, i.e. the transition from shifting cultivation has been completed. Lack of security of tenure may prevent long-term investments in land, and a farmer's work situation may prohibit accepting an otherwise attractive proposition. Treatments that are risk-reducing, low in labour demand at peak periods, have short payoff periods, and do not mean foregoing much existing production would find relatively ready acceptance.

Traditional approaches

Ecologists emphasise the resource-conserving nature of traditional farming systems, and the need to marry those systems to advances in modern technology and biology. The reputed soundness of traditional systems was no doubt correct at one time, but since then pastoralists have, for example, been forced to take up crop cultivation of which they have little experience, and they are also no longer in full control even of their grazing areas. Migrants similarly may have little knowledge of their new surroundings, shifting cultivation is in a phase of rapid transition and marginal lands are being brought into cultivation. It may therefore, at this stage, be misleading to assume that existing systems do not cause degradation. In view of the diverse nature of dryland farming, as discussed in the previous paragraph, it will nevertheless be extremely important to interact with farmers on opportunities and constraints from the perspective of their present farming system rather than to prescribe particular treatments. If farmers are made aware of the options to overcome constraints and exploit opportunities, they can select the treatment that best fits their situation and interests. This assumes that existing research and development experience are used to compile a 'menu' of promising treatments on which to base discussions with local groups of farmers. The menu approach being tried in some ongoing UNSO projects is an integral part of the India Integrated Watershed Development Projects. It is proposed for the preparation of a number of resource management projects in West Africa and is being advocated in the Long-Term Perspective Study (LTPS) for sub-Saharan Africa as well as in the Asia region review of watershed development strategies. This more interactive mode of extension assumes staff can grasp the overall system of farming and analyse the consequences of different interventions and relate it to farmers. The compilation of an initial menu must be supplemented by a vigorous adaptive and operational research programme (systematic testing of the proposed treatments under varying conditions and studying their impacts and constraints to adoption in the field).

Gaps and priorities

The compilation of a treatment menu may also help identify priority gaps in our knowledge and stimulate more interest in dryland problems: an area of research which has so far been given little emphasis. The following subjects appear to deserve particular attention:

- *Drought resistant crops and varieties*

  The work of the Negev Institute in Israel illustrates the scope for developing crops and genetic material which perform well under arid and semi-arid conditions. Present breeding work in sub-Saharan Africa does not emphasise the moisture stress, short growing periods, low soil fertility status and intercropping that characterise the drylands. In spite of 40 years of sorghum breeding it is, therefore, not surprising that less than 5% of the area is planted with so-called 'improved' varieties.

- *Land husbandry*

  This heading embraces a large spectrum of activities to enhance production through soil and moisture conservation and preserving soil structure and fertility. It includes contour cultivation, strip cropping, intercropping, rotational practices, vegetative barriers for soil and moisture conservation, integration of crop,

livestock and forestry, adjusting land use to soil depth and slope conditions, etc. Priority research gaps include: the identification of legume crops or fallows to facilitate the transition from shifting cultivation; agro-forestry (present research mainly refers to more humid conditions); and fodder cultivation.

- *Irrigation*

  In spite of past failures one can ill afford to pass up opportunities for irrigation development. The central issue will be how the problems experienced in the past can be overcome. The type of crops and the utilisation of saline water will need attention.

A community-based integrated approach to natural resource management

Disillusionment with the ability of central government to manage common property, assess local conditions and priorities, and design and implement a successful conservation and development programme has led to growing appreciation of the need to decentralise ownership of land. It also highlights the need to mobilise local initiatives and energies through a more participatory and integrated way of working. Such a community-based integrated conservation and development strategy is being promoted in the most recent efforts in relation to natural resources, but effective means of implementation are still being sought. The importance of public participation was realised long ago, but progress in implementing it has been very limited. Previous integrated rural development projects are of particular relevance and it is time to reconsider this experience. The management of natural resources is frequently complex and calls for simultaneous action through well coordinated planning and implementation. Some major concerns in implementing the strategy, which will be reviewed in the following paragraphs, refer to the degree of integration (the responsibilities that should be entrusted to the local community), interactive planning, common property resources management (CPRM), mobilisation of local resources, and organisation of community activities.

Degree of integration

The local community can obviously be encouraged to play an active role in the planning, execution and maintenance of investments: it can manage and help protect public forests and parks; it can become a conduit in the dissemination of new technology and provision of veterinary services; and it can organise itself to take part in marketing, input distribution, savings and credit. The range of activities depend on the analysis of local conditions and priorities. To the extent external support is needed to achieve these priorities they would need to fall within the 'menu' of eligible activities, which could be defined more or less narrowly depending on government objectives and the perceived need for integration. Eligible investments could range from soil and moisture conservation, afforestation, range improvement, horticulture, drainage and irrigation, livestock improvement and deer farming, water supply and roads, education, health, family planning, sanitation, etc. A balance between local priorities and central objectives can also be maintained by prescribing a certain relation between different types of investment – or by varying the proportion of central government funding – and the range of community activities could be allowed to grow in some sequential fashion as managerial competence increases. The degree of integrating a range of activities became a major concern in rural development projects because of the difficulties experienced in their coordination and management. There is, however, a difference between the execution of a centrally-planned integrated project and what is now being contemplated, i.e. the support of a set of locally-generated activities.

Interactive planning

With the objective of improved livelihoods, village members would need to work with government staff on an analysis of opportunities and constraints, or the performance of existing land management systems, the identification of areas which are particularly vulnerable to degradation, the scope for infusion of new technology and improved management, and the need for investment. The resulting plan would reflect local agro-ecological conditions, resources and priorities. It would embrace both individual and community actions and could provide the basis for a written agreement between the government and the community. The plan would need to provide not only an investment programme (selections from menus of eligible treatments) and a review of the arrangements for management of common land, but also suggest ways and means to mobilise the required resources and indicate what training would be required for members to take charge of its execution. The plan would need to be simple. The initial aim should not be to elaborate data collection and land use planning, but to focus on observations and interaction in the field. A large number of models for this kind of interactive planning (also called 'rapid rural appraisal') exist. The main difficulties lie in the analytical capacity of staff and their ability to change from a prescriptive to an interactive mode of operation. The introduction of

this kind of local planning would necessitate some changes in sectoral planning. The main concern at the national level would be with the overall strategy for agriculture and rural development, with the generation of a favourable policy and institutional environment (marketing, pricing, credit, etc.) and with central services, such as research and agricultural education.

The district planning will need to: take note of physical resources (natural as well as infrastructural); identify opportunities and constraints; generate a menu of treatments to deal with these constraints and exploit these opportunities; identify priority locations for treatment; review and adjust ongoing projects; and generate new investment proposals (for example, strengthening of the main infrastructure and capacity to support village initiatives).

Common property resource management

The degradation of rangelands and woodlands will be a major concern in village planning. Some areas may give a higher return in crop production and, if yields can be sustained, there should be no objection. There are, however, many examples where expanding cultivation has resulted in serious erosion and loss of fertility. In any further privatisation both land capability and methods of cultivation of such marginal lands require serious attention. The viability of private ranches for extensive livestock production is often questionable in view of the patchy rainfall, the scarcity of water and the need for seasonal movements. The private ranch would need to be of a size to be hardly sustainable at present population densities. The main opportunity for enhanced rangeland production centres on the prospect for improved management by local groups. A precondition for management is the exclusion of other users, which means moving away from open access. This assumes a legal right to exclude non-members of the group and a capacity to enforce this right and protect the boundaries.

The group ranches in Kenya, for example, became popular as a way of protecting land from appropriation by others. The control over land by the pastoral associations in West Africa derives its legitimacy from the projects under which they are established, a control which may not be sustainable unless legislation to confirm local ownership is introduced. Having the right to protect boundaries, though, does not necessarily imply a willingness to do so. In view of the uneven geographical distribution of rainfall, the group ranches in Kenya did not choose to enforce exclusion of other groups, and consequently never introduced any improved management practices. Under such circumstances a system of selling and buying grazing rights or fodder would need to be (but was not) introduced. Even if this hurdle is overcome, the outcome will still depend on the internal ability of the local group to regulate stocking, arrange rotational grazing, rest areas when needed, plant trees for fuelwood and improve water availability. This task becomes more difficult when ownership of livestock is unequally distributed and a few people own most of the herd. If so, it will be necessary to contemplate some sort of grazing fee or tradable grazing quotas to compensate families with fewer livestock.

There are few examples of successful introduction of such improved management arrangements. Improved management of rangelands, especially in areas occupied by pastoralists, is still an elusive goal which requires further experimentation and testing. A partnership between government and surrounding communities in the management of dryland public forests and parks is being proposed to make protection a mutual interest. This will require: the definition of the area of influence of each community; a review of the fodder, fuel wood, income and employment needs of the community; and the extent to which these can be met through rehabilitation of the forest/park in question and agreements on cost and benefit sharing and on the community responsibilities for protection and management.

Mobilisation of local resources

Local initiatives and a decreased dependency on central government will require a higher degree of self-reliance and mobilisation of local resources. Communities are often said to be willing to tax themselves if funds are used locally for priority purposes. Initially such resource mobilisation (which often would be in the form of labour) could be encouraged by central government matching the amount raised locally. This would have particular merit in the case of conservation treatments, which frequently have benefits outside the community in question. In the case of dryland forestry it may be possible to cover some of the government contribution by prescribing some form of benefit sharing. Private investments should usually be funded through credit, but in situations which are subject to a high degree of variability and where the technology is insufficiently tested and demonstrated, this will be difficult. The community may be empowered to raise various types of user fees (e.g. grazing fees) or impose penalties. Community investments may also be funded through locally-generated savings and repaid with the help of user fees.

Organisation of community activities

The village, being a relatively small, homogeneous and cohesive group, probably provides the best organisational basis for implementing the above tasks. Nevertheless, the average village contains people with very diverse interests, resources, competence and ambitions (such as farmers and landless, herd-owners and people without livestock, wealthy and destitute, educated and illiterate, politically-active and indifferent, men and women) and it may be necessary to form subgroups and to guard against dominance by any one group or person. There is need for better understanding of village dynamics: how village decisions are taken; how minority views are protected; what type of planning and resource generation presently prevails or used to prevail, etc. The legal status of a village organisation to carry out the above tasks must be considered (informal or registered under societies or cooperative acts). Its relation to the local administration (e.g. in Lesotho it constitutes the lowest level of the administrative hierarchy) and to traditional leaders needs attention; some tasks (e.g. marketing and credit) may need a separate organisational structure. Rules will need to be established for: taking decisions and for electing or appointing members to take charge of various managerial and technical tasks; for rewarding and training these members; for collecting, keeping and disbursing funds; and for maintaining records. Arrangements for audit and for providing maximum public insight must be put in place. The promotion, guidance, and supervision of a vast number of village organisations and training of their elected or appointed officials is a matter of social engineering for which government agencies have very little aptitude and previous experience. This task is often entrusted to a suitable NGO, where available.

Non-farm opportunities

In many dryland areas a substantial part of family income comes from non-farm activities. Some of this constitutes remittances by family members that have left the area permanently or seasonally. But some has its origins in trading and crafts, which we need to understand better before we can identify the limitations and opportunities involved. The investment priorities of local communities are frequently for improvements in infrastructure (water supply and roads) and social services (education and health), which are of profound importance both for production and living conditions and also may promote specialisation, mobility, and migration. The big problem in defining the local responsibilities for such investments will be to match sectoral development priorities, in terms of the use of national resources, with local initiatives and funds, and to ensure the sustainability of whatever facilities are created. Arrangements for cost recovery will be needed to ensure maintenance and operation (e.g. water supply), but even so the task may be complicated by the lack of skills and imported spare parts. Recent studies point to opportunities for local communities to engage in wildlife management and tourism. Establishment of such activities would face many of the same problems encountered when establishing control over rangeland management areas for livestock production, but would also have to deal with poaching and the migration of wildlife.

Some specific dryland policy issues

Price policy can have a substantial impact on the use of natural resources, but it is hard to generalise about these effects. A general price increase (structural adjustment) will tend to increase the demand for basic factors of production such as land, labour and capital, the supply of which are relatively fixed in the short-term. Although both future and present benefits are enhanced by such a general increase, it may result in land 'mining' if the permanency of the change is questioned or if future returns are heavily discounted by farmers. Open access to rangelands may encourage overexploitation. A border price policy may similarly result in undesirable resource allocation if inputs are not valued at world market prices. Large-scale mechanised farming may develop as a result, and encroach onto fragile rangelands. A general price increase will also affect export crops more than food crops since the impact will be related to the degree of market orientation. The consequent change in the production mix may be good or bad from an environmental point of view, depending on the type of export crops that are encouraged. If the production of tree crops, such as tea or coffee, or nitrogen-fixing crops, such as groundnut, is expanded, this may contribute to the preservation of natural resources. The government may wish to consider the pros and cons of deviating from border pricing principles to promote crops with a positive impact on the environment by an increase in their relative price. If the price of fuelwood is increased in relation to competing products, this will lower demand and encourage planting. Changing factor prices may similarly have environmental effects. Promoting cost-recovery for water may diminish overgrazing in the vicinity of boreholes.

One of the big problems in pastoral livestock production is the distress sales in times of drought, which result in sharply depressed prices and

deteriorating terms of trade with other food items. It may be possible to stabilise prices in localised events, but no way has been found to deal with countrywide stress. The only way to limit distress sales will be through the promotion of a more commercial type of pastoralism under which the breeding herd is restricted to what can be sustained under 'normal' conditions, and marketing of non-breeding stock is a continuous process. This will require both incentives (e.g. availability of consumer goods) and efficient marketing arrangements, as well as alternative and attractive means of keeping wealth (banking) or, in other words, assets which can be utilised to survive during emergencies and subsequently to rebuild the breeding herd.

Apart from the devolution of ownership of common land to local groups advocated earlier, there are other land tenure constraints. If user rights are acquired simply by taking-up crop cultivation, there is an incentive to exhaust the soil and move on. This is particularly the case when the fallow in shifting cultivation reverts to cultivated legume fallow or conservation structures. Rules need to be introduced to protect the rights of farmers who are prepared to undertake such investment. The existence of such rules would be a powerful conservation incentive.

International collaboration in dryland management

The suggestions highlighted above regarding the formulation of a strategy for drylands development in Africa should not be interpreted as a prescription. Each government must obviously formulate its own strategies in the best interest of its drylands people. In the absence of clearly articulated government strategies, however, ongoing projects now tend to reflect a series of donor perceptions and resulting efforts are often confused and contradictory, ineffective and discontinuous, detracting from, rather than enhancing, the prospects of building a long-term development capacity. A joint task force of both African and international institutions concerned with drylands development in Africa may be needed. It would review the problems of poverty and drylands resources degradation and clearly identify development prospects and generate treatment menus. Its aim would be to establish priorities and pursue the institutional and organisational implications of community-based integrated development and sustainable natural resources management strategies. Following such a review, international development partners would need to co-finance various community development approaches within the strategy to achieve harmonised and more effective development.

The Global Environment Facility (GEF) is such a partner currently giving support to developing countries for sustainable environmental management. As a relative newcomer within the international development community, the GEF is probably best placed to assist in the coordination of such an effort with its governmental and non-governmental partners. The GEF currently provides grants of approximately USD 250 million and leverages a further USD 250 million in support of dryland management and land degradation control activities in African drylands. The GEF recently announced a new African land and water initiative to support integrated land and water management at the community level. This initiative will be one of the beneficiaries of the USD 500 million earmarked by GEF for land and water management activities in the five years beginning in 2000. Through this effort, the GEF could act as catalyst to bring together the various actors to elaborate the strategies and approaches needed to make a difference on the ground.

The short-term nature of development interventions in drylands so far constitutes another major constraint in achieving the desired development objectives. Drylands development should be a long-term learning process in which failure by itself does not constitute a sufficient reason for discontinuing the efforts, as long as something is being learned from the experience. A partnership will need to be forged to pursue dryland development while testing the various approaches underlying strategy through careful monitoring of the impacts on production, incomes and resources degradation as well as institutional performance and distribution of benefits.

A last but difficult question concerns the relative priority of investments in Africa's marginal drylands. There is, on the one hand, a legitimate concern about the human suffering of the people living in these areas and the continued resource degradation. On the other hand is a catalogue of possible and relatively successful approaches and technologies to come to terms with these problems. Development partners in the area of dryland management must continually seek the appropriate balance that will bring about the desired results within reasonable time limits. There will, however, be a continuing need for short-term relief in periods of adverse weather conditions, which could also be used for increasing productive capacity. Some further degradation of natural resources may be unavoidable in the short-term, but a

consistent application of best practices and lessons learned from previous experiences should be able to reverse the downward trends and introduce sustainable development and livelihoods.

References

Lusigi W.J., Nekby B.A. 1991. Dryland management in Africa: the search for sustainable development options. AFTEN working paper. Washington DC: World Bank.

Trupp L.A., Megateli N. 1999. Critical links: food security and the environment in the Greater Horn of Africa. WRI Project Report. Washington DC: WRI.

World Bank. 1990. Sub-Saharan Africa, from crisis to sustainable growth (long term perspective study). Washington DC: World Bank.

Conservation and Sustainable Use of Dryland Agro-biodiversity in Jordan – Current Status

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Abstract

Jordan's geographical location and climatological and geological formations supports biodiversity of global importance, with species related to different biota present within a relatively small area. Agro-biodiversity forms a significant component of Jordan's biodiversity. It has been accumulated during long periods of interaction between cultural and management systems and natural ecosystems and species. At the same time, Jordan suffers from the combined pressures of human population growth, excessive resource demands, exotic species introduction and atmospheric pollution, which have led to significant losses of biodiversity. Further loss of habitat must be stopped and a substantial fraction restored. This will require study of the causes of agro-biodiversity degradation, alternative land uses, raising awareness of the importance of agro-biodiversity, training and in-situ demonstration of the sustainable use and conservation of biodiversity. Measures at the national and international level are proposed to support this.

Introduction

The Near East is an area of enormous diversity of important food crops and pasture species. It is one of the few nuclear centres where numerous species (notably wheat, barley, lentil, pea and vetch) of temperate-zone agriculture originated 10,000 years ago, and where wild relatives and landraces of enormous genetic diversity are still found. Many fruit trees, such as almond, olive and pistachio, also originated from this region and have dominated its traditional agricultural systems; they are present as a diverse range of wild relatives and local varieties. Cultivated olive, for example, exists as fifty different clones in the region, while almond, one of the most widely cultivated fruit trees in the Mediterranean, exist as more than fifteen local clones with distinct variations in fruit size, inflorescence, hairiness and flower colour.

Jordan comprises a sizeable part of the Near East. The global importance of Jordan's biodiversity lies in its geographical location and climatological and geological formations. The country has three main topographical features: the Jordan Rift Valley, including the Dead Sea Basin, the Highlands, which are covered mainly by forests, and the Eastern Desert (Badia). These unique geographical features provide a tremendous diversity of habitats, including some of the most peculiar distribution of species, communities and coral reefs. It is located at the crossroads of three continents and has been the bridge for an extensive exchange of cultural and natural resources. Nestled, so to speak, between Europe, Asia and Africa, Jordan straddles four distinct biogeographical zones: Mediterranean, Irano-Turanian, Afro-Subtropical and Saharo-Arabian.

As the global conservation community becomes increasingly concerned with dryland biodiversity and the consequence of its conservation and management, Jordan is the only country that has maintained and continued to maintain species related to different biota in a small, semi-land-locked country.

Agro-biodiversity components

Biodiversity is defined as the variability of living organisms and ecological complexes in which they occur, the number of different items and their relative frequency. It encompasses different ecosystems, species, genes and their abundance. The importance of conserving and making sustainable use of biodiversity is stressed at international, regional and national levels. Agro-biodiversity can be defined as biodiversity in an agricultural context, and can be described as the variety and variability of living organisms (of animals, plants and micro-organisms) that are important to food

and agriculture in the broad sense and are associated with cultivating crops and rearing animals and the ecological complexes of which they form a part. It is not just a subset of biodiversity, but an extension of it because it embraces units (such as cultivars, pure lines and strains) and habitats that are not normally considered or even accepted as proper parts of biological diversity. In other words, agro-biodiversity includes all those species and the crop varieties, animal breeds and races, and micro-organism strains derived from them, that are used directly or indirectly for food and agriculture, both as human nutrition and as feed (including grazing) for domesticated and semi-domesticated animals, and the range of environments in which agriculture is practised. It also includes habitats and species outside farming systems that benefit agriculture and enhance ecosystem functions.

Agro-biodiversity can be considered at three main levels: those of ecological diversity, organismal diversity and genetic diversity, including the human interaction with all these levels. It is the result of the deliberate interaction between humans and natural ecosystems and the species that they contain, which often leads to major modifications or transformations. Agro-ecosystems, therefore, are the product of not just the physical elements of the environment and biological resources, but vary according to the cultural and management systems to which they are subjected. Agro-biodiversity thus includes a series of social, cultural, ethical and spiritual variables that are determined by local farmers at the local community level. These factors are often overlooked, but must be taken into account as part of the process of selection and introduction of new or underdeveloped crops.

Reasons for biodiversity loss

There is virtually no place on earth where biodiversity is not under siege from the combined pressure of human growth, excessive resource demands, exotic species introduction and atmospheric pollutants. Jordan is affected by these factors, too.

Combined pressure of human population growth

Jordan is a small country and 90% of its land area consists of desert. The total population of Jordan is approximately 4.5 million and is estimated to be growing at an annual rate of 3.4% – one of the highest growth rates in the region. Most people in Jordan live in the highland region, which also contains most of the agro-biodiversity. Due to the pressure of population growth, urban areas have expanded at the expense of the forest and rangeland areas. The felling of trees and ploughing land for the cultivation of new and highly productive varieties cause most of the loss and degradation of the agro-biodiversity in the country.

Excessive resource demands

As the population in Jordan has grown rapidly, plant cover in the country has been under increasing pressure from the need to produce more food and animal feed. The vegetation has been subjected to the following activities:

i) Illegal felling of trees to be used in furniture manufacturing or as fuel during the winter in urban areas.

ii) Overgrazing: sheep and goats have been reared in the area for generations and uncontrolled grazing has destroyed the plant cover in many areas. In some areas, forest regeneration is being prevented because tree seedlings are eaten by livestock.

iii) Illegal collection of medicinal and ornamental plants: many plant species of medicinal and ornamental use are collected every year without any control.

Introduction of exotic species

This is considered to be the most important factor behind the loss of agro-biodiversity. Many plant species have been introduced to the country. These highly productive genotypes are replacing the landraces, which are adapted to local environmental conditions and can survive under the adverse conditions of drought. This has led to soil erosion, especially during the last few years in which the dry seasons have been very long.

Natural disasters and atmospheric pollution

Natural disasters and pollution have caused significant destruction to the plant cover in Jordan. It is estimated that each year fires destroy about 30,000 trees and about 500–1,000 dunums (about 50–100 hectares) of rangeland. The climate is changing; lower rainfall and drought are causing desertification and a decrease in plant cover. In addition, industry and urbanisation are sources of chemical and biological pollution.

Examination of these processes reveals that the magnitude of the problem is overwhelming. Therefore, the question that has to be raised is,

'How can we stop this loss of biodiversity?' To answer this question, we have to take into consideration the extinctions caused by habitat destruction over the centuries. We should first stop habitat loss immediately and try to restore a substantial fraction of the habitat that has already been lost, bearing in mind the growing population, the consequent increase in the consumption of resources, and the social costs of these practices. Under these circumstances, our plans for the conservation and sustainable use of biodiversity should meet the social and economic needs of society.

Action to be taken for the conservation and sustainable use of Jordan's biodiversity

- *Study the causes of agro-biodiversity degradation*

  Many plant species in Jordan are under a direct threat of extinction and some have already become extinct during the last century. Plant diversity in Jordan has declined dramatically as a result. Many reasons have been identified for this loss of plant species, but they do not affect all ecosystems and their importance differs from one ecosystem to another. Therefore, we have to study the causes of agro-biodiversity degradation in each ecosystem and determine their effects in order to find suitable ways of stopping these factors and rehabilitating the ecological system. The socio-economic situation influencing the utilisation of these plant species has to be studied, too.

- *Find alternative uses for land that ensure the conservation and sustainability of the ecosystem*

  To ensure the conservation and sustainable use of the agro-biodiversity of ecosystems, the land uses and the cultural systems currently used by farmers should be studied and evaluated. Appropriate land uses should be adopted and spread to other areas with similar eco-geographical characteristics, and damaging practices corrected.

- *Raise national awareness of the importance of agro-biodiversity conservation and sustainable use at all levels*

  Appropriate information should be prepared and presented to policy makers, technical staff, relevant institutions and local users of agricultural biodiversity, including producers and consumers. Opportunities for relevant work should be identified.

- *Provide training on in situ and on-farm conservation and sustainable use of agro-biodiversity at various levels, including individual farmer and farming communities*

  Jordan, like many developing countries, lacks the expertise needed to deal with these issues, especially now that it faces new obligations under international agreements, such as the Convention on Biological Diversity. Therefore, any new programme or project has to be screened to ensure that first priority is given to building local expertise and capacity in areas such as resource management, technology transfer, biological surveys, data management, environmental policy research, legal expertise, conservation biology, participatory methods and biotechnology.

- *Review and reform the existing national policies and legislation in order to promote the conservation and sustainable use of agro-biodiversity; reform land tenure arrangements to promote the use of land for profitable and sustainable production; and introduce new conservation measures*

  Existing policies and legislation should be revised. These policies have to be evaluated and good practices should be adopted by farmers and transferred to other areas.

Measures to be undertaken at the national and international levels to support these plans

At the national level

- Determination of the macro-policies that deal with issues such as land ownership, the creation of conservation areas, and access to and control of biological resources.
- Recognition of intellectual property rights and the creation of incentives or deterrents to resource use in the public domain.
- Proper guidance for conducting and harmonising assessments of resources and of relevant sectoral and cross-sectoral capacities and priorities.
- Identification and enhancement of relevant legal instruments and mechanisms.

- Identification of areas of focus to determine priorities for programmes and action plans.
- Encourage the different sectors to meet and agree on the need to collaborate and establish mechanisms to ensure that agricultural biodiversity is properly incorporated into national instruments.
- Make fundamental changes in society to slow the loss of biodiversity.

At international level

- Stress the importance of creating a framework for:
  i) regulation of access to and control of biological resources;
  ii) protection of intellectual property rights;
  iii) environmental protection;
  iv) commercial laws that promotes the development, conservation, and fair and equitable sharing of benefits derived from the sustainable use of biological / genetic resources.
- Coordinate the identification, assessment and development of strategies and programmes between countries.
- Develop the agreed criteria and indicators to strengthen cooperation on the conservation and sustainable use of agro-biodiversity.
- Take various initiatives through consultation and information exchange to develop a joint work programme.
- Invite international organisations, such as the World Bank, UNEP, etc., to contribute to the conservation and sustainable use of agro-biodiversity.
- Encourage international cooperation and coordination among funding agencies to ensure adequate resourcing for the development and implementation of the multi-year action programme on agricultural biological diversity, and the mechanisms needed for its development.
- Integrate the concern for biodiversity conservation with development needs.

References

Sittenfeld A., Artuso A. 1995. A framework for biodiversity prospecting: the INBio experience. The Arid Lands Newsletter 37.

General Corporation for Environmental Protection. 1998. Jordan country study on biological diversity.

Mulvany P. 1997. ITDG technical workshop on farming systems approaches for the sustainable use and conservation of agricultural biodiversity and agro-ecosystems. FAO.

Reid W.V. 1995. Reversing the loss of biodiversity: an overview of international measures. *The Arid Lands Newsletter* 37.

World Resources Institute. 1992–1993. *World resources: root causes of biodiversity loss*. Oxford University Press.

Australian Rangelands: Managing for production and biodiversity

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Abstract

About 70% of Australia is composed of semi-arid or arid landscapes, commonly termed drylands, supporting a range of savannah and grasslands, *Eucalyptus* and *Acacia* woodland and shrublands. The predominant land use is grazing. Population densities are low, but since Europeans settled these areas 150 years ago overgrazing, weed invasion, predation by introduced species and altered fire regimes have had a significant impact, causing degradation and species loss. However, much of the biodiversity in the Australian rangelands still remains. Its future survival, though, will require adaptive management regimes that strike a balance between agricultural production and biodiversity conservation. This should be based on monitoring of appropriate species as surrogates for detecting changes in biodiversity as a whole in relation to changes in land use.

Introduction

We have heard about the impacts of human land use in the drylands of Africa (Lusigi 2001) and Jordan (Ajlouni 2001). I would like to compare their situations with that of the rangelands of Australia – a country with a first world economy and a low population density in its rangelands. And yet this low human population has had a significant impact on the biodiversity of the rangelands over the last 150 years since Europeans first settled the heartland of the Australian continent. This paper summarises the major impacts of European land uses on the rangelands and suggests ways of mitigating further loss of biodiversity.

The rangelands

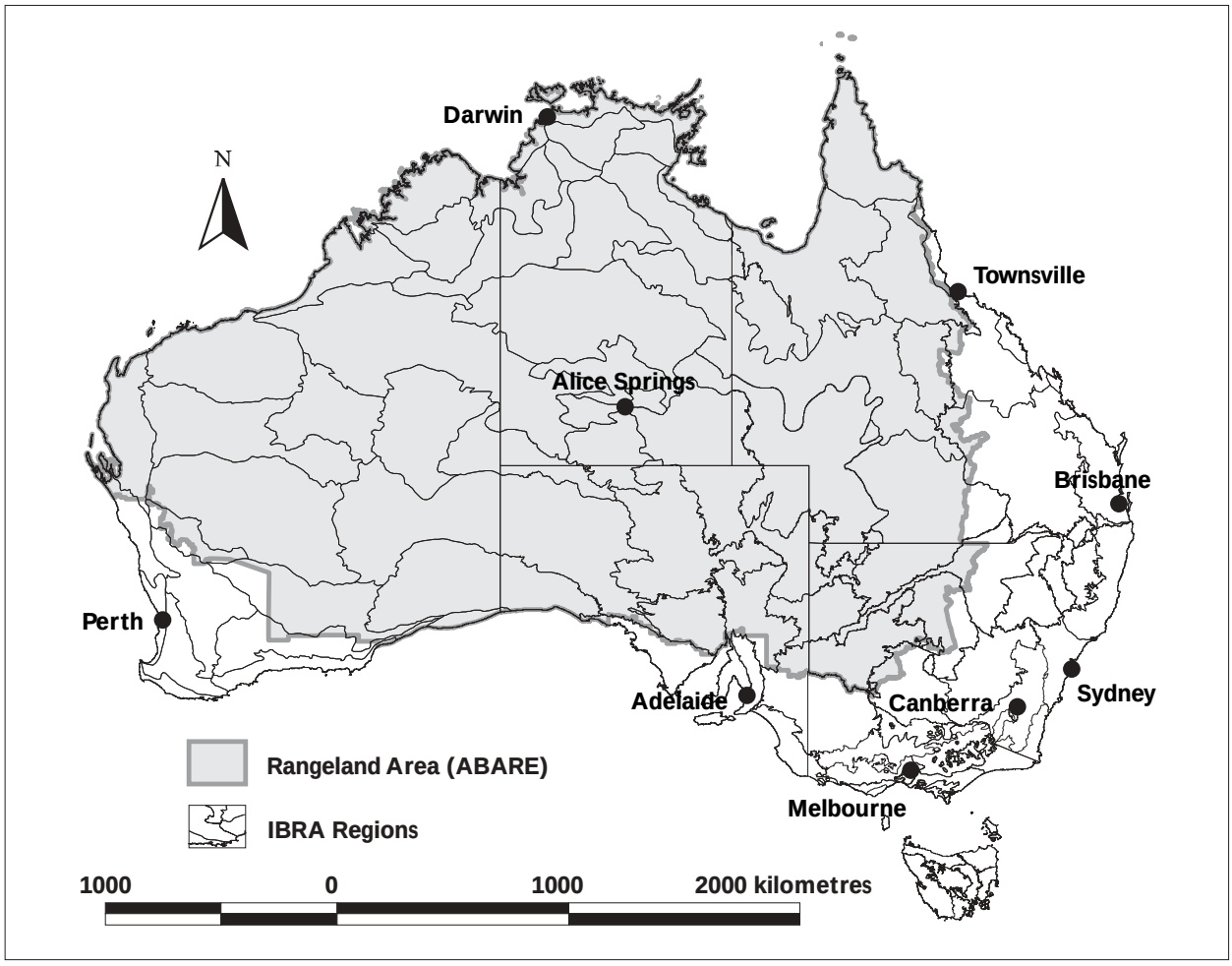
About 70% of Australia is composed of semi-arid or arid landscapes, commonly termed rangelands. Rangelands generally receive less than 400 mm annual rainfall (with the exception of the tropical savannah that receives higher rainfall from December to May), are prone to regular drought and are predominately used for grazing. Most of the rangelands are composed of ancient, low fertility soil that does not support intensive agriculture.

About 50 of the 80 broad climate/substrate bioregions defined for Australia in Thackway and Cresswell (1995) occur in the rangeland zone. These bioregions in turn contain a large array of ecological communities consisting of many thousands of plant and animal species. The plant communities have been coarsely mapped on a continental scale by Carnahan (1990) and at regional scales in many papers and reports.

The main vegetation types include tropical savannah, *Eucalyptus* woodlands in the north, hummock grasslands on sandplains in the more arid zones, mallee (multi-stemmed) eucalypts with hummock grass and shrubs in the south and centre, a wide range of *Acacia* shrublands and woodlands throughout, heath and sclerophyllous shrublands on sandplains in the south, *Callitris* (native cypress pine) woodlands, *Eucalyptus* woodlands with tussock grass ground covers in the east and south, halophytic (chenopod) shrublands across the south, open grassy and herbaceous rangelands on rocky areas and on sandplains, riparian *Eucalyptus* woodlands and forests, and a range of ephemeral wetlands on rivers, lakes and floodplains.

Land use

Grazing by cattle (all bioregions) and sheep (southern half of the continent) has been and remains the main use of the rangelands. Small areas are mined for minerals and ore, and about 7% of the rangeland zone is protected in conservation reserves. Some of these reserves are focal points for tourism, including the World Heritage listed Uluru National Park in central Australia and



IBRA Regions and Rangeland Area of Australia

Kakadu National Park in northern Australia. Cropping occurs on a small scale and where it does occur it often relies on irrigation from groundwater or intermittent river flows. The main cropping zone of Australia adjoins the rangeland zone to the south-east, south and south-west in more temperate and moister climates.

Causes of degradation and species loss

Vegetation clearance

The most obvious and preventable cause of degradation is clearing of native vegetation. This is occurring in the *Eucalyptus* woodlands and *Acacia* shrublands on the eastern edge of the rangeland zone – mainly in the States of Queensland and New South Wales. Currently, about 500,000 hectares are cleared annually in Australia. About 400,000 hectares of this is in the State of Queensland. About one third of this clearing is in the rangeland zone – mainly in western Queensland, but also around Darwin in the Northern Territory and western New South Wales. Marginal crop growing areas are being cleared using groundwater for irrigation, a practice which is unsustainable because the groundwater is running out and the soils are often highly susceptible to erosion and lacking in fertility.

It is rather disappointing that a first world nation with a well-educated population and strong environmental laws allows so much land clearance. It does not set a good example to developing nations, including Australia's northern neighbour Indonesia, which is destroying 1.7 million hectares of tropical rainforest annually through logging, clearing and burning (Barber 2000).

Land clearing leads to species extinction through the direct destruction of populations and the habitats of plants and animals. It fragments remaining populations and habitats, changes predation patterns, increases invasion by exotic species and

affects ecological processes such as water and nutrient cycles. In regions with saline water tables, which cover much of Australia, clearing the vegetation leads to salinisation of the land. This is a massive problem on the margins of the rangelands in Australia where crops are grown. It affects both land and rivers. Models indicate that up to five million hectares of agricultural land in the Murray Darling Basin in eastern Australia will suffer from salinity in the next 50 years (Murray-Darling Basin Ministerial Council 1999) and up to one third of the Western Australian wheat belt may be similarly affected.

Impacts of overgrazing

Domestic stock and introduced species, such as the rabbit and goat, have grazed most of the rangelands of inland Australia over the last 100 years. A considerable body of research and monitoring of the impacts of stocking rates on soil erosion and vegetation (summarised in Landsberg *et al.* 1997) gives us a reasonable understanding of grazing impacts. A substantial literature on this subject has been published in journals such as the *Australian Rangelands Journal*.

Recent research on the impacts of grazing and trampling within the vicinity of artesian water bores on the flora and fauna shows that there is a correlation of species loss and loss of vegetation structure with proximity to the bores (Landsberg *et al.* 1999a, Landsberg *et al.* 1999b). In areas that have been heavily grazed many plant species have not recruited seedlings to adult plants; the seedlings were grazed before they could establish. This has resulted in ageing cohorts of palatable plant species to a point where their eventual senescence and death will lead to significant changes in the vegetation. In some regions, non-palatable, woody native species are increasing in abundance and acting like weeds.

Impacts of introduced species

A major cause of loss of fauna in Australian rangelands has been the introduction of predators such as fox and cat (Burbidge and McKenzie 1989, Dickman 1996). A large proportion of medium-sized native mammal species have disappeared over most of their original distribution or become extinct. Some species survive in pockets on the mainland, where baiting keeps predators at bay. Other species only survive on oceanic islands where foxes and cats are absent. Introduced herbivores such as goats, donkeys, horses and camels have adversely affected native flora and fauna through increased grazing pressure, especially when their grazing is combined with grazing by domestic stock.

Altered fire regimes

Although much of the Australian flora was adapted to drought and fire well before Aborigines arrived more than 40,000 years ago (Gill 1981), Aboriginal fire regimes would have impacted on the biota. However, the degree of these impacts remains unclear and is currently vigorously debated (Flannery 1994, Kohen 1996, Benson and Redpath 1997, Bowman 1998). Cessation of Aboriginal fire regimes may have led to decline in some species abundance. However, there are cases where fire frequency may have increased after European settlement, leading to localised species extinction.

Mitigating biodiversity decline

Although a number of species have become extinct in the Australian rangelands since European settlement, a large number of species survive, and many habitats are in reasonable condition. Certainly the rangelands are in better condition than the extensively cleared cropping and intensive pastoral zone of Australia. Ensuring sustainable grazing regimes while protecting biodiversity will require the following:

- Cease clearing native vegetation
- Establish a comprehensive, adequate and representative (CAR) reserve system
- Control of feral animals, herbivores and predators
- Control of weeds where they are a problem
- Destocking and removal of artificial watering points from some areas
- Apply stocking rates that do not degrade the land, including during droughts
- Encourage and introduce alternative land uses, including ecotourism
- Monitor biodiversity over decades and apply adaptive management

It is likely that more farmers will look to alternative income from their rangeland properties, particularly if the prices of wool and meat continue their downward trend. It will be quite possible for Australian governments to produce a CAR reserve system over the rangelands because the land is relatively cheap to purchase. However, this will

only account for about 10–15% of the area and, in any case, such damage as rabbit and goat grazing, weed invasion and predation of native animals by cats and foxes does not stop at reserve boundaries.

Increased appreciation of wildlife and ecotourism are changing the way rangeland properties can be valued and managed. For example, over the last three years the non-governmental conservation organisation Birds Australia purchased two rangeland properties with a history of light grazing that contain populations of highly threatened birds, such as the Black-eared Minor and the Night Parrot. These huge properties (the one in central Australia is 250,000 hectares) are to be destocked and managed for conservation using volunteer managers. Interestingly, their high market value was determined by wildlife attributes, not their potential for pastoral production.

Monitoring biodiversity

The future survival of biodiversity in this vast array of Australian rangelands will require adaptive management based on the results of monitoring various management regimes. The Australian Government is currently undertaking a land and water audit of Australia (see web site www.nlwra.gov.au). Audit themes include: surface and groundwater, dryland salinity, vegetation cover, condition and use, agricultural productivity and sustainability, the capacity of and opportunity for farmers and other resource managers to implement change, and rangeland monitoring. The Tropical Savannahs Cooperative Research Centre (TSCRC), based in Darwin, has been commissioned to prepare a framework for monitoring biodiversity in Australian rangelands (TSCRC 2000).

In order to produce this framework the TSCRC has compiled a series of papers on the Australian rangelands and monitoring techniques. These include a review of the changes in status and threatening processes across the bioregions of the rangelands, a review of the Australian pastoral monitoring programmes and their potential for contributing to biodiversity monitoring, and a review of the Australian and world literature on monitoring biodiversity. These show, in short, that few nations have undertaken long-term wide-ranging biological monitoring programmes (two programmes operate in the United States).

TSCRC (2000) concluded that to answer questions regarding biological diversity the following action must be taken:

- Use elements of the existing pastoral monitoring programmes
- Increase application of remote sensing and improve linkage to both measures of landscape function and direct monitoring of biodiversity
- Undertake wildlife surveys to repeat past 'landmark' surveys and validate surrogates or indicators
- Maintain regular monitoring of populations of a range of selected species, emphasising those most sensitive to prevailing adverse processes or otherwise identified as good indicator species
- Link monitoring programmes for parks and reserves to their equivalents on lands used for primary production

When the protection of biodiversity is the primary reason for monitoring, species population change is generally the main aspect studied. The challenge is to select appropriate species that act as surrogates for detecting changes in biodiversity as a whole in relation to changes in land use.

After reviewing the literature and the cost of establishing monitoring programmes, it was decided to build on the data collated from the existing 8000 pastoral monitoring plots that had been regularly monitored by various agencies over the last few decades (for example, Green et al. 1994). Because these plots are unevenly distributed across the ecosystems in the rangelands it was recommended that extra plots be established in under-sampled ecosystems. The indicators for assessing the status of biological diversity in rangelands are:

- Progress toward a comprehensive, adequate and representative (CAR) reserve system
- Extent of clearance of woody vegetation
- Landscape function metrics
- Native perennial ground cover (including grasses and shrubs palatable to stock)
- Exotic plant species cover
- Status of fire-sensitive plant species and communities
- Status of grazing-sensitive plant species, including ageing perennials ('living dead')
- Status of susceptible mammal species
- Status of susceptible bird species

Conclusions

While there have been significant impacts on the rangeland biota of Australia due to clearing, grazing, weed invasion and predation by feral animals, much of the pre-European biodiversity remains. The challenge for the future is to accommodate sustainable pastoral production without losing more species. This will require setting stocking rates that do not lead to overgrazing and soil erosion, particularly during drought. Some key areas should be destocked and artificial water points removed. Land clearing should cease in what are marginal lands for cropping. It will be possible to establish a comprehensive reserve system to sample the variety of rangelands ecosystems but this will not necessarily prevent species loss because some threatening processes extend onto reserves. A comprehensive, long-term monitoring programme of selected species and environmental indices will allow assessments to be made of the impact of land use on biodiversity. The results of monitoring should drive adaptive management so that a balance can be struck between agricultural production and biodiversity conservation.

References

Ajlouni M. 2001. Dryland agro-biodiversity project, Jordan. In: Proceedings of IUCN Second World Conservation Congress, Amman, Jordan; 2000. Interactive Session 8: Sowing the seeds of sustainability: agriculture, biodiversity, economy and society. Gland, Switzerland: IUCN.

Barber C.V. 2000. Flashpoint: Forest management, civil conflict, and environmental security in Indonesia. Draft paper prepared for IUCN-CEESP Environment and Security Task Force.

Benson J.S., Redpath P.A. 1997. The nature of pre-European native vegetation in south-eastern Australia: a critique of Ryan D.G., Ryan J.R. and Starr B.J. (1995) The Australian Landscape – Observations of Explorers and Early Settlers. *Cunninghamia* 5(2): 285–328.

Bowman D.M.J.S. 1998. The impact of Aboriginal landscape burning on the Australian biota. Tansley Review No. 101. *New Phytologist* 140: 385–410.

Burbidge A.A., McKenzie N.L. 1989. Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biological Conservation* 50: 143–198.

Carnahan J.A. 1990. Australia: natural vegetation. In: *Atlas of Australian resources, volume 6 Vegetation*. Canberra: AUSLIG.

Dickman C.R. 1996. Overview of the impacts of feral cats on Australian native fauna. Canberra: Australian Nature Conservation Agency.

Flannery T. 1994. *The future eaters*. Melbourne: Reed Books.

Gill M.A. 1981. Adaptive responses of Australian vascular plant species to fire. In: Gill M.A., Groves R.H., Noble, I.R., editors. *Fire in the Australian biota*. Canberra: Australian Academy of Science.

Green D., Hart D., Prior J. 1994. Rangeland study site manual: site selection and field measurement procedures. Condobolin, Australia: New South Wales Department of Land and Water Conservation.

Kohen J.L. 1996. Aboriginal use of fire in south-eastern Australia. *Proceedings of the Linnean Society of New South Wales* 116:19–26.

Landsberg J., James C.D., Morton S. R., Hobbs T.J., Stol J., Drew A., Tongway H. 1999a. The Effects of Artificial Sources of Water on Rangeland.

Landsberg J., Lavorel S., Stol J. 1999b. Grazing response groups among understorey plants in arid rangelands. *J. Veg. Sci.* 10: 683–696.

Landsberg J., James C.D., Morton S.R. 1997. Assessing the effects of grazing on biodiversity in Australia's rangelands. *Aust. Biol.* 10: 153–162.

Lusigi W. 2001. Desertification and sustainable development in African drylands. In: Proceedings of IUCN Second World Conservation Congress, Amman, Jordan; 2000. Interactive Session 8: Sowing the seeds of sustainability: agriculture, biodiversity, economy and society. Gland, Switzerland: IUCN.

Murray-Darling Basin Ministerial Council. 1999. The Salinity Audit: a 100 year perspective. Canberra: Murray-Darling Ministerial Council.

Thackway R., Cresswell I.D. 1995. An interim biogeographic regionalisation for Australia: a framework for establishing the national system of reserves. Canberra: Australian Nature Conservation Agency.

Tropical Savannas Cooperative Research Centre. 2000. An adaptive framework for monitoring biodiversity in rangelands. Australian Land and Water Audit. Canberra: Commonwealth Government.

Discussion Points from the Session – Drylands

Maintaining biodiversity

- "Diversity within arid agriculture systems is vital. Drought stress causes the loss of varieties. Rangeland diversity is also vital for sustainable production. But many factors are causing loss of biodiversity."
- "Bush fires and greenhouse gases are important factors to consider. Drylands apparently resist change better than in humid areas. More attention should be given to research in this field."
- "Institutions need to assess how to restore and protect diversity."

  "Institutions are not always weak, but rather the resources are lacking. There are experts and strategies, but we need to look at implementing strategies."
- "To combat desertification we need internal legislation to protect 'green' areas, the development of protected areas and the establishment of seed banks."

Incorporating social considerations and experience into biodiversity conservation

- "We need to help communities to appropriate their own resources."
- "Indigenous knowledge must be incorporated into dryland biodiversity conservation."
- "It will be very important to help farmers sustain the diversity they have at the national and international level."
- "To address the loss of biodiversity to agriculture we need to demonstrate that protection of biodiversity and agro-biodiversity provides social and economic benefits to the population and the farmer."

  "Yes it is essential that agro-biodiversity integrates socio-economic development."

Desertification, Biodiversity and Environmental Problems in the Agricultural and Socio-economic Development of Nigeria

– Causes, consequences and recommendations

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Introduction

Desertification is not a new environmental problem, and yet it is only since the 1970s or 1980s that serious attention has been given to the increasing rate and debilitating effects of desertification in Nigeria. It is one of the main environmental problems afflicting biological diversity, agriculture and other sectors of the nation's economy, as human activities alter natural ecosystems in the direction of agro-ecosystems. Continuous degradation is causing significant change, sometimes altering ecosystems completely. With further perturbation, and in the presence of acute climatic changes such as drought, these ecosystems could collapse permanently, laying them open to desertification.

Causes and consequences of the problems

The United Nations Conference on Desertification (1997) defines desertification as the reduction and destruction of the land's biological potential, resulting in the appearance of desert conditions. It is an aspect of the generalised degradation of ecosystems under the combined pressure of adverse and uncertain climatic conditions and over-exploitation. The various forms of over-exploitation, misuse and mismanagement of limited resources that have contributed to these major changes are largely non-sustainable. They include overgrazing and bush-burning, over-cultivation and over-harvesting, poor farming practices (such as soil tillage with heavy machinery and shifting cultivation), over-use and wrong use of pesticides and other chemicals, mismanagement of water and poor irrigation techniques, poor management of mineral and natural resources, and the construction of dams and other infrastructure on environmentally sensitive spots. Such activities lead to a destructive chain of events, which include genetic and soil erosion, nutrient and mineral leaching, land and habitat degradation, water and atmospheric pollution, and biodiversity and soil fertility losses. The continuous removal of vegetation-cover by deforestation, overgrazing by livestock, over-cultivation and planting crops in ecologically frail soils are the most devastating activities.

These changes have occurred to satisfy people's immediate needs and demands, to the detriment of precious biodiversity. Biodiversity refers to the numbers, varieties and variability of living organisms and the ecological complexity within the living world, expressed in three basic levels – genetic, species and ecosystem diversities (McNeely et al. 1990). The rate at which biological diversity is being lost to the activities mentioned above is unprecedented, and this is a clear indication that all life forms, including man, are in jeopardy.

The process of desertification often starts with an unremarkable expansion of cropping activity into ecologically fragile areas. But eventually so many other disturbances build-up in the environment that the natural system is disrupted and people suffer. Ecologically, the environment is broadly defined as the total sum of conditions and materials required to sustain all living things. In practice, the environment is virtually everything in the world around us (Eedy, 1995). The untold damage to both aquatic and terrestrial ecosystem components in turn lead to serious economic losses. Inhabitants of the African Sahara regions suffer severe hardship as a result of desertification. The most devastating consequences for people are the significant losses of water and food shortages, famine and a depressed economy. More serious and concerted efforts must be put in place to reduce and halt disturbing processes such as these (Arimoro 1998a).

The underlying hurdles which stand in the way of improvement include the failure of the authorities and agencies concerned to carry out the proper environmental impact assessment (EIA) and environmental risk assessment (ERA) studies, and the fact that the general public still does not seem to

know the long-term effects and dire consequences of these types of environmental deterioration. Those with some knowledge may not know what to do to safeguard the environment and contribute to its preservation, or may not know how to make proper use of the available resources.

On top of that, in the past 25 years or so the agricultural sector has not been given the attention it needed. It was pushed into the background while most attention was given to the oil (petroleum) sector – the 'breadwinner' of the nation. Thoughtful or efficient agricultural strategies were not in place for implementing the appropriate agricultural practices and sustainable farming techniques. While some non-sustainable farming techniques are gradually being phased out in recent years, a lot of work is still needed for significant improvement. Moreover, much agricultural and horticultural produce, especially vegetables, fruits and grains, is wasted. Each year hundreds of thousands of tons of fruit and grain from cultivated and naturally growing fruit trees and shrubs are not harvested for human consumption or processing, but are left to rot or left for animals and insects. Mango (*Mangifera indica*), cashew (*Anacardium occidentale*), guava (*Psidium guajava*), citrus (*Citrus* sp.), banana (*Musa* sp.), papaw (*Carica papaya*), tomato (*Solanum lycopersicum*), chillies (*Capsicum* sp.) and many other indigenous fruits are examples of such casualty crops. If appropriately harnessed and utilised, the agricultural sector, like the oil sector, has a huge potential and capability to contribute significantly to the economic growth and progressive development of the nation.

Another notable factor is that agricultural research programmes and other studies are often not given the attention and incentives they deserve. Research activities have been known to slow down; they have limitations and sometimes prove to be inferior because of inadequate facilities and technology. Research reports often remain on the shelf. Research scientists and experimental field workers are almost never given the opportunity to turn their research findings into workable solutions to problems. In short, enormous amounts of energy, time, money and other resources are being wasted, contributing little or nothing to the growth and development of the country.

Proposed solution and recommendations

In the tropics and subtropics, targeting environmentally destructive processes, such as desertification and biodiversity loss, and addressing faulty and non-sustainable agricultural practices are large tasks. More research work should be proposed and executed to address some of these issues and contribute to efforts to ameliorate such environmental problems. This would improve the agricultural and socio-economic development of Nigeria and of other developing countries with similar problems.

To find a sound solution to these environmental and biodiversity problems and to improve the agricultural sector in Nigeria, we must make a concerted effort to highlight the ecological consequences of human actions. Some valued ecosystem components should be selected to demonstrate the level of ecosystem degradation and biodiversity loss that may result from anthropogenic activities (Freedman 1995). Appropriate recommendations that may contribute to environmental protection laws should also be highlighted. This may lead to legislation to help the appropriate authorities make and enforce policies, and legislation to improve and restore the ecosystems under threat (FEPA 1990). The result may also lead to the identification of endangered species and of procedures for preserving them.

A genuine EIA study should be carried out for proposed projects and an environmental impact statement (EIS) produced (Olokesusi 1984). A good study can reveal the need for this. The study should emphasise the value of EIA as a process of identifying and evaluating the consequences of human actions on the environment and, when appropriate, mitigating those consequences (Erickson 1994). This will demonstrate the importance of carrying out a thorough EIA before embarking on the project, and that the results of an EIA study should always be studied and considered before proceeding to other aspects of the decision-making process.

Such information should be directed primarily to the government or appropriate authorities, scientists, regulators, consultants and stakeholders directly responsible for and involved in decision-making processes, preparing proposals and implementing projects. Simulations and models of environmental problems and their resolution should be designed. This will help in predicting the outcome of certain actions, thus serving as a useful tool in future monitoring, evaluation and analysis of similar environmental issues when they arise. The research work should also make provision for the design of an efficient curriculum and taught programme that will educate all on environmental protection and preservation procedures. This

should then be recommended for the educational system (right from the primary level). The media and residents in the project location and its surroundings should be given adequate information and the opportunity to exercise their moral and social welfare rights and opinions (Arimoro 2000).

The agricultural sector should be given undivided attention as it may bring in as much revenue as other leading sectors of the economy, thus augmenting the growth and expansion of the country's economy. An efficient programme to implement appropriate agricultural practices, and farming techniques should be put in place and utilised uncompromisingly. All should be made to appreciate and abide by the principles and regulations of the programme and strategy. Due to the fragile nature of tropical soils, agricultural practices such as no tillage, crop rotation and the use of environmentally-friendly, biological materials for pest management should be encouraged. These have proved consistently viable and sustainable over the years.

If farming is to be done on forest floors and in other sensitive ecozones, the principles and methods of agroforestry and alley cropping are highly recommended. These have not only proved to be profitable but have also been effective technical tools in restoration programmes. These methods involve the systematic planting of a combination of economic tree species with arable crop plants (Baumer 1990). To strengthen these tools, the art and science of planting trees (afforestation) such as *Eucalyptus* sp., *Gmelina* sp., *Acacia* sp., *Cassia* sp. and many different types of fruit trees along, among and within plantation plots as shelter belts are employed, instead of the indiscriminate felling of trees (deforestation). These comprehensive techniques have been used extensively to reclaim sensitive and degrading portions of forests in sub-humid and humid zones in Nigeria, as in many parts of the Amazon rainforests of Brazil (Anonymous 2000).

Other combinations of bioremediation techniques could also be effectively used to ameliorate, improve and restore deteriorating habitats and already degraded ecosystems. Bioremediation is both a principle and a technique whereby biological resources are utilised to restore a degraded area to its original state. For example, the Vetiver grass (*Vetiveria zizaniodes*) has been grown to check and restore flood disaster zones and used to rehabilitate communities that have been degraded by soil erosion (CE-RASE 2000). Adequate and efficient training should then be provided for subsistence and large-scale farmers and foresters in all the workable techniques and principles introduced.

Improved and efficient harvesting procedures should be put in place to prevent enormous amounts of fruit and grain being wasted, with the aim of storing and processing such produce for future use during the off-season periods of scarcity. Excess fruits could be locally and industrially processed into a variety of products such as fruit juices, drinks, jams, marmalades, jellies, flavours, spices, wine and other alcoholic and non-alcoholic beverages. Many of these items, if processed and packaged well, could be sold and exported to raise national government income instead having to import them at extra expense from other countries.

Whenever viable research programmes and scientific work activities are proposed and designed, it is important that scientists and others concerned should be given all the necessary resources, including adequate finances and incentives, to implement, execute and establish the project. Provision should be made to educate and train others to ensure continuity, multiplication and maintenance of the work activity and research programme. The use of modern and sophisticated equipment and technological know-how (e.g. supercomputers and GIS) and state-of-the-art telecommunication systems (such as fax, email and internet facilities) should be readily available and sufficient, and appropriately used to enhance and facilitate research. This will boost and accelerate study and research work by providing ease of information retrieval and dissemination between developing countries and the developed world. Indeed, the brilliant successes and achievements we see in developed nations today are a result of the application and utilisation of all these forms of technological facilities for scientific research and development (Arimoro 1998b).

Conclusion

The conservation and sustainable utilisation of biological diversity and the protection and preservation of the environment are undeniably important aspects of our lives, and as such, issues relating to these must not be underestimated or neglected. Our continued existence and that of future generations largely depends on how well we treat and care for the things we depend on, and how well we look after the things that depend on us. Since desertification and the activities that lead to it are a threat to man, his agricultural development and his socio-economic progress, it is high

time for all developing and underdeveloped countries to sit up and contribute significantly to the campaign and actual conservation of the earth's biological resources. Desertification, leading to biodiversity losses, is one of the most important environmental problems facing the world in general. Embarking conscientiously on sustainable agricultural and environmental practices, therefore, will go along way towards curbing this menace.

The suggestions made in this paper are workable and may enhance the agricultural, environmental and socio-economic development of present-day Nigeria, and contribute in no small way to sustainable development for the benefit of future generations.

References

Anonymous. 2000. Greening the Amazon forests. *Awake!*, November 22, p 24–27.

Arimoro A.O. 1998a. Desertification in Nigeria: causes and consequences. Unpublished M.Sc. research paper. Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria.

Arimoro A.O. 1998b. Information and communication: Vital tools for research. Unpublished M.Sc. research paper. Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria.

Arimoro A.O. 2000. The environmental impacts and ecological consequences of dam construction on selected valued ecosystem components in surrounding aquatic and terrestrial ecosystems: The contribution of my proposed research / skills to the social and economic development of my country. A Ph.D. proposal prepared for academic study and research in the University of Guelph, Canada / University of Otago, New Zealand.

Baumer M. 1990. The potential role of agroforestry in combating desertification and environmental degradation with special reference to Africa. Technical Centre for Agricultural and Rural Cooperation, ACP-EEC Lome Convention, P.O Box 380, 6700 AA Wageningen, Netherlands.

CE-RASE Centre for Environmental Resources and Sustainable Ecosystems. 2000. We have solution to environmental degradation in Nigeria. *The Hope Home and Environment Journal.* November 17 2000, p 12.

Eedy, W. 1995. The use of GIS in environmental assessment. *In*. Impact Assessment. *International association for impact assessment (IAIA)* Vol. 13, No. 2, p.199.

Erickson P.A. 1994. *A practical guide to environmental impact assessment*. Toronto: Academic Press.

FEPA 1990. The environment and sustainable development in Nigeria. In: Adegoke O.S., editor. Proceedings of a workshop held at the Nicon Noga Hilton Hotel, Abuja, FCT; 25–26 April 1989. Federal Environmental Protection Agency (FEPA).

Freedman B. 1995. *Environmental ecology: The ecological effects of pollution, disturbance, and other stresses*, 2nd edition. Toronto: Academic Press. p 452–454.

McNeely J.A., Miller K.R., Reid W.V., Mittermeier R.A., Werner T.B. 1990. Conserving the World's biological diversity. Gland, Switzerland: IUCN / Washington DC:WRI, CI, WWF-US and World Bank.

Olokesusi A. 1984. The environmental assessment process, initiating and making it work for Nigeria. Proceeding of the NNPC seminar on the petroleum industry and the Nigerian environment; 1984; NNPC, Lagos.

United Nations Conference on Desertification. 1997. Status of desertification in hot arid regions. (maps plus explanatory notes)

Pasture Farming Strategy for Ecologically Sustainable Agriculture and Reconstruction of Biodiversity in Deserted Territories

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Current situation of the pastures

The current condition of the pastures of the Kalmyk steppe is poor and is a result of their barbaric exploitation during the period of the Soviet planned economy. About 80% of the pasture territories have been destroyed to varying degrees, more than 30% of agricultural soils have suffered water and wind erosion, and 50% of the pasture territories are saline. Air and water quality is poor and has an adverse effect on the health of the population.

Desertification first became an extensive problem in the European part of the territory of the Republic, where 25 villages and farms are buried under the sand, and 30 will soon be flooded by rising groundwater caused by soil improvement measures. The new Republic immediately faced a problem requiring an urgent solution: ecological migrators who have moved out of territories as a result of ecological catastrophes, such as desertification and related problems.

The desperate ecological situation in Kalmykia not only depresses the rural economy, it leaves the population without livelihoods. This was predicted at the beginning of the 20th century by a number of Russian scientists who were against cultivation of Merino sheep on vulnerable land, but no one heeded their warnings. In the 1970s more than 3.5 million Merino sheep were pastured there. Everyone was deaf to the problem, and now we have 1 million hectares of desert and a great number of ecological, social and economic problems caused by the desert. The country is fighting for its very survival.

Reasons for desertification in Kalmykia during the Soviet era

- Ignoring the ethnic, economic and social basis, and the traditional and national features, of land use that put ecology, climate and natural conditions at the forefront.
- Deportation of the population to Siberia in 1943–57. Kalmyks lost practically all their animals, especially Kalmyk breeds adapted to the climate and environment which can aid the process of biodiversity reconstruction, maintaining arid territories and never causing great harm or destruction.
- Expansion of the area of arable land for cereals and industrial crops. When 140,000 hectares of light soiled pastures were ploughed up in the 1960s, the action of the wind created a desert within the traditional and unique pasture area of Tcherny Zemli (called the Black Lands because they are rarely covered with snow in winter).
- Pressures on the steppe caused by the use of machinery and new technologies, which has also provoked destruction of pastures.
- Replacing traditional nomadic farming with a settled system, Kalmyk sheep have been replaced by Merinos that can degrade pastures, and the number of sheep increased to 3.5 million as opposed to 1 million pastured traditionally. This heaped additional pressures on the pastures.

What the project proposes

During the last 20 years attempts have been made to stop desert expansion in the area. By sowing seeds and planting, sands have been stabilised on 100,000 hectares, and a further 200,000 hectares will soon be ready for exploitation. But phyto-amelioration itself will produce no effect unless appropriate livestock are pastured on the land. Merino sheep pastured on improved land will cause its destruction and the return of the desert.

The suggested project proposes the proper

exploitation of reconstructed, that is, of phyto-ameliorated, pastures to prevent them degrading to wasteland.

Proper management requires:

- Seasonal treatment of recovered pastures, in which animals are grazed on certain territories in the area during winter only, and never in summer, following a strict pasture circulation by season.
- Cultivation of traditional methods of pasturing, when all four Kalmyk livestock breeds were kept in certain proportions (about 1 million sheep, 200,000 cattle, 100,000 horses and 20,000 camels).
- Replacement of Merino sheep with Kalmyk breeds of sheep in the area of Cherny Zemli with reconstructed pastures and transference of Merino sheep to other parts of Kalmykia.
- No fodder storage (hay, technical cultures) on the territory subjected to desertification. In the nomadic system animals are pastured day and night, and only 25% of food needed for stationary farming should be stored for an expected severe and snowy winter. There is no need to store feed for mild winters. We wish to stress that nomads have never fed their animals concentrates.
- Use of traditional methods based on a detailed knowledge of rural conditions affecting farming.

All these measures are able to safeguard arid pastures and can be used for the reconstruction of their biodiversity, even though it seems a paradox trying to save pastures by grazing animals there.

The key principal is to pasture Kalmyk breeds in certain proportions within the herd, so that different animals can eat different plants. They do not graze down to the root stem as Merino sheep do, allowing the plants to cluster. Clustering binds the upper, light soil layer, giving water and wind erosion, and degradation no chance. Merino sheep remain in a compact group and move slowly, removing the plants down to the root stem and raising clouds of dust from the ruined areas they leave behind them. In contrast, Kalmyk move quickly, spreading out more widely and do not break up the soil surface.

The Kalmyk breed of sheep has been lost in Russia, but has remained as a pure breed in China and Mongolia, and, with partial loss of their characteristics, in Kazakhstan, according to an expedition of Kalmyk scientists several years ago.

To quickly realise the goals of restoring pasture biodiversity in Kalmykia – to preserve unique pastures in the Cherny Zemli area, phyto-ameliorated especially to develop ecologically sustainable agriculture, and reintroduce Kalmyk sheep back to the steppe – we have to buy 1,000 Kalmyk sheep in China or Mongolia to set up a model agricultural enterprise.

The required finance to buy and transport 1000 sheep to Russia is USD 64,000.

Ecological, social and economic effects are inevitable

The main goal of the project is the development of an ecologically sustainable agriculture by restoring pasture biodiversity and reintroducing Kalmyk breeds of sheep. Additional effects are inevitable and expected:

Ecological effects of reintroducing appropriate numbers of Kalmyk sheep to the steppe and the development of traditional nomadic method of livestock pasturing. This provides the opportunity to restore ecological balances on pastures subject to desertification and degradation, enabling the restoration of their biodiversity and productivity. This will lead to more and greater effects.

Social effects, expressed as the opportunity to create many new jobs for the unemployed and provide a solution to the problems of ecological migrators, etc.

Additional economic effects from the increase in pasture productivity and avoidance of damage from degradation and desertification.

Agriculture and Biodiversity in the Drylands of Africa

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Abstract

Conservation efforts in Africa have tended to emphasise the international, scientific values of biological diversity and focus on areas of high species richness and endemism, primarily lush tropical forests and coral reefs. Drylands have been considered of limited interest for biodiversity. This perception is gradually changing as research is proving that drylands are home to unique species with special characteristics, the origin of many important crops and a significant source of genes.

This paper provides a regional overview of the impact of agriculture on biodiversity in the drylands of Africa in northern Africa, the West African Sahel, East Africa and the Horn, and southern Africa. Agriculture accelerates loss of biodiversity in all these regions as farmers attempt to increase crop and animal production to feed the growing population and boost national economies. Traditional agricultural practices and natural resource uses have caused little damage to biodiversity, in part because of low population density but also because these societies fostered belief systems and social norms that encourage or even enforced limits to exploitation. A pressing issue for African nations is how to retain the best attributes of traditional systems under conditions of rapid urbanisation and modernisation.

The drylands of Africa have the potential to be more productive, but they are fragile and must be wisely managed. A comprehensive landscape planning approach is required to avoid conflicts over resource use and loss of biological resources. Biodiversity conservation strategies must respect and incorporate African values, knowledge systems and priorities. The planting of trees on and around farms, for example, is recommended because these trees will serve as windbreaks and provide fuel wood, timber, poles, fodder, fruits and medicines. There is a need to assess national agricultural policies with a view to enhancing the sustainable use of arid and semi-arid ecosystems, and research is needed to fill the gaps in our knowledge of biodiversity across regions, countries and local areas in the drylands of Africa.

The single most important way of promoting biodiversity conservation in the medium- to long-term is to raise well-informed future generations that are strongly committed to the sustainable management of natural resources and biodiversity. Biodiversity conservation should, therefore, be an integral part of environmental education.

Introduction

Biodiversity is a concept used to describe the variety of life forms. It encompasses biomes (e.g. tropical moist forests), ecosystems, species, and genetic varieties (McNeely et al. 1990). It can also be defined as the variety and variability among living organisms and the ecological complexes in which they occur (OTA 1987, USAID 1993). The interdependent relationships that occur within and between ecosystems, species and genetic varieties are complex, but it is important to remember that these are essentially different ways of looking at the same thing. Biodiversity has captured the world's attention since the United Nations Conference on Environment and Development (UNCED) in 1992.

The term 'drylands' is easily understood in a general sense, but it is not so easy to define in precise terms. Although precise definitions of dryland areas vary, general agreement exists on a number of characteristics. The principal defining characteristic is that mean precipitation is less than mean evapotranspiration for a significant part of the growing season (Hassan and Dregne 1997). This means that rainfall is deficient for maximum plant production. In this paper, 'drylands' refers to regions where annual potential evaporation and plant transpiration exceed annual precipitation. The salient feature of dryland climates is the low

average rainfall and the variability in rainfall patterns.

Characteristics of drylands

Geographically, drylands are divided into four climatic zones: hyper-arid, arid, semi-arid, and dry sub-humid (UNEP 1992a, b). Hyper-arid areas are natural deserts that are relatively uninhabited, with the exception of sparse tiny date palm oases that provide habitats where very ancient life styles and traditional ways of managing natural resources are still practised (Ghabbour 1997). Arid regions are almost exclusively used for extensive grazing. Semi-arid lands are largely pastoral, but include extensive rain-fed cropping in the wetter parts. Dry sub-humid zones are woodlands and forested lands where intensive cropping is practised, along with livestock production.

Water deficiency is the principal limiting factor affecting soils and plant growth in all the four climatic zones. Dryland soils are generally characterised by low fertility associated with low levels of moisture, organic matter and nitrogen. Plant growth is inhibited by lack of water, with vegetative cover varying from forests, woodlands and grasslands in the dry sub-humid and semi-arid zones to virtually nothing in the hyper-arid zones, except in oases and stream channels.

Dryland vegetation generally has been notable for its resilience, often recovering rapidly from frequent incidence of drought and fires. Because of this resilience, a re-thinking of ecology and management of natural resources in Africa's pastoral drylands has taken place (Behnke et al. 1993, Scoones 1996). The new so-called 'disequilibrium theories for range ecology' (DTRE) state that dryland ecosystems do not follow equilibrium dynamics; instead such systems are characterised by high levels of temporal and spatial variability in biomass production. A basic assumption of the disequilibrium theories is that livestock grazing causes insignificant changes to arid and semi-arid lands with underlying highly variable climatic conditions. However, recent research seems to point out that this situation may be the case for plant productivity in certain arid and extremely variable environments with limited grazing pressure, but not for floristic composition and vegetation structure which are important aspects of pastoral strategies (Lykke 2000). In most arid and semi-arid areas, livestock-induced vegetation modification and degradation have been described during past decades in scientific studies and local knowledge.

Drylands in Africa, including hyper-arid deserts, comprise 1,959 million hectares or 65% of the continent, and about one-third of the world's drylands (UNEP 1992a, b, Darkoh 1998). One-third of this area is hyper-arid desert (672 million hectares) while the remaining two-thirds – or 1,287 million hectares – are made up of arid, semi-arid and dry sub-humid areas, with a population of some 400 million (two-thirds of all Africans).

Agricultural practices and emerging threats to biodiversity

Discussion on biodiversity used to focus mainly on conserving natural habitats, preserving their variety and preventing the extinction of species. For some time, biodiversity has been associated with lush, tropical forest and coral reefs, and drylands have been considered as areas of limited interest for biodiversity. This perception is now slowly changing as research shows that drylands are home to unique species with special characteristics, the origin of many important crops, particularly cereals and pulses, and a significant source of genes. Dryland ecosystems have provided many of the plant and animal species that have shaped the development of many cultures and civilisations (Hassan and Dregne 1997). Crop species such as wheat, barley, sorghum, millet and cotton all originate from dryland ecosystems, as do animal species such as the horse, the sheep, the goat, the cow and the camel. Drylands harbour many drought-resistant species and varieties of plants and animals.

Millions of people in Africa depend directly or indirectly on biological resources for basic subsistence needs, and commercial use of natural resources makes an important contribution to many national economies. However, Africa is undergoing unprecedented losses of biological diversity as a result of habitat alteration, over-harvesting, and other causes. Many forms of human activities, including agriculture, continue to deplete these resources, some to the point of extinction. This trend in biodiversity loss has in some cases adversely affected ecosystem functions, increasingly posing a threat to the livelihood and well-being of many Africans. Habitat change is the greatest threat to biological diversity because plants and animals may fail to adjust to the new ecological setting in the modified environment.

Africa is a diverse region with a predominantly rural economy centred on agriculture. For several generations rural economies have been adapted to

the dynamics of the biological and physical environment. One of the rudimentary forms of agriculture is gathering agro-pastoral societies. This practice has been a response to drought and is common in areas of marginal agricultural potential. A striking feature of the drylands in Africa is that food collecting and agriculture still play a significant role in the subsistence economy of several countries. Dryland ecosystems have a wide range of wild food plants. Grivetti (1979) for example notes that the principal factor contributing to Tswana nutritional success at the peak of the drought in the Kalahari is a diversified food base with emphasis on wild food plants. It is the removal of the trees and the pressure of high human and animal population densities that reduce biodiversity in these areas, which are considered marginal.

Shifting cultivation is another widely-practised traditional form of agriculture in the drylands of Africa, and is an efficient way of manipulating environments that would otherwise be unproductive under arable farming. It is based on an intimate knowledge and understanding of the environment. According to Schusky (1989), this practice is carried out by between 25% and 33% of African farmers. He identifies two kinds of shifting cultivators: those that practise shifting cultivation to supplement other, more permanent cropping activities; and those that have been forced out of their 'traditional' homes with little option but to try to gain a living by encroaching into forests and other environments. It is mainly the latter that have disastrous effects on the natural resources. This is because they lack the accumulated knowledge of many generations of shifting cultivators; nor do they have access to sufficient land to allow for long fallow periods.

In the past, the sparse population operated the system for subsistence needs. It was not intensive, which did little or no harm to the environment as the long fallow periods restored soil fertility. Now, however, increased population density combined with intensive cultivation of cash crops as well as subsistence crops has led to a much more intensive shifting, with very short fallow periods. Under these conditions, shifting cultivation is unsustainable as it leads to a disastrous decline in soil fertility. As it is essentially suited to the maintenance of a subsistence economy for sparse populations, it is clearly incapable of yielding adequate returns to provide for the increasing population; the system tends to break down when the population becomes too large to support. In a bid to produce more food crops, farmers encroach into the forests. Rapid population growth is pushing farmers to extend farming into areas that are agro-ecologically unsuited to these forms of land use. The most pressing problem is the high rate of deforestation, mainly as a result of conversion of forests and savannah to croplands, which has led to loss of biodiversity in these ecosystems. The continued use of fire under shifting cultivation also inhibits recolonisation and eventually leads to eradication of woody species. Consequently, the ecosystem's biogeochemical cycles could be permanently altered; the storage component in the biomass may be considerably reduced and even the grasses themselves may be slow to grow (Mannion 1995).

Pastoralism is another form of agriculture carried out on land that cannot be readily cultivated to produce crops, or from which it makes economic sense to generate animal products. Nomadic pastoralism occurs in arid and semi-arid environments, which necessitates the migration of animals and herders on a regular basis from one area to another. Like shifting cultivation, nomadic pastoralism, when well managed, is ecologically balanced through the varying requirements of the livestock components. This makes the agricultural system stable in a fragile environment. Grazing, however, becomes a threat to biodiversity because it not only displaces wildlife but also disrupts plant-species composition. When the population increases, there tends to be permanent replacement of naturally occurring biota, with lasting changes in the output, input and components of the system. This system is associated with a major reduction in species diversity as just a few domesticated animals replace the wide range of wild species (Mannion 1995). Farmers often remove trees from grazing lands with the intention of improving grass growth by reducing competition for water and soil nutrients, but this has an effect on the biodiversity.

Like traditional pastoralism, modern animal rearing on private ranches in rangelands is also a threat to biodiversity. Many farmers in ecological zones rich in biodiversity see the wild animals as a threat to their domesticated livestock as well as their own lives. As a result, fences are sometimes erected to keep wild animals away from the farms. These and other veterinary fences erected to control the spread of diseases account for a considerable loss of wildlife as the animals are denied access to their grazing areas. An example can be drawn from Botswana where, in response to the outbreak of diseases, the semi-arid rangelands are criss-crossed by veterinary cordon fences emanating from the European Community's (EC's) precautionary measures to prevent meat imports from foot-and-mouth stricken areas. There are many references in the literature on Botswana to

the damaging effects of these fences on the capacity of some highly mobile species (for example, wildebeest, hartebeest, buffalo, zebra and eland) to cope with drought and the loss of their range (Perkins and Ringrose 1996, Williamson and Williamson 1983, Patterson 1987). Fence damage is in the form of barring of seasonal movement, trapping and high mortality of animals. Species like wildebeest and hartebeest, which form the bulk of the large herbivore biomass, have suffered as much as 90% mortality (Murray 1988, Patterson 1987). Modern animal rearing has also taken land away from other uses and marginalised indigenous communities in rangelands by depriving them of their grazing and cultivation rights (Sporton et al. 1999).

The majority of farming enterprises that characterise Africa are subsistent mixed farms which also support the majority of the population. Mixed farming may be rain-fed or reliant on irrigation. Innovative methods of crop production involve the use of more productive hybrids and the use of crop plants resistant to various diseases, which requires active crop breeding policies and institutions, improved irrigation and efficient use of artificial fertilisers. In West Africa, approximately 80% of cattle are reared in crop–livestock systems or fully integrated systems (Jabbar 1993). This is causing environmental change as forests are cut down to expand the area of crop production into which livestock are then introduced.

Government policies promoting agriculture also play an important role in habitat change and the loss of biodiversity. This may be experienced in countries that are trying to promote export crop production, or to be self-sufficient in food production, with preferential support given to large-scale monocropping systems that often use imported seeds. This has resulted in the abandonment of indigenous plant varieties and species. In Sudan, for example, extension services and donor agencies have promoted sorghum monocultures and discouraged traditional methods, even though they have proved far more resistant to pests and drought and are more sustainable in the long-term (Bedigian 1991).

In the savannah lands of northern Ghana, promotion of alternative cash crops such as yams has resulted in unanticipated deforestation. Farmers clear land for planting yams and also cut down trees to obtain poles required to support the growing yams. This promotion of cash crops as a strategy in many African countries has had adverse effects on biodiversity. In areas such as central Tanzania where fuel is needed to cure tobacco, a lot of wood is consumed every year. In one area, Isikizya village has long since exhausted its principal source of wood supply, the natural Miombo woodland.

Unnecessarily high levels of fertiliser and pesticide use have sometimes been stimulated through inappropriate price subsidies (Repetto 1985, 1989). These have had adverse effects on biodiversity, killing other living organisms along with pests. A World Bank report states that the dependence on pesticides in the Gezira Province of central Sudan led to a massive and permanent reduction of beneficial invertebrates, and that an aid programme linked to multinational chemical companies inhibited rational pest control (World Bank 1991).

The status of the environment is a crucial aspect of the development process in Africa. However, the rich biodiversity, together with the time-tested, diversified indigenous systems of managing them, have recently come under increasing pressure from: population growth; social change; migration of people in search for new agricultural land and the degradation of former frontier regions; shifts in cash cropping; and the impact of policies adopted by post-colonial governments.

In Africa, about two-thirds of the land that supports habitats for wild plants and animals is now used for other purposes (MacKinnon and MacKinnon 1986). Agriculture and other human activities are reducing biological diversity at a rate that is unprecedented in the history of the continent. It is not easy to assess, with our limited knowledge, the consequences of the disappearance of species for the stability of the continent's environment or the economic value lost because of extinction. McNeely (1995), citing Cary and Mooney (1990), notes that since the beginning of this century alone about 75% of the genetic diversity of the most important crops has disappeared from farmers' fields across the world. This has increased agricultural vulnerability and reduced the essential variety of diets of rural people.

In Africa, traditional and local species, varieties and breeds of domesticated plants and animals vital for the nutrition of the poorest people are either neglected or being displaced by exotic species. Modern farming technology is now removing innovation from the farm and placing it in the laboratory instead (McNeely 1995). The uniform varieties produced at the research centres, with their dependence on fertilisers and pesticides, are fast displacing farm-bred varieties. Once these traditional varieties are gone, the knowledge of their cultivation and use is also lost. Traditional agriculture is currently threatened by the new

global consumer culture that is spreading through television, trade and other means. Management systems that were effective for thousands of years in natural resource utilisation and conservation have become obsolete in a few decades, replaced by systems of exploitation that bring short-term profits for a few and long-term costs for many (McNeely 1995).

The dominant biome in Africa's drylands is the savannah. The term 'savannah' has been widely applied to plant communities in the tropics and sub-tropics characterised by various combinations of trees and grasses. They are typified by a continuous ground layer, consisting mainly of grasses (*hemicryptophytes*) and a discontinuous woody tree or shrub overstorey of *phanerophytes* (Stock et al. 1997, Meadows 2000). In West Africa three types of savannah are biogeographically identifiable. These are the Sahel savannah, Sudan savannah and Guinea savannah which are described in the section on West Africa in this paper. The savannah biome has not only provided a home for the majority of humans, livestock and wildlife in the continent, they have been the richest grasslands in the world with a high incidence of indigenous plants and animals and the world's greatest concentration of mammals (UNEP 1997).

For some time, large parts of these savannahs and adjoining arid and hyper-arid areas in Africa have been protected by their remoteness, their vastness, and their marginal direct usefulness for agriculture or other economic pursuits. This situation is rapidly changing. Now these drylands are under siege. Their biological systems are under threat from recurrent droughts, population and migration pressures, inappropriate agricultural methods and overharvesting of natural resources.

Regional perspectives

Northern Africa

The drylands of North Africa occupy about 6 million km^2. They experience a Mediterranean climate that is characterised by warm-wet winters and cool dry summers. The semi-arid to humid zones have a native vegetation dominated by sclerophyllous evergreen trees and shrubs. Commercial farming dominates. The drier areas have a steppe type of vegetation with perennial grasses and/or dwarf shrubs. The dominant land uses are subsistence farming and grazing. In the hyper-arid zones in the Sahara, native vegetation is restricted to depressions in waterways. The density of species, or 'areal species richness', when calculated for the whole desert is of course very small (Ghabbour 1997). Date-palm agriculture is practised in the oases. Irrigation is on the increase, causing major changes in the natural drylands habitats.

Biological diversity varies in complex ways depending on local moisture regimes, topography and soil type. The number of flowering plants of the sub-region is approximately 6,000, with an endemism of about 25%, highest in the west and the east of the sub-region (IPED 1994, Hassan and Dregne 1997). There are presently about 200 endangered species (3.3%) (ibid.). A few crops are thought to be native – the date palms, olives and primitive wheat, barley from the oases – and some of these are known to have genetic traits of potential use for breeding programmes around the world.

Many large mammals have become extinct over the past 150 years. The only common survivors are the jackal, wild boar and fox. Others are on the verge of extinction: the cheetah, leopard, striped hyena, mountain gazelle, Barbary sheep and baboon. About 100 species of small mammals, 200 resident species of birds and some 80 species of reptiles remain.

The original breed of cattle, Atlas brown (*Bos taurus*), has been excessively crossed with European and Indian cattle (*Bos indicus*) and it is doubtful whether they now remain in their original state. Several major breeds of sheep have retained their genetic identity and little breeding work has been done with camels.

Increasing human population has led to clearance of large areas previously covered by forest and scrubland, partly for cultivation and for stocking. Traditionally, livestock raising has been the major agricultural activity in this region, sheep being the most important as a source of wool and meat. This is closely followed by cereal cropping, particularly wheat and barley in the more humid areas. This has been greatly encouraged by the introduction of mechanised agriculture and exploitation of underground water sources. Aboriculture based on fruit trees such as olives, almonds, figs, citrus trees, date palm (naturally linked with oases) and grapevines are important along the Mediterranean coast and other suitable hinterland areas. In Libya and Algeria, increased incomes from oil and natural gas have enhanced the power to invest in capital development and agriculture. This has had a telling impact on both grazing lands and woody vegetation formations in the arid zones.

Generally, agriculture has encroached into alpha and steppe grasslands in the drylands of North Africa with dire consequences for biodiversity. In Egypt, a major constraint to biodiversity is expansion of agriculture into more marginal areas and the loss of fertile arable land to urban expansion and development (about 25,000 *feddans*, or 10,500 hectares, are lost in this way each year). In the arid and semi arid zones of Algeria, Morocco and Tunisia, rain-fed croplands have been degraded mainly through extension of cropping into dry, sandy soils and the use of inappropriate heavy machinery. A further constraint in all these countries is the conversion of agricultural land to other uses, which has had great impact on whole ecosystems by destroying the ecological equilibrium and accelerating wind and water erosion, thus contributing to desertification and declines in biodiversity. In Libya, degradation of land resources, and the consequent desert encroachment and erosion of biodiversity, are directly linked to overgrazing and conversion of grazing and other rangelands to cultivation. Wind erosion is particularly serious in the cultivated areas of Jeffara plain (110,000 hectares) and the Gharian Plateau (92,000 hectares) where dry farming is practised. Shifting sand dunes and sand drifts are of particular concern. Irrigated agriculture is expanding and as a result reducing the area available for grazing.

There has also been widespread destruction of woodlands by clearing for cultivation or grazing and by fires. In Morocco, between 1973 and 1983, bush fires destroyed an estimated annual average of 3,000 hectares of forest and alpha grassland. In 1980 more than 6,000 hectares were burned causing an estimated loss of USD 1.4 million (UNEP 1983). If present deforestation rates (0.5% to 1.0% per year) continue, it is unlikely that forests will still exist in year 2050. This will have a strong impact on total biodiversity.

Salinisation of irrigated lands is reported from all these countries; in Egypt it is linked to inadequate drainage. Much irrigated land is threatened by encroaching sand caused by heavy grazing or the abandonment of irrigated lands. This has had a diverse effect on biodiversity in the region.

The removal of perennial vegetative cover through human mismanagement of land causes desertification, and the consequences have been particularly severe on the fauna. The flora is likely to become severely affected over the next 50 years unless preventive measures are taken. On the whole, biodiversity is under severe threat in North Africa, largely because of changes in land use and human mismanagement of land.

The West African Sahel

The 'Sahel' refers geographically to the narrow band of territory between the Sahara desert and the Sudan and Guinea savannah lands to the south. It is characterised by a strong seasonal climate, with a short rainy season and long dry season. Ecologically, however, the countries commonly referred to as the Sahel countries of West Africa straddle the different savannah types mentioned above. As Table 1, on Mali's situation, shows, there are six agroclimatic zones. From north to south, these are: Saharan, North Sahelian, South Sahelian, North Sudanian, South Sudanian and Guinean.

Table 1

Agroclimatic zones in the Republic of Mali

Zone	*Climate*	*Rainfall mm/year*	*Length of agric. season days/year*
Saharan	Arid	<150	<25
North Sahelian	Semi-arid	150–350	25–45
South Sahelian	Semi-arid	350–550	45–90
North Sudanian	Semi-humid	550–750	90–120
South Sudanian	Semi-humid	750–1150	120–150
Guinean	Humid	1150–1450	150–180

Source: Republic of Mali (1987, p15)

For about 25 years, rainfall has been substantially lower than it was during the first seven decades of the last century in the West African Sahel (Nicholson 1978, Hulme and Kelly 1993, Kelly and Hulme 1993). The climate of the Sahel has become drier over recent years with particularly severe droughts in 1972–73 and 1983–84. There have been numerous and intermittent local droughts.

The Saharan Zone is characterised by highly irregular haphazard precipitation amounting to less than 150 mm. Drought is a limiting factor to plant growth and its impact is strengthened by the wind, which increases evaporation. The soil is covered with a green herbaceous carpet upon which the nomadic herds and wild fauna feed. There are a few stunted bushes, especially in depressions. Surface water resources are limited to the Niger River at its bend, oases, temporary wadis and a

few ponds; specially adapted wild fauna can be found in this zone (dorcas and dama gazelles in the south, Barbary sheep in the mountains, and addax) living off the meagre, ephemeral vegetation.

The fundamental characteristic of the Sahelian Zones (North and South) is the long dry season, with a short rainy season of about three to four months (June–July to August–September). Plant formations are very discontinuous in space and fleeting in time. The plant cover consists of small, stunted, often thorny trees, with spreading crowns like parasols. The herbaceous carpet is often sparse and grows rapidly with the first rains. The long dry season forces the plants to have an extended period of dormancy every year, often characterised by falling leaves. *Acacia albida*, whose cycle is reversed, is an exception. This zone is the normal habitat for many animal species: dorcas, damas, red-fronted gazelles and some oryx. The Sahelian zone is a land of mostly transhumant shepherds. Herding is in fact the only way of life that ensures permanent exploitation of these regions through mobility from one pasture to another.

The Sudanian Zones (North and South) are best described as savannah woodlands. The zone deteriorates progressively from south to north into a savannah that is still rather rich in woody perennials. The herbaceous carpet is made up of perennials and annual grasses. Water resources are abundant: there are large rivers (Niger and Senegal), small rivers and lakes and ponds. This Sudanian Zone is an area whose activities revolve around food and cash crops (cotton, groundnuts) and livestock, especially sedentary livestock. There are also transhumants coming from south to north.

The Guinean Zone is a mosaic of savannah woodland and open woodland forest, but these two formations are regularly exposed to bush fires. The herbaceous vegetation contains many perennial species. The river valleys are fringed by dense vegetation made up of gallery forests. This is the home of the tsetse fly (which causes sleeping sickness) and filarial worms (which cause onchocerciasis, or river blindness). This zone is characterised by cereal growing, industrial plants (e.g. cotton) fruits, and tubers. There is traditional sedentary livestock, mainly trypanotolerant races that are smaller than Sahelian ones.

While the flora of the West African Sahel region as a whole has a relatively low species diversity (less than 1,800), these species are known to have a high genetic diversity and considerable resilience to the periodic droughts and fires that affect the region (Hassan and Dregne 1997). Nevertheless, increasing population pressures and cyclical drought stresses have led to serious reductions in regional wildlife populations.

Approximately 100 million people in the West African Sahel rely largely on the primary production potential of the area. The population increases vary from 2.2% to 2.8% per year with urbanisation rates at around 7% per year. Based on considerations of weather patterns alone, the vegetation of the Sahel adapts regularly to shifts in the climatic gradients, and species loss is, therefore, limited. However, the increase of the human and animal population and clearing of land for agriculture has had major impacts on biodiversity. Man is responsible here more than elsewhere for the alarming decline of species types and their numbers. Harmful agricultural practices intensify the degradation of the soil and vegetation. These include: overcultivation; overgrazing; selective grazing; bush fires, cultivation of marginal and easily eroded land; reduction of fallow lands which are not compensated by organic fertiliser; total elimination of trees from the open woodland forests (destumping) to introduce mechanisation on fields that are often too large and bordering fragile lands; and lopping and leaf-thinning trees (African Rosewood, baobab) for fodder and leaves for sauces and fruit.

Longer wet periods have allowed cropping to penetrate into grazing areas, but reverses in precipitation patterns have made these lands highly vulnerable. Although it has often been assessed that the heavy grazing pressure may lead to lowering of the biodiversity of Sahelian rangelands, recent evidence indicates that, for example, bush encroachment naturally follows. The Sahelian vegetation appears very unstable but resilient to pastoral stresses due to the strong dynamism of annual seed production, dispersion and germination cycles, and to the spatial equilibrium between herbaceous and woody plants.

Animal populations appear to have been seriously reduced over the last few decades and many major mammals have largely disappeared, such as leopard, cheetah, elephant, Nile crocodile and hippopotamus. Birds of prey are less common. Animal reserves have not been very effective, and civil strife has reduced the protection offered by legislation and designated areas.

In recent years, considerable efforts have been mounted to rescue the genetic diversity of native crops and of local varieties. The international research centre ICRISAT, with facilities in Niger and Mali now has significant ex situ collections of seed of sorghums millets and some pulses.

Limited work has been performed on identifying and monitoring the types of biodiversity of the Sahelian sub-region. There is a very serious need for careful surveillance of the biodiversity of the region, which seems particularly threatened due to significant increases in population pressure and long spells of increasing unfavourable weather conditions.

East Africa and the Horn

The dryland countries of Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan and Uganda occupy just under 5 million km^2 around the Horn of Africa. Of these about 80% (4 million km^2) receive on average less than 600 mm precipitation per year. The population is around 120 million, with an overall annual growth rate of 3.2%. The dryland areas have slightly lower population growth rates. The countries are all among the economically poorest of the world.

The drylands of this region are drought prone and there have been severe droughts in recent years. As a result, there have been significant variations in cropping areas, in livestock productivity and in natural biomass available for harvesting.

Although there are few studies on the biodiversity of the region and monitoring of biodiversity is difficult due to the strong variations in inter-annual rainfall, several authors have identified significant reductions in beta and gamma biodiversity over the last thirty years. The expansion of croplands, particularly in the Sudan and Kenya, has altered the habitats of wild plants and animals significantly. In both Kenya and Tanzania, there are widespread movements of landless poor from the more humid and densely populated high potential areas to the adjoining peripheral dryland areas in search of farmland (Darkoh 1982, 1996a). This permanent immigration, which is a recent phenomenon, has been problematic in terms of land degradation as these migrants often put the land under increasing pressure and import inappropriate technologies. Land mismanagement and land use conflict have considerably eroded biodiversity in these drylands.

Over the sub-region as a whole, large human and animal populations, with few alternatives for economic activities outside agriculture, are placing increasing pressure on natural resources at times of drought. Many countries of the sub-region have suffered repeated breakdowns of law and order in recent decades. The ensuing forced migration and concentration of refugees at levels well beyond local capacities to provide land for farming and fuelwood for cooking has exacerbated land degradation from overcultivation and overharvesting of biomass fuel. The availability of firearms has also contributed to severe reductions in wild animal populations. There is significant poaching of key species and limited enforcement of international conventions, e.g. CITES.

Although East Africa has been intensively studied ecologically, little is still known about the biodiversity of the area apart from the large mammals, and monitoring procedures have been difficult to undertake except in selected places. East Africa's lowlands are predominantly arid, within which pockets of humid environments have formed in highlands, wetlands and the rift valley. This has created a strong diversity of habitats in the region. These drylands have much to offer in terms of plant resources, with possibilities for wider cultivation and commercial exploitation. It is widely believed that long periods of dry years combined with mounting human and livestock pressure on land is putting a severe strain on the biodiversity of the countries around the Horn of Africa. There are, therefore, indications of links between dryland degradation and biodiversity.

Southern Africa

The eleven countries of the southern Africa sub-region have been severely hit by drought at least five times in this century, including the latest droughts in 1981–87 and 1991–92. Historical and geological records indicate that incidents of below-normal precipitation in all parts of the sub-region recur at intervals. The effects of these droughts have varied, but in general the vegetation cover has been severely reduced and fauna put under severe stress. The biodiversity of these drylands is seemingly in a state of flux. Southern Africa has one of the fastest growing populations in the world and faces the challenge of trying to increase food production by 3% a year, which usually involves bringing more land into cultivation.

The vegetation of southern Africa has the highest species richness of any floral region in the world (Gibbs Russell 1987). Cowling and Hilton-Taylor (1994) have identified southern Africa's eight centres of plant diversity (hot spots), which include about 3.5% of the world's flora, on just 0.2% of the earth's surface area. The 'hottest' of these hot spots (Myers 1990) is the Cape Floristic Region, where almost 9,000 species are squeezed into just 90,000 km^2 (Meadows 2000). Hot spots, according to Myers (1990), are areas with exceptional concentrations of species with high levels of endemism and which face exceptional threats of

destruction. The rich floral biodiversity could be attributed to its morphological evolution and contemporary ecological conditions. The combination of the region's transitional location, relative to the subtropical summer rainfall and temperate winter rainfall climates, and its varied topography are ecological gradients along which many species can be found.

Grazing is the most extensive form of land use in Southern Africa, and about two-thirds of the region is estimated to be suitable for grazing. Pastoralism has been practised for centuries over a large proportion of the region, especially Tanzania. Nomadic pastoralism occurs in arid and semi-arid environments, which necessitates the migration of animals and herders on a regular basis from one area to another. When nomadic pastoralism is well managed the varying requirements of the livestock components are ecologically balanced. This makes this agricultural system highly stable in a fragile environment. Grazing, however, becomes a threat to biodiversity because it not only displaces wildlife but also disrupts plant-species composition.

In the South African karoo ecosystems of low and erratic rainfall, Tainton et al. (1989) have noted that overgrazing, selective grazing and lack of fire have caused major changes in the composition and structure of the vegetation. While overgrazing and selective grazing lead to a sward dominated by unpalatable pioneer grasses such as *Aristida congests* subsp. *barbicollis*, *Tragus racemosus*, *Sporobolus nitens* and shrubs, overgrazing and the exclusion of fire have resulted in the dramatic encroachment of karoo and savannah species into arid grasslands (Tainton et al. 1989)

The most important impacts of introduced plants on the biodiversity in the region are their effects on the endemic flora. This invasion poses the most serious threat to the survival of the numerous endangered plant species occurring in the biomass. Huntley (1984) states that an area of some 66,000 km^2 of former grassland has been encroached on by species such as *Chrysocoma tenuifolia*, *Pentzia incana*, *Felicia muricata* and *F. filifolia*. The replacement of grassveld by karoo is undesirable because it is accompanied by reduced cover, increased runoff, and erosion (Snyman and Van Rensburg 1986). In some cases, areas invaded by karoo are so severely eroded that regeneration to productive grassland may not be possible, although Howell (1976) gives some hope of reclamation being successful.

Overgrazing reduces the competitiveness of the grass layer and produces a more favourable environment for the germination and establishment of shrubs and trees. *Acacia karro* is the most widespread of the encroaching species, having spread into the arid and semi-arid grasslands of the Transvaal, central Orange Free State, eastern Cape and Natal (Acocks 1975).

In drier and more fragile zones, such as Kalahari, with persistent famine and drought, many people are living through a period of rapid and dramatic changes in land use patterns, economic conditions and natural environment. This pace of change often exceeds the capacity of local institutions to design new land use practices that support both the natural resources and people's welfare. With more technological developments (e.g. dams and boreholes), more marginal areas have been opened up. Livestock numbers have now reached 45 million cattle and 71 million sheep and goats (SARDC / IUCN / SADC 1994). The recent expansion of arable cultivation in the Kalahari has been seen as one of the major causes of land degradation in the region (Ringrose et al. 1997b), resulting in loss of biodiversity.

One of the most significant hotspots in the Kalahari is the Okavango Delta, a large wetland located in the Ngamiland district of Northern Botswana. In this wetland, water is the primary factor controlling the environment and associated plant and animal life. The Okavango is the habitat for diverse species of plants, arachnids (spiders, scorpion, ticks and mites), large herbivores and birds. Land use changes in the Okavango Delta are having tremendous impacts on the ecosystem of this wetland. While it is not known how many rare or threatened species of flora and fauna exist in the Delta, the wetland ecosystem as a whole is a critically endangered environment of international significance. The growth of tourism in the area offers prospects for conservation but if not properly managed, this may exacerbate the threat to sustainable use of resources in this wetland area in the long run.

Cultivation of crops in the drylands, too, has an effect on biological diversity in the region. Unfortunately, cultivation is not only a major factor in reducing biodiversity in what would be considered legitimate arable land, but it takes up large tracts of land in semi-arid areas (that cover the largest area of the subcontinent). There are unconfirmed reports that in the Namaqualand agricultural region (68,719 km^2), for example, 2,449 km^2 had been cultivated by 1983 and only 180 km^2 was under irrigation (Macdonald 1989). In Karoo agricultural region (290,600 km^2), 1,920 km^2 is cultivated whereas a mere 200 km^2 is considered suitable for rain-fed crop cultivation (Schoeman

and Scotney 1987). Such examples show that there are some drylands that are being unwisely cultivated under dry conditions. This has an effect on the biological diversity in these areas because such drylands are unlikely to revert to the original plant communities characteristic of uncultivated sites. Probably the most important effect of cultivation on ecological processes in the sub-region is the effect of soil erosion.

The loss of woodlands in particular is not only a loss of biodiversity in the drylands but also has implications for climate change. This is because trees act as sinks of atmospheric carbon dioxide. The loss of trees induced during initial preparations for land cultivation diminishes the flux of carbon dioxide from the soil via photosynthesis and reduces the storage capacity of the biosphere for carbon. Burning, a method used by farmers to clear land, releases stored carbon into the atmosphere along with carbon from the litter and soil, which contributes to the enhanced greenhouse effect.

Increase in agricultural activities can be attributed to government policies. In Botswana, the agricultural policy pursued by the post-independence government encouraged people to go into arable farming by providing agricultural extension services and other incentives, resulting in the abandonment of the indigenous plant varieties and species. Government settlement policies have curtailed the movement of the Basarwa in the Kalahari, and the provision of permanent water supplies at wells and boreholes has resulted in concentrated settlements around the water points. This has had adverse effects on wild animals, which are denied access to these grazing lands because they are considered a threat to people's lives.

The future of Africa's biodiversity

The economic and social forces driving the transformation of the natural habitats of Africa's biodiversity cannot easily be stopped as long as the stated goal of most people and their political representatives is to increase production of food for the growing population.

It has been established that agriculture accelerates the loss of biodiversity in the drylands as farmers attempt to increase crop and animal production to feed the growing population and to contribute to the growth of the economy. To avoid a situation in which agricultural activity leads to conflicts over resource use and loss of biodiversity, and to ensure environmental sustainability a broad landscape planning approach to conservation is required. Multiple-use areas that bring benefits to local people and combine conservation with sustainable land use need to be considered as practical and possible alternatives to the establishment of protected areas and buffer zones; these often lead to conflicts with local people over rights of access to land and other natural resources. It is crucial that biodiversity conservation be extended beyond buffer zones and protected areas to include all elements of the landscape and all ecosystems (USAID 1993). The drylands of Africa have the potential to be more productive if wisely managed.

Successful biodiversity conservation strategies must respect and incorporate African values, knowledge systems and priorities. With regard to ecological knowledge, the traditional people occupying the marginal environments such as semi-arid areas tend to possess much knowledge of how to conserve and use the resources sustainably (McNeely 1995, Darkoh 1996b). Any biodiversity conservation projects must involve local people in the management and use of biological resources. This will encourage the local people to accept the biological resources as their own and fight to protect them against depletion. Successful conservation strategies take many forms, both traditional and innovative. In Africa, the emphasis on formal education in general has been at the expense of traditional knowledge systems; most schools use curricula and teaching materials based on those of Europe. The single most important activity that will enhance biodiversity conservation in the medium- to long-term is to raise well-informed future generations with a strong commitment to the sustainable management of natural resources and biodiversity. Biodiversity conservation should be an integral component of environmental education throughout formal education systems, and both traditional and modern knowledge systems, and values need to be integrated into school curricula.

There is a need to use agricultural production systems that are likely to intensify production and so reduce the rate at which land is cleared for cultivation. Such production systems need to be self-sustaining, allowing land to be used for a long time without the need to shift to other places. Agroforestry, the planting of trees on and around the farm, should be recommended because these trees will serve as windbreaks and shelterbelts. They also provide other needs like fuelwood, timber, poles, fodder, fruits and medicines. This will cut down the rate at which trees are harvested to meet these needs.

The sustainable use of drylands depends upon the development projects that take into consideration the fact that all the components of drylands systems directly or indirectly affect all other components. Development activities in drylands have in the past not been very successful. Their failure may be attributed to the fact that past projects often did not consider the entire system – which includes the local people – in planning, implementing and following up projects.

There is a need to assess the agricultural potential of the semi-arid environments and develop specific agricultural policies or programmes to enhance the sustainable utilisation of the ecosystem. For such policies or programmes to succeed, they have to be in line with the needs, aspirations and abilities of the users. In other words, they have to be formulated with the participation of the beneficiaries.

So far, only limited research on biological diversity, species composition, characteristics and endemism has been conducted in Africa's drylands. Research in only a few countries, such as Botswana, Kenya, Namibia, South Africa and Sudan, has yielded results that make a significant contribution to our understanding of dryland ecology. For the majority of African countries, drylands remain a largely unknown domain. Knowledge of dryland ecosystems and their genetic characteristics is an important tool in efforts to mitigate the effects of drought and combat desertification. Research is needed to fill the gaps in our knowledge of biodiversity across regions, countries and local areas in the drylands of Africa. Efforts should be made to identify and strengthen activities that transfer or disseminate lessons learned, for example through regional sharing of information. The transfer of ideas and technologies is an important aspect of the challenge to strengthen the capacity of African societies to take responsibility for the management of biodiversity in the ways that are sustainable in the long term.

There is also a serious lack of natural resource inventories and other baseline data that are of fundamental importance for monitoring biodiversity trends. Inventories provide information on existing levels and patterns of biodiversity. Baseline inventories can, if carefully carried out, provide the basis for ecological monitoring. Above all, there is an urgent need for regular ecological monitoring to identify both positive and negative trends in biodiversity in the drylands of Africa.

References

Acocks J.P.H. 1975. Veld types of South Africa, 2nd edition. *Memoirs of the Botanical Survey of South Africa* 40: 1–128.

Bedigian D. 1991. Genetic diversity of traditional sesame cultivators and cultural diversity in Sudan. In: Oldfield M.L., Alcorn J.B., editors. *Biodiversity: culture, conservation, and ecodevelopment*. Boulder, Colorado: Westview.

Behnke R., Scoones R., Kerven C. 1993. *Range ecology at disequilibrium: new models of natural variability and pastoral adaptation in African savannah*. London: Overseas Development Institute.

Cowling R.M., Hilton-Taylor C. 1994. Patterns of plant diversity and endemism in Southern Africa: an overview. In: Huntley, B.J., editor. *Botanical diversity in Southern Africa*. Pretoria: National Botanical Institute.

Darkoh M.B.K. 1982. Population expansion and desertification in Tanzania. *Desertification Control Bulletin* 6: 28–33.

Darkoh M.B.K. 1996a. Environmental problems in Kenya's arid and semi-arid lands. In: Eden M.J., Parry J.T., editors. *Land degradation in the tropics*. London: Cassell.

Darkoh M.B.K. 1996b. Towards an adaptive and community-based approach to the management of natural resources in the drylands of sub-Saharan Africa. In: Hjort-af-Ornas A., editor. *Approaching Nature from Local Communities*. EPOS, Linkoping University, Sweden.

Darkoh M.B.K. 1998. The nature, causes and consequences of desertification in the drylands of Africa. *Land Degradation and Development* 9: 1–20.

Ghabbour S.I. 1997. Threats to biodiversity in Arab countries. In: Barakat H.N., Hegazy A.K., editors. *Reviews in ecology desert conservation and development*. Cairo: Metropole

Gibbs Russell G. E. 1987. Preliminary floristic analysis of the major biomes in southern Africa. *Bothalia* 17: 213–327.

Grivetti L.E. 1979. Kalahari agro-pastoral hunter-gatherers: the Tswana example. *Ecology of Food and Nutrition* 7: 235–256.

Hassan H., Dregne H.E. 1997. Natural habitats and ecosystems management in drylands: an overview. Washington DC: World Bank. World Bank Environment Department Papers No. 51.

Howell D. 1976. Observations of the role of grazing in revegetating problem patches of Veld. *Proceedings of the Grassland Society of Southern Africa* 11: 59–64.

Hulme M., Kelly M. 1993. Exploring the links between desertification and climate change. *Environment* 35(6): 1–11, 39–45.

Huntley B.J. 1984. Characteristics of South African biomes. In: Booysen P. de V., Tainton, N.M., editors. *Ecological effect of fire in South African ecosystems*. Berlin: Springer.

IPED 1994. Effects of desertification and drought on the biodiversity of the drylands. Geneva: United Nations. International Panel of Experts on Desertification. Preliminary Executive Summary Report.

Jabbar M.A. 1993. Evolving crop livestock farming systems in the humid zone of west Africa: potential and research needs. *Outlook on Agriculture* 22: 13–21.

Kelly M., Hulme M. 1993. Desertification and climate change. *Tiempo* 8: 1–7.

Lykke A.M. 2000. Refining the ecological aspects of disequilibrium theories for Africa's pastoral drylands. *Desertification Control Bulletin* 36: 23–33.

Mannion A.M. 1995. *Agriculture and environmental change: temporal and spatial Dimensions*. Chichester: John Wiley and Sons Ltd.

Mcdonald I.A.W. 1989. Man's role in changing the face of Southern Africa. In: Huntley B.J., editor. *Biotic diversity in Southern Africa: concepts and Conservation*. Cape Town: Oxford University Press.

MacKinnon J., MacKinnon K. 1986. *Review of the protected area system in the Afrotropical realm*. Gland: IUCN.

McNeely J.A. 1995. Biodiversity conservation and tradition agrosystems. In: Saunier R.E., Meganck R.A., editors. *Conservation of biodiversity and the new regional planning*. Gland: IUCN

McNeely J.A., Miller K.R., Reid W.V., Mittermeier R.A., Werner T.B. 1990. *Conserving the world's biological diversity*. Gland: IUCN.

Meadows M.E. 2000. The ecological resource base: biodiversity and conservation. In: Fox R., Rowntree K., editors. *The geography of South Africa in a changing world*. Cape Town: Oxford University Press Southern Africa.

Murray M. 1988. Management plan for Central Kalahari and Khutse Game Reserve. Kalahari Conservation Society, Gaborone, Botswana.

Myers N. 1990. The biodiversity challenge: expanded hot spot analysis. *The Environmentalist* 10: 243–256.

Nicholson S.E. 1978. Climatic variation in the Sahel and other African regions during the past five centuries. *Journal of Arid Environments* 1: 3–24.

Office of Technology Assessment (OTA). 1987. *Technologies to maintain biological diversity*. Washington DC: US Government Printing Office.

Patterson L. 1987. Cordon fences. *Kalahari Conservation Newsletter* 18: 10–11.

Perkins J.S., Ringrose S. 1996. Development cooperation objectives and the beef protocol: the case of Botswana: a study of livestock / wildlife / tourism / degradation linkages. Gaborone: University of Botswana.

Repetto R. 1985. Environmental ethics and global imperatives. In: Repetto R., editor. *The global possible: resources, development and the new century*. New Haven: Yale University Press.

Repetto R. 1989. *Wasting assets: natural resources in the national income accounts*. Washington DC: World Resource Institute.

Republic of Mali. 1987. National plan of action to combat desertification. Bamako: Ministry of Natural Resources and Livestock.

Ringrose S., Vander Post C., Matheson W. 1997. The use of image processing and GIS techniques to determine the extent and possible causes of land management. Fenceline induced degradation problems in the Okavango area, Northern Botswana. *International Journal of Remote Sensing* p 35.

SARDC / IUCN / SADC. 1994. *State of the environment in Southern Africa*. Johannesburg: The Penrose Press.

Schoeman J.L., Scotney D.M. 1987. Agriculture potential as determined by soil, terrain and climate. *South African Journal of Science* 83: 260–268.

Schusky E.L. 1989. *Culture and agriculture*. New York: Bergin and Garvey Publishers.

Scoones I. 1996. *Living with uncertainty: new directions in pastoral development in Africa*. London: Intermediate Technology Publications.

Snyman H.A., Van Rensburg W.L.J. 1986. Effect of slope and cover on run-off, soil loss and water use efficiency of natural veld. *Journal of the Grassland Society of Southern Africa* 3(4): 117–121.

Sporton D., Thomas D.S.G., Morrison J. 1999. Outcomes of social and environmental changes in the Kalahari of Botswana: the role of migration. *Journal of Southern African Studies* 25(3): 441–459.

Stock W.D., Allsopp N., van der Heyden F., Witkowski E.T.F. 1997. Plant form and function. In: Cowling R.M., Richardson D.M., Pierce S.M., editors. *Vegetation of Southern Africa*. Cambridge: Cambridge University Press.

Stuart S.N., Adams R.J., Jenkins M.D. 1990. *Biodiversity in sub-Saharan Africa and its islands: conservation, management and sustainable use*. Gland: IUCN. Occasional paper of the IUCN Species Survival Commission no. 6.

Tainton N.M., Zacharias P.J.K., Hardy M.B. 1989. The contribution of diversity to the agricultural economy. In: Huntley B.J., editor. *Biotic diversity in Southern Africa: concepts and conservation*. Cape Town Oxford University Press.

UNEP. 1983. *Promotion of exchange of information and expertise on desertification control and technology in Africa, Volume 1: Actions*. Nairobi: Desertification Branch of UNEP.

UNEP. 1992a. *World atlas of desertification*. London: Arnold.

UNEP. 1992b. *Status of desertification and implementation of the United Nations plan of action to combat desertificatio*n. Nairobi: United Nations Environment Programme.

UNEP. 1997. *Global environment outlook*. New York: Oxford University Press.

USAID. 1993. African biodiversity: foundation for the future. Beltsville, Maryland: Professional Printing Inc.,

Williamson D.T., Williamson J.E. 1983. An assessment of the impact of fences on large herbivore biomass in the Kalahari. *Botswana Notes and Records* 13: 107–110.

World Bank. 1991. *World development report 1991*. Washington DC: Oxford University Press.

CHAPTER 2

FARMING IN WETLANDS

Agriculture and Wetlands in the Mekong Basin

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Abstract

Over 60 million people live in the Mekong Basin, where the natural biodiversity is immense and highly significant internationally for biodiversity conservation. But of the initial 4 million hectares of the delta, only 1.3% now remains in a natural or semi-natural state. Expanding agriculture poses a number of threats to the wetlands, their resources and biodiversity, as well as to local communities. These include the conversion of wetland habitats for farming, particularly intensively cultivated rice fields, irrigation schemes and water pollution by agrochemicals. The construction of dams for hydroelectric power schemes is altering the hydrological regime, causing further wetland degradation in the Lower Mekong. Regional coordination and cooperation is required for integrated and harmonious development in the region, and governments need assistance with decision making and regional cooperation. Recommendations for improving the situation are made.

Introduction

The Mekong is one of the world's great river systems. Rising from the Tibetan Plateau and discharging into the South China Sea some 4,800 kilometres later, it is the twelfth longest of the world's rivers. It drains a catchment area of 795,000 km^2 extending across parts of six countries – China, Myanmar, Thailand, Lao PDR, Cambodia and Vietnam. Each year, the Mekong discharges 475,000 million cubic metres of water, making it the eighth largest river in the world. The seasonal variation in water level is the source of the productivity of the system: wet season river levels are up to 8–10 metres higher than dry season ones, creating a rich and extensive series of wetlands in the four countries of the Lower Mekong Basin and the 4 million hectare delta.

The natural biodiversity of the Mekong River Basin is immense and of truly exceptional significance to international biodiversity conservation, even in comparison with other parts of tropical Asia. The river and its numerous tributaries, backwaters, lakes, and swamps support many unique ecosystems and a wide variety of globally-threatened species, such as the Irrawaddy Dolphin, Siamese Crocodile, Giant Catfish and birds such as the Giant Ibis and Sarus Crane. The diversity of the river fauna itself is only surpassed by that of the Amazon and the Congo, with between 500 and 1,300 species of fish in the main channels, tributaries, and associated wetlands.

Over 60 million people live in the Mekong Basin, more than 90% of them in the Lower Mekong Basin, including about one third of the total populations of Cambodia, Lao PDR, Thailand and Vietnam. Population growth remains high in the Lower Mekong countries: 2.6% in Cambodia and Lao PDR and 1.7% in Vietnam (the East Asia / Pacific regional average is 1.6%). Despite the rapid economic advances made over the last decade, Cambodia, Lao PDR, and Vietnam are classified as low income countries with a per capita GDP of USD 280–360 (compared with an East Asia / Pacific region average GDP of USD 990). It is estimated that some 36% of the population in Cambodia, 36% in Lao PDR, 13% in Thailand and 37% in Vietnam live below the poverty line.

With the exception of Thailand, a middle income country with a per capita GDP of USD 2,200, and to a lesser extent Vietnam, the national economies of the Lower Mekong states are based primarily on agriculture and natural resources. Agriculture is the main sector of Cambodia's economy, accounting for nearly 45% of the GDP and supporting 85% of the labour force. Rice is the predominant agricultural crop and forms 80% of crop output, although rice yields are among the lowest in the world. Fish constitutes about 70% of animal

protein consumed in the country. Other important crops are rubber, corn, mung beans, vegetables, tobacco, soybean and sesame. In the Mekong Basin area of Thailand about 90% of the population relies on agriculture. This area has a relatively low level of industrialisation and service sector development compared with the rest of the country.

Over three-quarters of each of the populations of Cambodia, Lao PDR, Thailand, and Vietnam live in rural areas and rely almost entirely on subsistence farming, fisheries, wildlife, forest products and plant resource utilisation. Scarcity of fertile agricultural land, or lack of access to it, coupled with rising needs for income and subsistence, are placing increasing pressure on wetlands and their biodiversity. Such high levels of human population and usage have led to increasing development pressures within the basin, which present direct threats to many of the endangered species and important ecosystems for which the region is renowned. Only 1.3% of the Mekong Delta, once so rich in biodiversity is in a natural or semi-natural state, with the few remaining wetland species wholly reliant on these remnant patches. Similarly, in Esarn, a Thai portion of the Lower Mekong Basin, infrastructure development has reduced natural wetlands to a small fraction of their original area.

Extent of the Mekong Wetlands

The Mekong Basin wetlands are complex systems with a variety of physical, hydrological and vegetative characteristics. Simple categorisation of these systems is difficult. The structure and function of wetlands in the Lower Mekong Basin are inextricably linked to the seasonal hydrological pattern of the Mekong River, involving a wet season rise in water levels of up to 10 metres above that of the dry season. However, the wetlands of the Lower Mekong Basin could be considered to encompass the following descriptive units:

- Upland tributaries and related systems, including streams, reservoirs and headwaters;
- Lowland river channels of the Mekong and its larger low-gradient tributaries;
- Permanently and seasonally inundated wetlands associated with seasonal rainfall and the annual inundation of the Lower Mekong Basin;
- The Mekong Delta from south-eastern Cambodia through to the estuarine associations in the delta in Vietnam.

Lowland river channels include the main channels

Table 1

Extent of known wetlands in the countries in Lower Mekong Basin

Country	*National*		*International*	
	No.	*Area (ha)*	*No.*	*Area (ha)*
Cambodia			4	3,650,000
Laos	30	434,275	4	222,000
Thailand			42	2,510,000
Vietnam			25	5,810,000

Source: Global Review of Wetlands Resources 1999

Figure 1

Mekong Basin, its main and tributaries waterways (*Source*: MRCS, Environmental Unit)

of the Mekong and its major tributaries, the Nam Ngum, Songkram, Pak Mun, Xe Kong, Se San and Srepok. These are permanent rivers that flow relatively slowly in the dry season and form a series of deep pools interspersed by rapids and islands.

Important wetland ecosystems in the Mekong Basin are found particularly along the main river channel and its tributaries; in the permanently and seasonally inundated riparian forests, such as the area around the Tonle Sap lake of Cambodia and in marshes and small pools in the wetland plains, as well as the vast delta plain. The Plain of Reeds in the delta area of Vietnam was once a large wetland depression of about 1.3 million hectares, encompassing the provinces of Dong Thap, Tien Giang and Lang Sen. The Plain of Reeds also encompassed parts of Svay Reang province in Cambodia. Except for areas of relatively high ground near the Cambodian border and the river levees along the main branches of the Mekong, the plain lies in a flat lowland region subject to seasonal flooding from July to January. At its peak between late September and the end of October, the plain virtually becomes a vast lake, with some areas flooded to a depth of nearly four metres. During the dry season, the plain all but dries out except for scattered ponds and swamps.

Main threatened habitats

As there is no single standard definition and classification of wetlands and no complete wetlands inventory, the actual extent and categories of wetlands have not been yet established. In many cases, wetlands areas are estimated according to their various levels of importance, the incomplete information available and national definitions. The information on the extent and distribution of wetlands also depends considerably on the objectives of the inventory. Due to a lack of knowledge of wetlands and wetland ecosystems in the Mekong, it is not known what proportions of the original ecosystems have been degraded and / or lost. Since the definition of wetlands in the Ramsar convention is broad and national boundaries are unclear, most wetland ecosystems are considered to be altered, e.g. from flooded forest to rice paddies, rather than lost; wetlands are considered to be lost only when their ecosystems cannot be restored naturally. In many cases, loss and / or changes of wetlands ecosystems are presented in terms of loss of production. Wetlands International–Asia Pacific is currently in the process of developing an Asian Wetlands Inventory programme to comprehensively update the 1989 version. Further details of the proposal can be requested from Matt Wheeler at Wetlands International in Malaysia via ayu@wiap.nasionet.net.

This is illustrated by some examples of the losses and changes in some prominent wetland ecosystems in selected countries in the Mekong Delta. In Cambodia, the expanse of flooded forest (vegetation) around the Tonle Sap lake has been reduced by about 60% since the 1960s (Woodsworth 1995):

pre 1930s	1,000,000 ha
late 1960s	614,000 ha – 386,000 ha lost to charcoal, firewood, population pressure
1970	564,000 ha – 50,000 ha converted to rice paddies during the Pol Pot regime
1990	460,000 ha – 104,000 ha converted to agriculture

In the Mekong Delta of Vietnam, the original plain was covered by dense vegetation with small natural streams. However, agricultural expansion over the past 40 years has led to most natural areas being converted to rice production. Of the initial 4 million hectares of the Delta, only 1.3% now remains in a natural or semi-natural state. Melaleuca once covered 220,000 ha (World Bank 1995) to 250,000 ha (Duc and Hufsschmidt 1993) of the Mekong Delta, but now only about 120,000 ha remain, of which only 10,000 ha are intact. By 1975 23% of the original melaleuca vegetation had been lost to drainage and clearance for rice farming and destruction during the Vietnam War from 1964 to 1975.

There has been a general increase in area of rice fields in the Mekong, where rice production is a crucial element in the regional (see Table 2). Other changes include an increase in the number of dams

Table 2

Area changes of rice paddies in Asia (FAOSTAT 1998)

Country	*1988*	*1997*	*1998*
Cambodia	1,735,000	1,928,689	1,928,689
Laos	524,828	572,000	572,000
Thailand	9,905,932	9,932,160	9,210,000
Vietnam	5,726,380	7,091,200	7,091,200
Total	130,092,618	133,811,958	133,608,448

and reservoirs for hydroelectric power generation and irrigation schemes. Often these reservoirs have limited seasonal variation in water height and possess a uniform underwater landscape.

Threats posed by agricultural developments

There are a number of agriculture-related threats to wetlands, their resources and biodiversity, as well as to local communities. They include the conversion of wetland habitats for farming, the construction of infrastructure, such as large dams and irrigation schemes, and water pollution resulting from the use of agrochemicals. As a result of the Doi Moi policy, a thousand hectares of mangrove forest in the southern part of the Ca Mau peninsula have been reclaimed for the cultivation of rice and soya bean. As the soil was initially rich in humus content and rainfall is high (2300–2500 mm/year) and concentrated in a 3–4 month period, production was good. But with a long dry season and strong sunlight, water evaporates quickly and the soil oxidises rapidly and becomes saline and acid. Another consequence of the policy was large-scale immigration into the Mekong Delta.

The expansion of agriculture land is frequently accompanied by the extension of irrigation schemes, particularly if the aim is to obtain high yields. This entails the construction of infrastructure for water diversion and distribution. For example, the Department of Energy Development and Promotion (DEDP) released a plan in 1995 to construct a dam at the mouth of the Songkram River, together with 47 pumping stations, to provide water to 90,400 ha of farmland in the three provinces. The proposed plan would permanently inundate 13,900 ha of currently seasonal wetlands, including flooded forests and farmland, while removing flooding from another 4,700 ha of seasonal wetlands. The remaining seasonally inundated area will remain under water for a longer period during the drawdown period of irrigation operations. The project is currently stalled after rejection of the EIA by the National Environmental Board, pending additional EIA studies.

Since 1995, there has been well-organised opposition to the planned dam by the primary stakeholders of Lower Songkram River, supported by local environmental NGOs. Lessons learned from elsewhere, particularly the effects of the recent Pak Mun dam on the Nam Mun (the largest tributary of the Mekong in Thailand) raise serious concerns about maintaining the livelihood of the Songkram user community. A Thai NGO, Project for Ecological Recovery, which has been working in the area for many years, has disseminated information widely about the proposed dam. In 1996, local people formed a network called 'Village People to Conserve the Songkram River Basin'. This active network, with members from 30 villages, is campaigning for the cancellation of the Songkram Irrigation Project and is pushing for the recovery and conservation of the Mekong Basin. Fish and forest reserves have been established in several villages under village rules and regulations. To enhance their bargaining power the network has also joined the Forum of the Poor, a nationwide network of organisations of local people affected adversely by government development projects.

Fertilisers and pesticides are intensively used in northern Thailand and in the Vietnamese part of the Mekong delta. Increasing quantities of agrochemicals are used owing to economic reforms and various incentives to increase productivity. At least four types of environmental problems occur as a result of pesticide use. These include health effects in people and the accumulation of toxic residues in the water, soil and in the food web, ruining crucial sources of protein and income. Overuse can also lead to pesticide resistance and, in response, an increase in the dose applied.

The main occupation of the local people in the Vietnamese Mekong delta is dry season rice cultivation, which takes up 83% of community labour. As elsewhere in the delta, rice production is based on an intensive model of production geared to export. This requires high capital inputs, such as high doses of fertiliser and various insecticides, to increase yield. The average agricultural land holding is 2 ha per family, on which typically two rice crops are produced each year, each having an average yield of 4 tonnes/ha. This means that a family can produce about 16 tonnes of rice per year with a value of USD 1,750. However, two-thirds of this amount is needed to cover the costs of farm inputs, including chemicals, fuel for water pumps, and labour.

In Laos, the provincial authorities are promoting dry season rice cultivation in line with the national development priority of overcoming food shortages. Irrigated dry season rice production was introduced into the province in 1997, with the construction of dams and systems supporting irrigation to an area of 1,000 ha. Traditionally, local people planted rice in the wet season only and are yet to be convinced of the merits of dry season

cultivation. In 1997–1998 the authorities were aiming for the planting of 1,000 ha of dry season rice, but achieved only 400 ha, and by 1999 the area planted had dropped to 200 ha, despite a strong provincial campaign. The intensive management, high production cost, high pumping costs and possible increases in the price of oil present a risk that many farmers do not want to take.

Communities living on the lowland plains cultivate rain-fed rice. The average land holding is 1 ha per family for rice production and 1 ha for a garden around the house used for growing maize, chillies, pumpkins, cucumbers and other produce. About one third of farmers have no draught animals for ploughing, so tilling the soil is done manually. This significantly limits the area of land cultivated each year. The rice yield is around 2 tonnes / ha.

In Thailand, the average land holding in the area is 2–3 ha / family, of which a large portion is for dry season rice dependent on small irrigation schemes using water from village reservoirs. The average yield for dry season rice is 4 tonnes / ha producing a total yield of 8–12 tonnes / family / year with a value of around USD 865–1,296. However, in the Lower Songkram Basin, local people's income from fishing and the harvest of wetland products is equal to, or greater than, that of rice farming. Project for Ecological Recovery conducted a detailed study of the products from wetlands in Dong San Village. In this village in 1996 the total catch of aquatic animals including fish, shrimps and crabs was 81 tonnes, or 788 kg / family / year, with a value of USD 1,432 / family / year. The harvest of plant products from the wetlands and inundated forest, e.g. edible leaves, bamboo shoots and mushrooms, was 26.2 tonnes for the village or 688 kg / family / year with a value of USD 216 / family / year. The average income for communities in the demonstration site is USD 2,500–2,950 / family / year, two thirds of which comes from direct harvesting in wetlands and only one-third from rice cultivation.

Underlying causes of wetland degradation in the Lower Mekong / Recommendations

Alteration of the hydrological regime

The wetland systems of the Lower Mekong Basin depend on the annual inundation of the wet season water flow, their productivity reflecting the height and duration of inundation. The Tonle Sap system is a critical example that depends on the annual pulse of water from the Mekong to reverse the flow of the Tonle Sap River from June until October or November. This reverse flow floods the lake, increasing its area from 250,000 ha to 1.3 million ha and its average depth from 1–2 m to 8–10 m. This flooding inundates the forest around the lake, releasing nutrients and creating exceptionally productive nursery grounds for numerous fish species. Changes to flood height and duration may result in some seasonal wetlands not flooding, or in previously permanent wetlands drying out, thereby diminishing wetland productivity. Reliable quantifiable data on these impacts are unavailable, but a current reduction of 15% on peak flows resulting from dam construction and water management structures has been suggested as likely to cause severe reductions in productivity. There are a number of existing and proposed developments that may result in reduced peak flows and increases in dry season flow. The cumulative effects of these on the biodiversity of the Lower Mekong Basin wetlands are unknown. Regardless of the agreement between participating countries in the Mekong River Commission (MRC), many hydropower projects have been designed and built without sufficient consultation or studies of downstream impacts, especially in areas outside the country's administrative authority.

Hydroelectric power dams

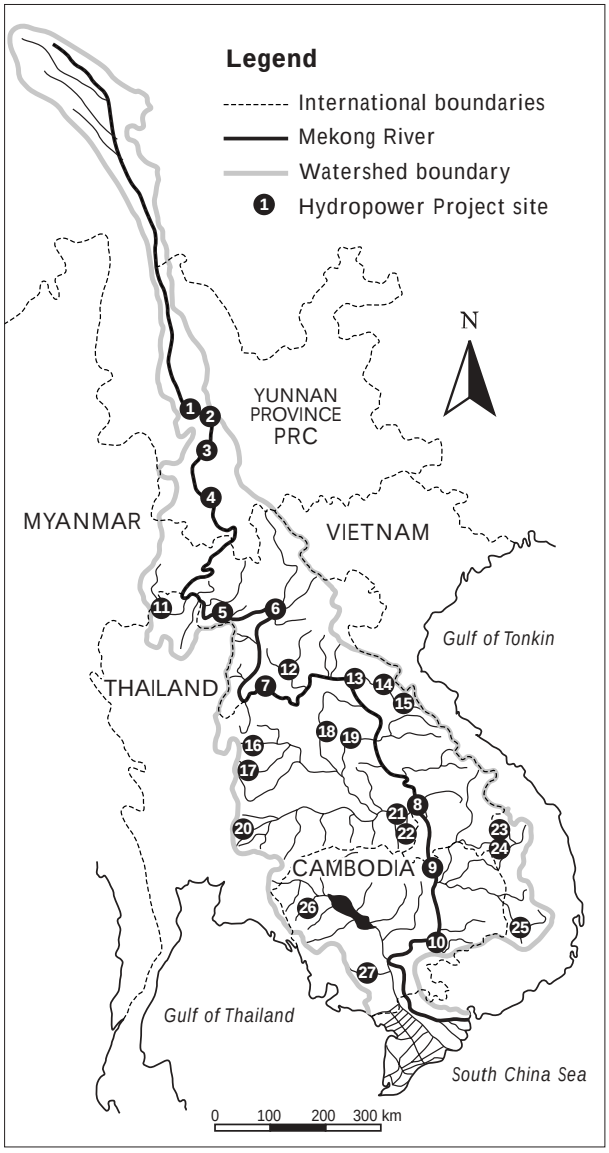
The Mekong River is viewed widely as a great potential source of hydroelectric power. The Manwan power station in China is already in operation and another 13 are at various stages of planning and construction. Lao PDR has 22 planned hydropower dams with a total expected output of 7,500 MW, mainly on the Mekong tributaries, and in Cambodia several dams are planned for the tributaries and one on the main channel of the Mekong near Kratie. Vietnam is currently constructing the Yali Falls Dam on the Se San. No impact assessment has been carried out on this scheme and so likely impacts in Cambodia are unknown. Vietnam is also planning to construct dams on the upstream reaches of the Srepok River. Thailand has dams on all tributaries of the Mekong except the Songkram River. The Laos PDR government looks to hydroelectric power development as the primary source of income for the country in future and hydroelectric power generation is expected to reach 1,500 MW by the end of this year.

Recommendations

- Avoid large scale dam constructions.
- Promote existing small reservoirs for water storage and irrigation.
- Reduce demand for water by providing economic incentives, farming techniques and market support for agricultural crops that requiring less water.
- Avoid inter-basin transfers of water.

Figure 2

Selected hydroelectric power projects in Lower Mekong Basin (After MRB Diagnostic Study 1996)



Irrigation

Dams built for electricity generation and irrigation in the past few decades in the north and north-east of Thailand have not performed as well as expected; the reservoirs have not reached the predicted water levels as a result of low rainfall and high rate of sedimentation. Soil quality in north-east Thailand is generally poor, with a low clay content and salinity problems. The expansion of irrigation and construction of reservoirs will worsen the salinity problems by raising the water table. It is estimated that saline soils and unsuitable topography affect about 75% of the land which is poorly suited to suitable for reservoir development (Natural Resource Management in the Mekong River Basin: Perspectives for Australian Development Cooperation, 1996). Dams built in the past two decades for power generation and irrigation in the north and north-east do not perform well because rainfall is low.

The construction of canals in Cambodia during the Pol Pot regime of 1975–79 was part of an extensive and expensive irrigation programme that failed because of poor hydraulic design. Cambodia is still suffering the negative impacts of these often stagnant canals; some of them have been converted for aquaculture. Many areas in the delta now grow two or three rice crops per year with an annual yield of up to 10 tonnes / ha, while in Cambodia many areas produce only one crop per year with a typical yield of less than 2.5 tonnes / ha. It is expected that Cambodia and Lao will invest heavily over the next few years in irrigation infrastructure to increase rice production, and so raise the demand for water from the Mekong River.

A large area (368,000 ha) of the plain in Vietnam (known as Dong Thap Muoi) is composed of acid-sulphate soils. Recent water management efforts, including canals and dikes, have increased the area of land available for agriculture and have also led to increased settlement of people in the flood plain. However, these areas are still subject to periodic flooding and more plans are being developed to modify the river flow and ensure that these periodic events do not affect crops and settlements. The expansion into the delta of both the canal network and rice cultivation has resulted in the disturbance and oxidation of sulphate-rich soils which, on exposure to air, produce acid. On occasions, particularly in the dry season, water in the delta becomes highly acidic; a pH of 3.5 has been recorded.

Recommendations

- Promote crop production requiring less water.
- Integrate habitat protection into agricultural policy through land use planning and inter-sectoral coordination.

Pollution

Increasing use of fertiliser is causing high nutrient run-off leading to eutrophication and oxygen depletion, raising the potential for toxic algal blooms. The use of herbicides and pesticides is also increasing throughout the Lower Mekong Basin. Lack of understanding and a desire to increase crop production often lead to applications of excessive doses of these toxins, which run off into water bodies and are absorbed by aquatic organisms. Accumulation of these toxins in many higher-level animals means high concentrations of toxins in animal products, making them unsafe for human consumption. They may cause death and sub-lethal effects such as reduced reproductive capability.

In Cambodia, at least 168 pesticides are available under various trade names, and 66 pesticides under various common names. According to the World Health Organisation (WHO) 83% of all pesticides used in Cambodia are listed in WHO class Ia or Ib and include hazardous and notorious chemicals such as Endrin, Chlordane and Methyl-Parathion. Pesticides are also used as preventive measures and use is often not targeted due to ignorance of the action and effects of pesticides. There is a lack of understanding of the roles of natural enemies of pests, and of the effects of pesticides on human health. Sixty per cent of farmers use pesticide on dry season crops and 20% on wet season crops.

Recommendations

- Regulate the trade in agrochemicals.
- Ensure appropriate labelling and instructions for use.
- Apply alternative pest management methods, such as biological control, farming techniques and soil management.
- Promote integrated pollution management (IPM) and the application of green manures.
- Raise awareness of the appropriate use of agrochemicals.
- Encourage agrochemical producers and traders to share their responsibilities for the use of their products.
- Promote the market for green products.

Institutional and political implications

The sustainable use and management of wetlands requires strong and coordinated multi-sectoral national institutions and policies. Many countries in the Lower Mekong Basin not only have weak policy frameworks and an economic environment not conducive to the sustainable use of wetlands, but also lack adequate capable human resources. Strengthening national capacity and policy, therefore, is the foremost priority in creating a favourable policy and commitment.

Decisions on the development of the Mekong Basin are also influenced by regional initiatives such as the MRC and investment and technical assistant from external institutions and bilateral agreements. The MRC secretariat plays a very significant role in coordinating the member countries, especially in reaching the 1995 agreement between the Mekong countries on cooperation for the sustainable development of the Mekong River Basin. But the countries still face great challenges in making use of the Mekong for national development. For instance, there are bilateral agreements on direct assistance from donor countries that are not necessarily coordinated with the MRC. A number of financial institutions, such as Asian Development Bank and World Bank, also play a significant role in development in the region.

Although coordination has been recognised as an important issue, and a lot of effort has been put into improving coordination for development in the Mekong, coordination and information sharing have proved to be a major constraint, not only among government institutions but also between donor agencies. Regional coordination and cooperation is necessary for integrated and harmonious development in the region, and the governments badly need assistance with informed decision making and regional cooperation.

The Macanas Wetland – Conservation and Agricultural Use Area

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Abstract

The Macanas Reserve in Panama lies in Parita Bay, a wide coastal-marine wetland important for migratory and local birds and a potential Ramsar site. Rice is grown on an industrial scale on 12,000 hectares within the boundary of the waterfowl area. This, and encroaching cattle ranching, horticulture and shrimp farms are causing habitat and environmental damage. Irrigation is placing a great strain on the freshwater reserves in the wetland, and aerial spraying of pesticides is seriously affecting the health of the local population. These expanding land uses are exerting increasing private control over the use of the wetland and threatening traditional fishing and forest cropping systems. CECA is working with local community groups to prepare a natural resource strategy for the wetland.

Introduction

The Circulo de Estudios Cientificos Aplicados (CECA), an NGO established in 1978, has made strenuous efforts to make wetlands management a main target for local communities and NGOs, governments and the private sector in the Pacific coastal region of Panama. The 'Alexander Humboldt' field station near the Parita Bay coastline is an environmental education centre, sponsored initially by the Germany Embassy in Panama, and is the CECA headquarters.

CECA is a member of BirdLife International. It cooperated in l983–1985 in the development of an international wetlands inventory, preparing the 'database' for an international programme for the adequate management of wetlands and the conservation of birds with the International Waterfowl Research Bureau. This allowed the CECA to identify the Macanas as the most important wetland in the region for the conservation of local and migrant birds and important sources of water. The local El Rincón de Santa María community and others in the region use the wetland to obtain firewood, fruit and fish, and more recently as an ecotourism resource. El Rincón de Santa Maria was founded by the Spaniards in the 17th century to provide housing for slaves working on a farm run by the Catholic Church called 'Virgen del Carmen'. Since then the wetland has been used as a grassland for grazing thousand of cows, sheep, horses and pigs and as a source of water for crops such as corn, sugar cane and rice, and for horticulture.

In 1986 CECA, with the support of the local municipal authority of Santa Maria district in Herrera Province, achieved an important goal when the legislation was adopted establishing Macanas Reserve. Later, the national government designated the Macanas Reserve as a Multiple Use Area within the National Parks and Wildlife programme. The CECA promotes the Reserve in a list of Wetlands of International Importance. The Macanas lies in a corner of Parita Bay, a wide coastal-marine wetland where a half million migrant birds (Sandpiper, Herons) come from Canada and USA to forage in the winter season. Parita Bay is included in the Ramsar Convention as a potential future reserve.

Land use problems

A number of agricultural and other activities take place within the boundary of the waterfowl area (including other wetlands along the Parita Bay coastline) and these lead to problems.

Rice plantations

Rice is grown on an industrial scale, with 12,000 ha under rice in the basin of the Macanas wetland. The rice cultivation is controlled by a big national company which grows other crops in the region as well. The most critical issues relate to the pesticides used to control pests, insects, fungi, etc. Pesticides are applied from the air. But problems

occur when the wind transports some of the pesticide over long distances to areas of human habitation. People in Rincón de Santa Maria suffer bronchial, dermal, stomach and cerebral damage, as do agricultural workers and their families. The health ministry have evidence of the existence of pesticide residues in maternal milk, groundwater contamination and the mortality of thousands of birds year after year. A major constraint is the lower resistance of the varieties used in the rice plantations to local agricultural diseases. In Panama a local institute is working to produce new varieties of rice with adequate resistance to these diseases. The companies consider Integrated Pest Management (using biological and natural pesticides, organic control) very expensive and difficult to apply and consequently progress with introducing these techniques has been slow.

Expansion of the area of plantations means that fresh water has to be pumped from the wetland. Near Las Macanas over 15,000 hectares are under crops, fed by water from the Santa Maria river and the Macanas wetland. The irrigation system provides fresh water for five months of the year. During the El Niño effect in l996, water reserves fell by 80%. The felling of forest near the wetland is a critical factor encouraging the continuing expansion of agriculture in spite of the conservation proposal for the area.

Cattle ranching and horticulture

A group of small farmers who form the local cooperative 'Asentamientos campesinos' have 1,500 hectares of land. On 30% of this land they grow rice and horticultural crops (in summer) using similar technologies as the big companies. Another 2,500 hectares are held by private individuals for rice growing, cattle rearing and horticulture. The main risk lies in the proximity of these rice and horticulture plantations to the wetland. Fish kills and dead aquatic plants are reported each year, but the water in the wetland provides drinking water for livestock owned by the Asentamiento cooperative and private individuals. Their livestock are probably contaminated by the pesticides, but there is not a single report on this. The cost of carrying out the required analysis is very expensive for Panama.

Fishing and forest cropping

Fishing has been a natural activity since the Neolithic period. Scientific studies in the Santa Maria basin (the Cerro Mangote Cave) close to the Las Macanas lake have revealed that Neolithic hunters used the wetland as a fishing and hunting area. Many poor people come from the Azuero mountains (80 km to the west) each year to fish and hunt in the traditional way to obtain protein during the long dry season (from December to April). The most important fish in the wetland is named the 'Macana', a long fish similar to the Anguilla, and the wildfowl hunted include Whistling ducks, doves, parrots, rails and herons. There is a risk in consuming the meat of these animals because many of them feed on insects and worms in the rice plantations, where excessive amounts of lethal pesticides are applied.

The wetland is in a dry forest region typical of the dry and semi-dry regions in the tropics. The most important characteristic is the presence of spiny cassias common in dry areas. The forests on the margins of the wetland are used to obtain wood, resins, fruits, charcoal, forage material and wood for building houses. Existing control over forest extractive activities is inadequate.

Mariculture

Shrimp farming in ponds is a new commercial activity and takes up long stretches of wetland and coastal marshes. The construction of these ponds involves removing large quantities of mangroves and aquatic vegetation. The companies involved are exerting an increasingly 'private' control over local resources, restricting common rights and free access for everybody.

Municipal waste

Another problem is caused by the dumping of domestic waste on a site just a few metres from the wetland. CECA is now working with a local institute to promote recycling and closure of the site.

Natural resource use strategy

CECA is cooperating with local comities in El Rincón de Santa Maria and other coastal communities in Parita Bay to prepare a strategy for the use of the natural resources in the wetland. This will include the following proposals:

- Establish a 'buffer' zone along the edge of the wetland to permit reforestation with native species of trees and shrubs;
- Research into the recovery of ancient seeds of native corn, beans and rice to increase resistance;

- A broad public educational programme in the Parita Bay area to promote ecological principles from primary school on;
- A campaign with the women in El Rincon and the surrounding area to help prevent contamination of foods, clothes, maternal milk, etc.;
- Research to identify the potential importance of wildlife for economic activities such as fishing, management of crocodiles, ducks, freshwater turtles, etc.;
- An ecotourism project to develop facilities for visitors to the wetlands and expand the local economy;
- A project with the agriculture ministry, health authorities and universities to promote the use of biological pest control, adequate management of equipment and pesticides, safety of workers, etc.

In the Parita Bay coastal zone, including the Macanas, we have an opportunity to improve the alternatives needed to develop a sustainable agricultural model. The challenge is to use educational campaigns, training, research, wetland protection and all cooperative activities to demonstrate the viability of agriculture and conservation in wet ecosystems in the tropics. CECA is seeking help from the international scientific community in achieving this goal.

Acknowledgements

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Discussion Points from the Session – Wetlands

Linking across sectors

- "We have heard less about solutions than problems here. What partnerships among different actors can develop to assist institutions in addressing problems in the long term?"

  "Yes, cross-sector cooperation is essential but in Mekong Basin is driven by an international system as well as a local. There is no clear government policy and for this and advice and help is needed from many bodies. The governments have many other priorities, such as poverty alleviation, so long-term concerns are low priority."

- "Who does the water belong to? It should be the people. There has to be comanagement by people and the government. In South America we are working towards democratisation in terms of wetland management. With the new openness internationally, the people on the ground are the ones who have the greatest impact."

Future work

- "In Argentina we have developed protocols for monitoring pesticide impacts in agriculture. Such work needs to be applied in the field."
- "Although a multilateral agreement on the Mekong was signed in 1995 there are still many points that need addressing, especially maintaining dry season flow."

Role of Biodiversity in the Conservation and Future Sustenance of the Rice Field Agro-ecosystem

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Among the vast array of agricultural systems in the world, rice fields can be considered as agronomically-managed temporary wetlands. About 150 million hectares of land throughout the world are devoted to rice cultivation, 90% of which is in Asia. In Sri Lanka, rice is the predominant crop, in terms of both land use and dietary importance. Rice is cultivated on approximately 780,000 ha, or about 12% of the total land area, under irrigated, rain-fed, upland and tidal wetland conditions. Until the advent of modern rice cultivation practices, rice fields remained one of the most sustainable agro-ecosystems.

This presentation forms a part of a larger study on the ecology and biodiversity of rice fields, funded by the NSF Sri Lanka and supervised by several investigators.

Rice field biodiversity

In order to assess the biodiversity in a rice field, and its role in the conservation and sustenance of the rice agro-ecosystem, an ecological study was carried out in two irrigated rice fields at Bathalagoda in the Kurunegala district over five consecutive rice cultivation cycles.

The overall biodiversity documented during the study consisted of:

- 494 species of invertebrates, of which 82% were arthropods (see Figure 1);
- 103 species of vertebrates, of which most were visitors;
- 89 species of macrophytes, representing rice field weeds;
- 39 genera of microphytes.

The contribution of arthropod biodiversity towards natural biological control in the rice agro-ecosystem was evident from the ratio of rice pest species to natural enemy species, 1:3.5. Pest–predator relationships can be seen in Figure 3. Using terrestrial arthropods as a surrogate group, the study was able to document temporal and spatial variations in rice field biodiversity, in relation to the progress of each rice cultivation cycle and the agronomic practices carried out (see Figure 2).

Multifunctional role

The rich biodiversity associated with this unique man-made habitat clearly indicates that the rice field agro-ecosystem could be compatible with conservation objectives, and meets the requirements, interests and preferences of agro-ecologists and conservation biologists. The rich array of natural biological control organisms of rice pests, as well as the diverse soil benthos which enhance and maintain soil fertility, are important functional aspects which meet the preferences of agro-ecologists.

Rice fields are ecotones between land and water and provide an important feeding habitat for waterfowl and other wildlife. Therefore, conservation biologists can view rice fields as managed wetlands that sustain a rich biodiversity outside natural protected areas.

Furthermore, the rich photosynthetic aquatic biomass contributes to a high primary and secondary productivity in rice fields, enabling them to function as sources of nutrients for less productive, contiguous aquatic systems.

Management

The following are recommended as means of conserving and sustaining the rice field agro-ecosystem through its rich biodiversity.

- Maintenance of refuges for natural enemies (especially the embankments covered with weeds).
- Minimal use of pesticides.

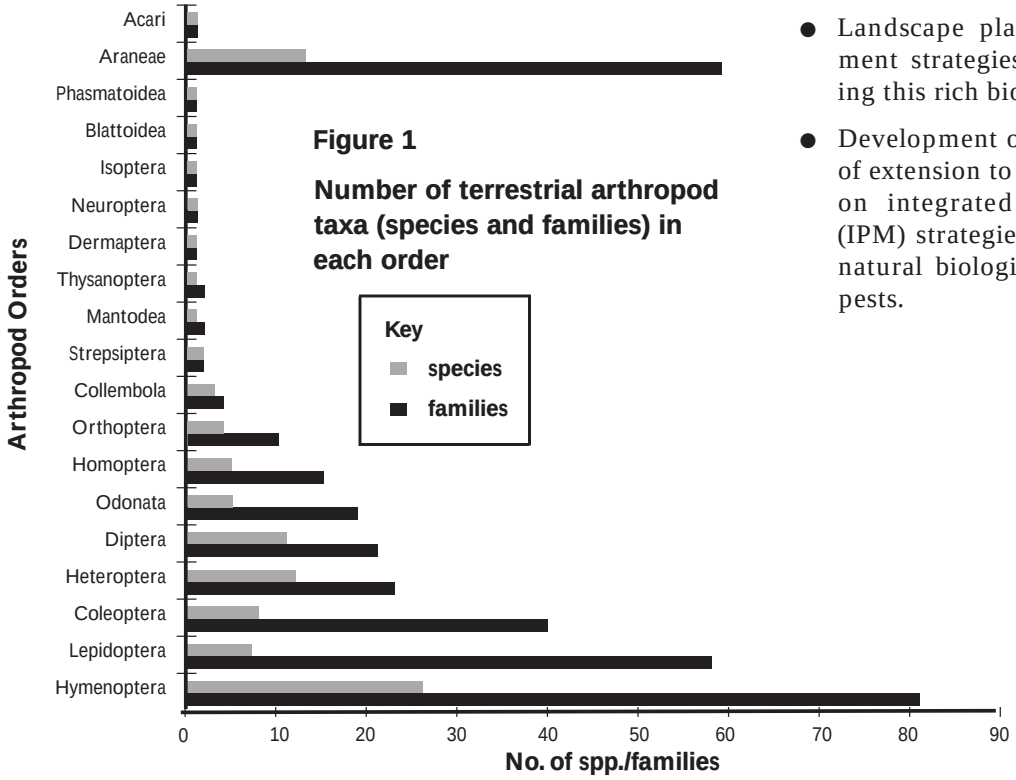

Figure 1

Number of terrestrial arthropod taxa (species and families) in each order

- Landscape planning and management strategies aimed at harbouring this rich biodiversity.
- Development of an efficient system of extension to educate rice farmers on integrated pest management (IPM) strategies, with emphasis on natural biological control of insect pests.

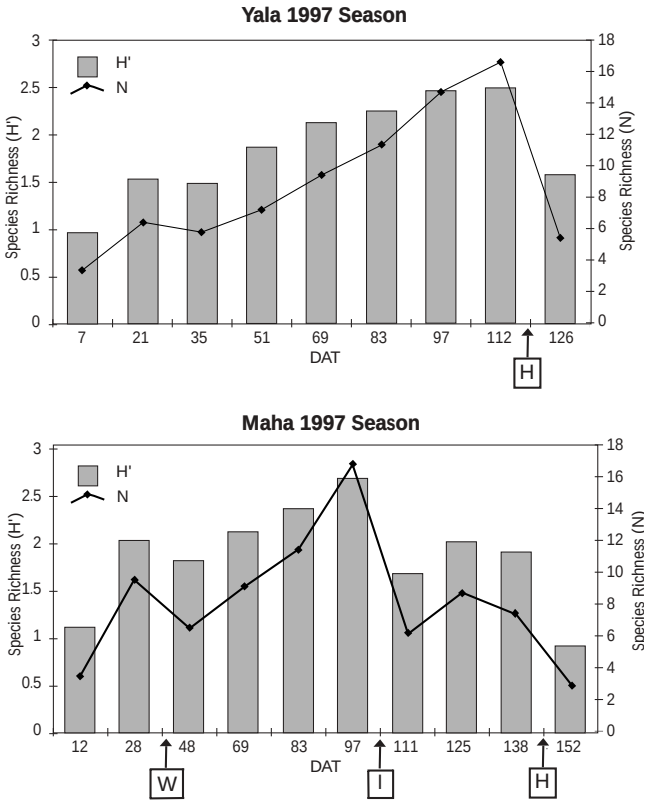

Figure 2

Temporal fluctuation pattern of arthropod species richness (N) and diversity (H') in the rice habitat, during the Yala 1997 and Maha 1997 seasons (Data-Blower-Vac sampling).

DAT - Days after transplanting; I - Insecticide application; W - Weedicide application; H - Crop harvest)

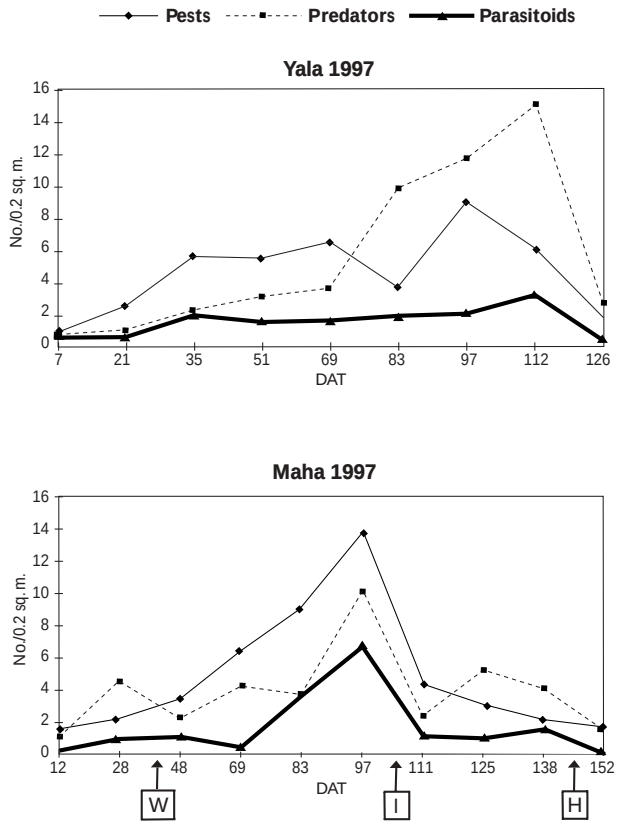

Figure 3

Temporal abundance patterns of pest phytophages, predators and parasitoids in the rice habitat, during the Yala and Maha seasons of 1997 (data - Blower-vac samples).

(DAT - Days after transplanting, W - Weedicide application, I - Insecticidae application, H - Crop harvest)

Dams in the Senegal Valley – a Case Study on Wetlands, Biodiversity and Local Communities

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While dams can provide socio-economic benefits for developing countries, it is very important that full consideration is given to ***all*** the consequences. Non-sustainable impacts on the environment will soon become new economic and social issues. The problems associated with dams throughout Africa are similar.

Introduction

Senegal has an area of 196,720 km^2 and a population of 10 million. It is bounded by Mauritania to the north, Mali to the east, Guinea and Guinea Bissau to the south and the Atlantic Ocean to the west.

In 1972 the OMVS (Organisation pour la Mise en Valeur du Fleuve Senegal) was created to manage the water system shared by Mali, Mauritania and Senegal. The first objective was to develop water management policies and projects. Two of these proposals were to dam the Bafin river at Manantali in Mali, 1,200 km upstream, and the Senegal River at Diama, 27 km upstream from Saint Louis, the main city of the northern province of Senegal.

The Diama dam, completed in 1985, was built to prevent salt water intrusion and to control the water levels in the main valley. Since then, it has changed the quality of the water considerably and caused much disturbance in the Djoudj National Park (a Ramsar and World Heritage site), its surroundings and villages and other landscapes throughout the region.

Ecological effects

Before the dams were built, the water was saline during the dry season and brackish during a certain period of the year (rainy season) when the water is more than 200 km inland from the ocean. Recently, there have been many changes in this area. Landowners have increased crop yields, mainly rice, by using high irrigation systems. Fishing and cattle herding are two of the main activities of the local communities. The introduction of modern agricultural methods has forced the population to make their own management provisions in the rice fields by building artificial canals, drains, small dams, etc. The modification of the area as a result of all of these constructions has caused real disturbance, affecting biodiversity and causing an explosive growth of aquatic plant species (in particular the free floating species *Pistia stratoites*, *Salvinia molesta* and other important vegetation like *Typha australis*, *Phragmites australis*, etc.).

Problems

The human impacts are very important because agriculture is practised everywhere and there are no pastures. Some species of fish have been lost and fish populations are declining in some areas.

Rice is the main crop grown in the region, but farmers face high competition from rice from abroad (Taiwan, Thailand, China, etc.) and the market for the local product is shrinking.

Floating aquatic plants occur on a large scale in some places and their numbers have grown to nuisance proportions. The plants disturb or alter the environment by:

Reducing the dissolved oxygen content in the water, resulting in reduction in water quality – symptoms being taints and odours;

Altering the fauna of aquatic ecosystems through the creation of new habitats, and the decline of some existing habitats caused by changes in the amount of light penetrating the water.

Solutions

Much effort has gone into the awareness programme for the local communities to help them shift towards sustainable development instead of high production for no clear market. People living around the main areas such as the national park have been very well organised by the park managers to help increase income through the village banks, ecotourism and cottage industries. The five year management plan is one of the key elements to help achieve good results.

Mechanical methods of controlling invasive species and scientific methods have been applied in many places to stop or reduce danger and threats in the Senegal valley.

Conclusion

Although dams are surely needed in Africa for development, the drawbacks are considerable. Where dams are built, scientists, decision-makers for protected areas and all stakeholders will have to adapt management plans to the realities in the field to achieve their conservation goals and to reduce poverty, which is always present – even where agricultural land is plentiful.

CHAPTER 3

FARMING IN TEMPERATE ZONES

Biodiversity and the Effects of the EU Common Agriculture Policy

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Abstract

Just over 50% of the land area of the European Union is farmed. The EU provides support to farmers through a range of different mechanisms according to the commodity in question. Much of the biodiversity-rich land of the EU depends on low intensity farming, but there has been a rapid progression in the more accessible areas towards intensification, coupled with abandonment in more remote areas. Price support mechanisms have exacerbated intensification in accessible areas and prevented abandonment in remote areas, thereby damaging biodiversity in some areas and maintaining it in others. Recent reforms of the price support mechanisms have signalled a shift in support to sustainable rural development and the introduction of specific environmental measures. WWF targets its work at further reform of the price support mechanisms, as well as pursuing market-driven approaches to reducing the environmental impact of agriculture.

Introduction

The Treaty of Rome (1957) set out the main elements of a common agricultural policy which aimed to increase agricultural productivity, secure Europe's food supplies and ensure a fair standard of living for Europe's farmers. The main approach adopted by the EU to achieve these aims is production support, which is applied using a variety of mechanisms according to the specific commodity sector.

Half of the territory of the European Union is farmed. Since 1945 agriculture in Europe has become more polarised as accessible areas are farmed with greater capital intensity while remote areas tend to be abandoned. There has been a decline in farming employment by 10% – 2 million people – in the last 20 years, and a gradual loss of agricultural land to built development.

About 40% of EU farmland is farmed at low intensity (Brouwer and Lowe 2000) and this land can be highly significant for nature conservation (Beaufoy et al. 1994). This general pattern of change, which is reflected at all scales from local to European, results in changes within farming systems that lead to a loss of conservation value. The abandonment of remote areas in Europe that have been farmed at low intensity for centuries leads to changes that can seriously affect the plant and animal communities living there. In accessible areas, intensification leads to similar losses of communities. In parallel, social and cultural diversity in these areas can decline and be lost.

Changes in agriculture in Europe and the role of the Common Agriculture Policy (CAP)

Brouwer and Lowe (1988) identify three main areas of concern about the direct effects of the CAP on the environment: the level and efficiency of input use; farm size and structure; and maintenance and encouragement of farming in remote areas. The continuing changes in agriculture in Europe, both positive and negative, are dependent on the form of the CAP.

The Common Agriculture Policy and its significance for nature conservation

The CAP provides direct grants for capital improvement of farms and direct financial support for production. It has accelerated intensification in accessible areas and held back the abandonment of land in remote areas. It has, therefore, played a significant role in both maintaining farmland biodiversity in remote areas and damaging it in accessible areas.

Examples of areas where nature conservation value is high and depends on continuing low intensity farming include:

- Low intensity livestock areas in France, including 1.25 million hectares of Internationally Important Bird Areas (IBAs), playing host to 50% of Europe's population of Hen harrier (*Circus cyaneus*) and 30% of Europe's population of Montagu's harrier (*Circus pygargus*);
- Traditional upland pastures in Portugal, which are key habitats for the wolf and lynx
- 9.5 million hectares of IBA in Spain, including the world famous species-rich grasslands (*dehesas*), the Cantabrian / Pyrenean mountains, Mediterranean mountains, wooded Mediterranean plains, and steppe, providing homes for large carnivores such as the bear and lynx
- 500,000 hectares of traditionally managed grasslands in Hungary, including 200,000 hectares of *tanyas* – small mixed farms, providing habitat for the White fronted goose (*Anser erythropus*), Lesser mole rat (*Micropalax eucodon*), Tawny pipit (*Anthus campestris*), and the rare Ursini's viper (V*ipera ursini rakosiensis*) (Baldock et al. 1996)

The significance of the CAP in maintaining areas of high nature conservation value is great. Around 98% of low intensity farming systems are within Less Favoured Areas (LFAs) designed to prevent abandonment. The value of LFAs in maintaining the nature conservation resource is reinforced by a study that shows that the coincidence of LFAs with areas of high nature conservation value is very high (Dax and Hellegers 2000).

The external costs of agriculture to the environment

The full costs of agriculture in both accessible and remote areas are not paid for directly by those buying the products of farming: the costs are not internalised. The downstream effects of pesticides, herbicides and fertilisers on water quality, loss of natural flood storage, unsustainable abstraction of water for irrigation, and loss of biodiversity-rich habitats incur costs that are either paid for through taxation, paid to water providers for increased water treatment costs, or cause disadvantage to parts of society that cannot choose or pay to avoid them. Conversely, those practising agriculture that is beneficial to society are not consistently rewarded: the benefits are not internalised. This decoupling of society from the benefits that an ecologically functioning landscape can provide has been exacerbated by the market support afforded by the CAP.

In the United Kingdom alone, the external costs of agriculture are high. Pretty et al. (2000) provide the following estimates of costs which, they state, are at best conservative:

Contamination of drinking water:	
Pesticides:	USD 156m / year
Nitrates:	USD 21m / year
Phosphate / soil:	USD 72m / year
Damage to wildlife:	USD 163m / year
Gas emissions:	USD 1,500m / year
Soil erosion and carbon loss:	USD 138m / year
Food poisoning / BSE:	USD 1,008m / year
Total:	**USD 3,045m/year**

Recent developments in the CAP

- Pre-1992: Price support with initial supply control and environmental measures

Up to 1992, price support was maintained in the form of direct payments for products. Initial supply control measures were introduced, e.g. milk quotas, and state-initiated environmental measures were allowed under Article 19 (special national schemes to subsidise farming practices favourable to the environment).

In the UK, Article 19 measures included the Environmentally Sensitive Area schemes, where farmers could choose to participate and receive payments per hectare on a sliding scale, according to their agreement to implement schemes of management. Base rates are payable for the 'do nothing' option, but guaranteeing that no damage will be done, with higher rates available for enhancement of the land for the environment. There were also options to receive one-off payments to carry out capital works, such as fencing, scrub clearance and access creation. The success of these schemes was, and still is, varied, usually

depending on local characteristics and, in some cases, local personnel.

- 1992–1999: Shifting the support to direct payments for production, together with specific environmental, forestry and early retirement schemes.

A limited reform of the CAP took place in 1992, led by the then agriculture commissioner, Ray MacSharry. The reform acknowledged environmental protection as an objective for the CAP for the first time and started to address the internalisation of costs and benefits described above. The main element of these reforms was a shift to direct support payments for crop and animal production. This change made the extent of support more visible and the recipient more accountable, allowing the possibility that the support might be made conditional on prescribed actions in the future.

The reforms also included, under Regulation 2078/92, specific measures to promote environmentally beneficial farming, including the reduction of agro-chemical inputs, assistance with organic farming, facilitation of shifts to extensive forms of crop production or grassland management, and direct payments to farmers for external benefits in the form of wildlife habitat conservation and management. Regulation 2078/92 built on initiatives started in the late 1980s that included the establishment of Environmentally Sensitive Areas, and made the introduction of such schemes mandatory across the European Union. Some member states introduced new schemes in response, while others adapted or simply maintained existing schemes. Forestry and early retirement schemes were included for the first time, and some steps were taken in some member states to integrate other EU environmental policy, including the Habitats and Nitrates Directives.

- 1999 reform of the CAP: Some mandatory conditions placed on farmers, and options made available for regulation, introduction of agri-environment schemes, and withholding direct payments

In 1994 and 1999 limited reforms introduced the option for European Union states to penalise farmers for carrying out damaging activities by withholding CAP financial support. Member states are required to ensure that application of the market regimes are not ecologically damaging, and they are offered the choice of regulation, agri-environment schemes and withholding of direct payments to achieve this. The last of these is known as cross-compliance. The debate about cross-compliance has been taking place for many years, and its implementation is the subject of much discussion among EU member states and NGOs. A useful review of the options for cross compliance is presented in Dwyer et al. (2000). There has as yet been very little action by European Union states to implement these measures.

An option was also introduced to allow EU member states to 'modulate' direct support payments to fund rural development (including agri-environment schemes and organic farming). This option allows member states to cap payments to farmers within overall limits set by the European Commission. It is up to member states to establish appropriate schemes within their own territories. Member states can either hold back a fixed proportion of direct payments from all farmers, or they can construct a sliding scale, withholding proportionally more from farmers who receive larger direct payments. Member states must identify within their rural development plans or Objective 1 plans where these modulated funds are to be spent.

The role of environmental organisations

Reform of the CAP

Reform of the CAP, and by implication other price support mechanisms, can bring significant social, environmental and economic benefits. Sustainable agriculture can be defined as 'agricultural technologies and practices that maximise the productivity of the land while seeking to minimise damage both to valued natural assets (soils, water, air, and biodiversity) and to human health (farmers and other rural people, and consumers' (Pretty 1995). The best use of renewable resources is a key part of sustainable agriculture, and the integration of 'free' processes such as nutrient cycling, nitrogen fixation, soil regeneration and natural pest predators plays an important role in making agriculture less environmentally damaging.

Practical examples of sustainable agriculture are now being developed worldwide. The role that business plays in developing sustainable agriculture is demonstrated by the way in which Unilever is piloting schemes for five major crops, with the aim of ensuring long-term supply of their raw materials. This shows that the corporate sector is starting to see sustainability as not only good for the environment, but good for business (Unilever undated). Such agriculture can be achieved through a combination of positive promotion of

sustainable activities, e.g. rural development support from the CAP, taxation or penalisation for environmentally damaging activities, and voluntary initiatives related to consumers. The continued reform of the CAP can bring significant social, environmental and economic benefits by making the true costs of intensive agriculture more apparent, and supporting farmers who deliver those benefits.

WWF's public policy priority in the EU: further reform of the CAP

The CAP will continue to be important for both the economies and the environment in the current and future EU ('accession') countries. Particularly important for WWF are the commodity regimes and rural development measures that apply in southern Europe, including the dry regions of southern Spain and Portugal and the Pyrenean mountains, the mountain systems of the Alps and the Carpathians, and in the states bordering the River Danube and its delta. These areas have been identified by WWF as some of the most valuable for nature around the globe. They are part of WWF's 'Global 200' ecoregions – large areas with consistent characteristics and high value for biodiversity.

WWF is allocating resources to campaign for reform of the CAP. WWF's priority is to be positive and build a constituency of support for sustainable rural development as a replacement for agricultural production support. A major initiative in this campaign is a project called 'The Nature of Rural Development'. Seven EU, three 'accession', and one non-EU country will work together to find good examples of sustainable rural development, build new policies together, and lobby for change during the key period of 2002–2004, preparing the ground for the new CAP regime which starts in 2006 / 2007.

Certification: organic products and FSC timber as examples of non-public policy initiatives

We recognise that agricultural support mechanisms, such as a reformed CAP, cannot deliver sustainable agriculture on their own. Therefore WWF is also directing resources to the development and promotion of food products that have at least a reduced negative impact on the environment, and preferably a positive impact. WWF believes that such work has an important part to play in delivering sustainable agriculture. The forestry sector has achieved notable success with the Forest Stewardship Council in reducing the environmental impact of forestry. The organic movement has succeeded in achieving the adoption of pesticide- and herbicide-free agriculture, and global sales of both these sets of certified products are rising.

WTO agreements

The importance of WTO settlements is relevant here, as they must not prevent states from supporting sustainable development, taxing or penalising damaging activities, and encouraging voluntary initiatives. A key task for environmental organisations should be to ensure that WTO settlements do not promote further polarisation of agriculture and prevent the internalisation of costs and the externalisation of benefits. Much of the biodiversity of extensively farmed areas in Europe is maintained by direct support to farmers though financial mechanisms. Without this support many extensively farmed areas would be abandoned, and there would be a consequent loss of both biodiversity values as well as social and cultural values. A WTO settlement that prevents states from providing support to farmers at appropriate levels would therefore be very damaging for biodiversity.

The way forward

WWF believes that working with business partners to address sustainable agriculture through accreditation is a critical activity for the NGO sector. In this way a wider range of environmental concerns associated with food production would be addressed, and substantial substantial benefits would arise for both people and nature. WWF therefore supports the engagement of IUCN with the organic movement through the Vignola declaration, and urges active support for agricultural certification as a means of promoting sustainable agriculture and rural development. This will benefit of people and nature.

In order to ensure success in development of certification there is a clear need to involve business partners, NGOs, IFOAM and governments. Certification must address not only pesticides and herbicides, but also water consumption, energy use, land redeployment and agricultural biodiversity.

WWF supports IUCN 2nd World Conservation Congress (Amman 2000) resolution CGR.PRG039, but urges inclusion of 'other environmental issues

such as water consumption and energy use' in clause (b) and 'NGOs and governments' in clause (c).

References

Baldock D., Beaufoy G., Brouwer F., Godeschalk F. 1996. Farming at the margins: abandonment or redeployment of agricultural land in Europe. Institute for European Environmental Policy, London and the Netherlands; Agricultural Research Centre, The Hague.

Beaufoy G., Baldock D., Clark J. 1994. The nature of farming: low intensity farming systems in nine European countries. London: IEEP / WWF.

Brouwer F., Lowe P. 2000. CAP and the environment: policy development and the state of research. In: Brouwer, F., P. Lowe, editors. 2000. *CAP regimes and the European countryside*. *Oxford*: CABI Publishing.

Brouwer F., Lowe P. 1998. CAP reform and the environment. In: Brouwer, F., Lowe P., editors. *CAP and the rural environment in transition: a panorama of national perspectives*. Wageningen: Wageningen Pers.

Dax T., Hellegers P. 2000. Policies for Less Favoured Areas In: Brouwer F., Lowe P., editors. 2000. *CAP regimes and the European countryside*. Oxford: CABI Publishing.

Dwyer J., Baldock D., Einschütz S. 2000. Cross compliance under the Common Agricultural Policy. London: IEEP.

Pretty J.N. 1995. *Regenerating agriculture: policies and practice for sustainability and self-reliance*. London: Earthscan.

Pretty J.N., Brett C., Gee D., Hine R.E., Mason C.F., Morrison J.I.L., Raven H., Rayment M.D., van der Bijl G. 2000. An assessment of the total external costs of UK agriculture. *Agricultural Systems* 65: 113–136.

Unilever (undated). Growing for the Future. Rotterdam: Unilever.

Agricultural Policy and Conservation in the United States

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Abstract

In the USA there are a number of agencies involved in environmental conservation and management, but there is little coordination between programmes. The USDA employs a range of policy tools to encourage or compel the adoption of conservation measures. Most of its schemes are voluntary, making uptake patchy across the country and dependent on support from farmers. There is a recognition that conservation programmes are underfunded. Expected and proposed changes in agricultural policy and conservation are listed.

Introduction

In the United States of America a number of agencies are involved in conservation issues and management:

- Department of the Interior, with a primary focus on national parks, fisheries and wildlife;
- Environmental Protection Agency, with a primary focus on science, hazardous substances and environmental programmes;
- Corps of Engineers, with a primary focus on waterway management and restoration (this agency carries out construction works, such as dams);
- Department of Agriculture, with a primary focus on agriculture.

Many of the conservation and management programmes operated by these agencies affect agriculture and vice versa. But how well do these agencies communicate and work with each other? Apparently, not very well; in fact, the programmes often conflict with each other. It is also worth noting that states, native American tribes and local governments can enact their own agriculture and conservation laws and they also work with agriculture and conservation policy and programmes. This adds to the complexity of conservation programmes.

Short background on USDA agriculture policy and conservation

Although the US Department of Agriculture (USDA) deals primarily with agriculture, it has a range of policy tools available to encourage or compel adoption of conservation and environmental practices. These instruments have evolved and expanded over the years. Present programmes relating to conservation and include the following:

- *Conservation Compliance Programs* e.g. Highly Erodible Land Conservation Compliance and Wetlands Conservation;
- *Subsidies for Conservation Investment and Public Works* e.g. Small Watershed Program;
- *Education, Data and Research Programmes* e.g. Pesticide Record Keeping;
- *Cost Sharing and Technical Assistance Programs* e.g. Environmental Quality Incentives Program, Wildlife Habitat Incentive Program, Conservation Technical Assistance, Forestry Incentive Program and Conservation of Private Grazing Lands Initiative.

In some of these conservation programmes the USDA has historically focused on policy instruments intended to benefit natural resources and the environment affected by agriculture. The emphasis on different policy tools or instruments in the USDA's programmes has also shifted over time and is often associated with commodity policy and the overall health of the agricultural economy.

There are both voluntary and compulsory USDA conservation programmes. Most of the programmes are voluntary and incentive based. An example of incentive-based programmes is the Conservation Farm Option (CFO), a pilot programme directed at wheat, feed grains, cotton and rice producers. The programme purposes are:

- conservation of soil, water and related resources;
- water quality protection and improvement;
- wetland restoration, protection and creation;
- wildlife habitat development and protection.

To be eligible the farmer must have contract acreage in Agricultural Market. Transition Act Program and must develop and implement a conservation farm plan. This plan becomes part of 10-year CFO contract. The incentive is annual payments for implementing the plan, provided the farmer agrees to forego payments under other incentive plans in exchange for consolidated payments.

What does the future hold for agriculture policy and conservation in the US?

With reference to what might be coming in terms of agriculture policy and conservation, three possibilities are outlined below.

- The former agriculture secretary, Dan Glickman, recognises that the conservation programmes are underfunded. He also believes that technological development and rising mobility in the US has helped to divorce the average American from a deep attachment to or connection with the land, and that it is time to 'revisit our conservation commitment'.
- Prior to the elections, former Vice-President Gore announced that the Administration would be seeking approximately USD 1.3 billion in the 2001 budget for conservation programmes that help family farmers take steps to protect water quality and the environment, as well as preserve farmland.
- Bob Stallman, president of the American Farm Bureau, highlighted that one of the ideas being proposed informally 'is to pay family farmers for extraordinary land, air and water conservation efforts'. Such farmers would be rewarded for going beyond existing standards, and it was suggested that farmers be offered added incentives to create extra wide buffer strips to benefit wildlife and further improve water quality.

Proposed further changes

- Analysis of, or programme focus on, reducing the impact of the use of agri-chemicals and industrial farming practices in relationship to wildlife, forests, water and soils / erosion.
- Analysis of the impacts on the environment and conservation of the decrease in the number of farmers and increase in farm size, and of the farming techniques necessary to support such large operations.
- Analysis of, programme focus on or discussion about the impact of genetic engineering on agriculture and biodiversity.
- Increased dialogue between agencies and programmes.
- Support for or sponsorship of environmental farming practices that have emerged during the last few decades, e.g. organic farming.

Conclusions

The USDA has a myriad of conservation-oriented programmes. However, there seems to be a lack of cohesive or overarching policy for agriculture, the environment and conservation.

The voluntary nature of most of the programmes makes them patchy across the country and dependent on individual farmers perceiving the benefits of any given programme and signing up. Moreover, most of the conservation programmes are for a fixed period only; once the incentive stops, the conservation practice may stop too.

Finally, the farm crisis in the US may present an opportunity to marry good farming practices with good conservation practices. Family farmers are looking for alternatives to conventional agriculture to ensure their survival.

Informative websites

International Federation of Organic Agriculture Movements (IFOAM): www.IFOAM.org

USDA Agricultural Resources and Environmental Indicators:

www.ers.usda.gov / briefing / arei / newarei / AREI6_1consoverview.pdf
www.ers.usda.gov / briefing / arei / newarei /

USDA Natural Resources Conservation Service
www.ers.nhq.nrcs.usda.gov

USDA Announcements and speeches
www.usda.gov / news / releases / 1999 / 12 / 0479
www.usda.gov / news / speeches / wh01

The Opportunities for Sustainable Agriculture in CIS: Balancing on the wire

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Abstract

After a period of dramatic decline following the fall of the Soviet Union, agriculture in the CIS is at a crossroads. If a new, sustainable agricultural sector is to be created, regional strategies are needed that take into account the complexity and diversity of each sub-region. They should be based on environmentally-friendly but economically-profitable farming. This will require a combination of market incentives and state-supported strategies. Economic efficiency is to be achieved by alleviating resource degradation and reducing environmental and social risks.

Introduction

The purpose of this paper is to draw attention to the exceptional situation in the agricultural sector of the countries of the former Soviet Union (Commonwealth of Independent States, CIS). It was important for the authors to establish a framework for the socio-ecological vision of development. The countries of the region have many obviously common problems as well as historical connections. At the same time, the diversity of the region is striking, even within one country. For this reason we have tried not to go into too much detail and present a more general overview.

Possible agricultural futures in the CIS

With the decline of the Soviet Union the agricultural sector deteriorated dramatically. Agriculture in the CIS is at a crossroads and can develop in different ways depending on state policies and available resources. Possible options are:

- Development of the agricultural market with a view to obtaining a quick profit, strong vertical integration in the world economy, development of monocultures and exhaustion of agricultural resources;
- Development of sustainable agriculture;
- Final decline and fall and replacement by imports.

Definitions are crucial as far as they drive goal-oriented policy making. As might be expected, there are many approaches to the definition of sustainability in the sector. Apart from the obvious misunderstanding of sustainability as sustainability of growth, we also reject the view that it means sustainable yields. An environmental view of sustainability should go beyond economic goals. ***Sustainable agriculture*** is perceived as a form of development that sustains the general usefulness of a landscape during the life of successive generations and allows the maintenance of a balance between natural, human and technological capital in the course of development. ***General usefulness*** in turn is a multi-factor criterion, which includes economic, social and ecological benefits from living in and using a landscape.

The shift towards sustainable agriculture requires the elaboration of regional strategies which take into account the complexity and diversity of each sub-region. Economic, environmental and social complexity should be taken into account.

Characteristics of the transitional period

The sustainability of the agro-industrial sector in the CIS is a cause for growing concern. In the post-Soviet period the market economy was set up mainly by political declarations, combined with a drastic decrease – and in some regions a complete suspension – of investments in the agro-industrial sector. That resulted in a deep economic breakdown, aggravated by the collapse of social policy. Despite many differences, the region displays the following common features:

- The current changes in the agricultural sector are part of the transition from the state economy to a market economy and from centralised to decentralised planning. However, not all the countries are planning to give up their state-dominated agricultural systems;
- State-owned agricultural lands are being privatised. The process is slow and sometimes hidden – in most countries arable land may not officially be sold;
- The food processing and supply industries are highly monopolised (inherited from the Soviet state);
- There is inadequate enforcement of environmental legislation;
- There is a lack of commercial credits and leasing and the sector is subsidised by the state;
- Sharp structural changes followed the disintegration, with a retreat from regional specialisation;
- There is a mixture of large estates (former state and collective farms), small- and medium-sized farms and small private plots.

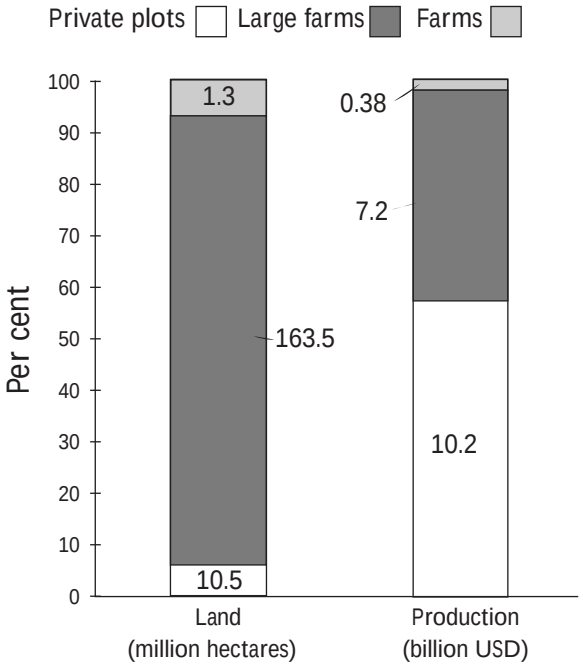
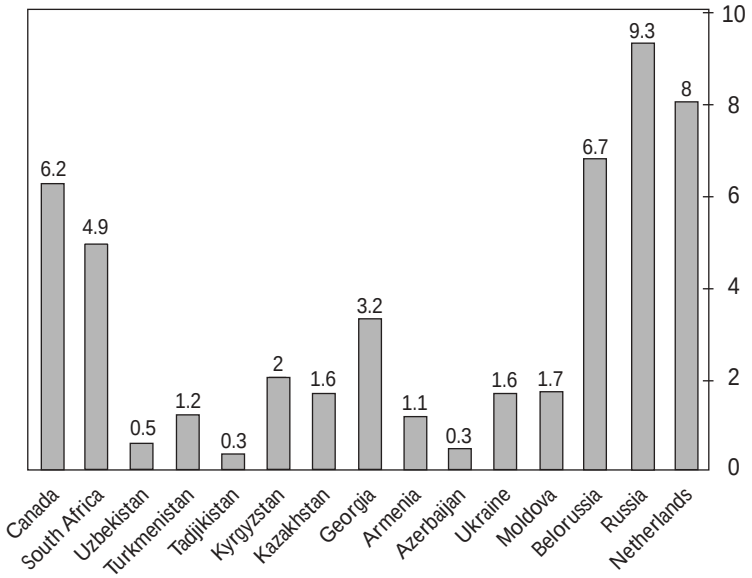


Figure 1

Farm size and productivity in the CIS countries

Figure 2

Alcohol consumption (litres per capita)



In general the productivity of the sector is poor compared with western countries. Productivity is better on the small plots (Figure 1) due to the short productive cycles and 'free labour': the owner works for himself and his family. Small private plots do not contribute much to the market, though. They are not united and do not tend to cooperate in marketing produce. According to official estimates, farmers are not active market participants, but this may be because they tend to sell their produce on the black market, about which there is little information.

In other ways, the countries and sub-regions are more diverse, and regional specificity may be determined by a combination of the available social, financial and environmental capital. Some features are of primary importance when sustainable development of the sector is under consideration:

- Alcohol use among a significant part of the population in rural areas is the main obstacle to innovation (Figure 2 – in this and subsequent figures Canada, South Africa and the Netherlands are included for comparative purposes). The pattern of alcohol consumption differs significantly through the region, but where it exists it contributes much to the further exclusion and deteriorating health of the population and decline in the economy.
- A decrease in the quality of life and social and economic instability have also resulted in a decline in the health of the population. Life

expectancy in the majority of the countries of the CIS is now about 65 years, and falling further in rural populations.

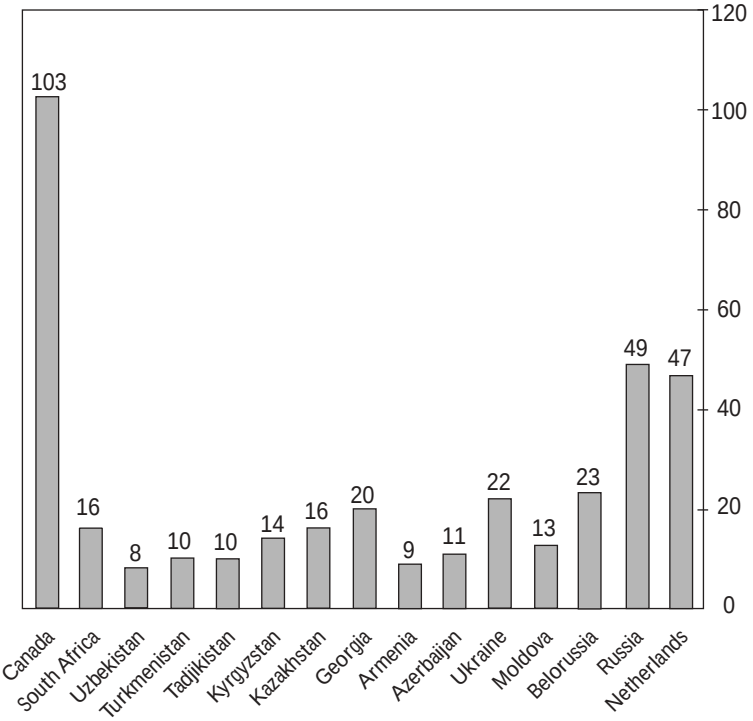
- Rural populations tend to be isolated from the wider community and have restricted access to information. Public transport services and telephone connections are well below national averages. In general, communications are much poorer than in Western European countries.

These features make the rural population an unlikely agent of change. The history of the countryside and its current position do not encourage development and leave the people few opportunities. Most observers agree that the rural populations are passive and take a short-term view because simply maintaining a livelihood requires a great effort. On the other hand, there are some features which hold potential and will help shape future development:

- The level of education and the scientific and educational potential of the population is varied, but mostly average to high (Figure 3);
- High levels of agricultural mechanisation, mostly within the large farms (Figure 4).

Figure 3

Educational potential of the CIS countries: graduates per 10,000 of population



Environmental responsibility and sustainable agriculture

The region still possesses a huge natural capacity, but the resource-oriented and extensive agricultural policy has brought the environment to a dangerous state. The most severe problems facing regions rich in arable lands are:

- A drop in soil fertility to a critical level, endangering long-term prospects
- Degradation of the steppes due to ploughing, salinisation of soils resulting from intensive agricultural practices, soil pollution
- Exclusion of arable and other productive land from agriculture by environmental disasters and (to a lesser degree) urban sprawl. The largest degradation zones are the area of radioactive contamination around Chernobyl, the Aral and Kaspiy regions, and the deserts of Southern and Middle Ural. Environmental disasters affect the most populated and productive areas.

Extensive agricultural development, coupled with the policy of 'conquering nature', has made agriculture (excluding forestry) a major land and water user. When the economic system crashed, it became evident that in many parts of the region ecosystems are no longer self-sustaining. Many species have become parts of agro-ecosystems and many crucial biotopes are dependent on human activities. Examples include sturgeon and salmon, which cannot reproduce naturally, and migrating birds such as geese that rely on agricultural meadows to feed.

In the face of growing economic instability people tend to rely more on agricultural activities or other ways of exploiting nature to feed themselves. The risk of an environmental catastrophe resulting from overuse of the agricultural landscapes depends directly on the number of people living in the countryside and their well-being. In the regions where a high percentage of the population rely on natural resources to sustain their (worsening) livelihoods, routine agricultural activities may be expected to present a risk of causing environmental disasters, while in other areas technological crises might be the largest source of risk.

Strategies for achieving sustainable agriculture

The CIS countries on average use much less aggressive agrarian technologies than countries with a developed agricultural sector. Nevertheless, in most of the territory of the CIS production per capita of basic products remains rather high. Crop and meat production is not a problem at a national level in most CIS countries; the spectre of food insecurity arises mainly from the redistribution of production capacity. Despite this, the existing mode of agricultural development cannot be considered sustainable. The price of extensive land use is too high, both in socio-economic and, in a number of cases, in ecological terms.

The situation has to be changed, with due consideration to positive and negative experiences of land use in different countries. Neither the market-oriented goal of 'raising productivity' nor the closed-society goal of 'achieving national food security' should receive the highest priority under the concept of sustainable agriculture. Sustainable agriculture strategies aim to maximise the overall usefulness of the landscape for the community and maximise the conservation of biodiversity. Agrarian market development, in essence, should be based on environmentally-friendly and, at the same time, economically-profitable farming. This mode of development needs a proper combination of market incentives and state-supported strategies.

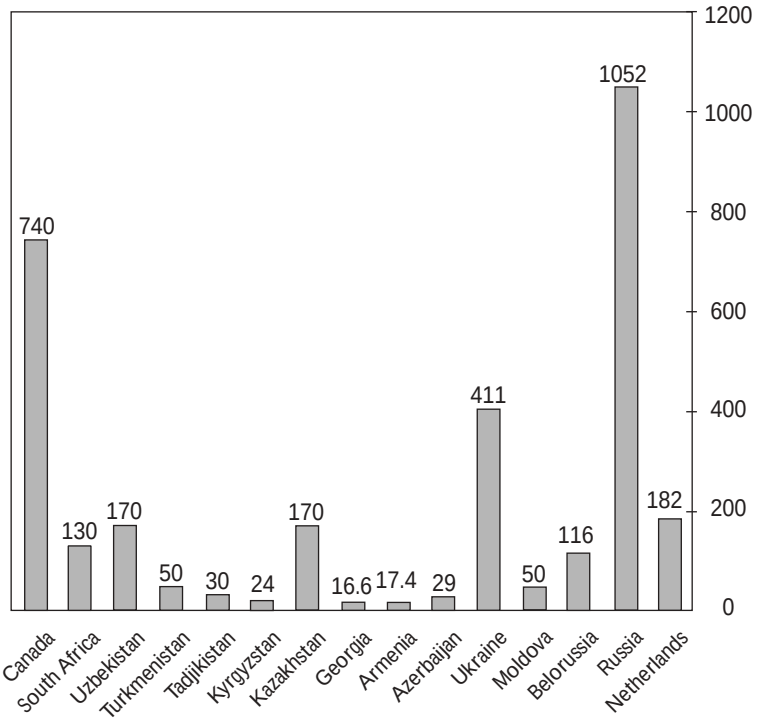
The attraction of this type of development to investors and shareholders of agricultural enterprises would be a decrease in economic risks through environmental and social planning. Environmental risks now comprise a significant part of the general instability that deters investors from entering the sector. Significant support to shift the development mode and reduce risks for both investors and communities might be provided through the preparation of regional development strategies. Management of development is the key to the implementation of sustainability. The ultimate aim is to make the strategy correspond to the resources of the territory. Sustainability cannot be achieved if the territory is too dependent on external factors for its development, whether these are markets or knowledge.

The strategies could be divided into two categories: 'simple' and 'complex'. 'Simple' strategies would be based on restructuring the activities of existing small private farms and households that do not need large arable fields, such as vegetable and small livestock units. These farms do not need large investments, are economically sustainable and produce a large share of total national yield. Their development into intensive small-scale enterprises and their orientation towards local markets will increase their competitiveness and cost-effectiveness. This mode of development does not depend on external scientific knowledge or large investments, an important consideration in regions with low human capital or where biological productivity cannot be increased significantly without environmental damage. 'Complex' strategies would be based on using technological and managerial innovations. Such strategies should reflect the complexity of the landscape and the community. The main features of any complex strategy are:

- Adaptive land use, new agricultural technologies;

Figure 4

Agricultural mechanisation in the CIS countries: Tractors (in thousands)



- Monitoring of environmental and social dynamics;
- Modern organisational structures, financial instruments.

It is evident that this kind of strategy needs both economic investments and growth in local human capital. The investments could be repaid by higher production or by the combined use of the landscape for agricultural and recreational purposes.

Sustainable strategies should enhance and support processes that are relevant for the given landscape. Economic efficiency is to be achieved by alleviating resource degradation, thus reducing environmental and social risks. The current situation presents good opportunities to make a reasonable choice for future development. Environmentalists should take the opportunity to prevent the unsustainable development of one of the most environmentally significant regions of the world.

Acknowledgements

We express our sincere gratitude to our colleagues from the Cohort 8 Leadership for Environment and Development programme in the CIS who shared the data and visions, collected facts, provided contacts within their countries and helped to polish the presentation. The work could not be completed without advice and technical assistance from the Moscow IUCN office staff.

Discussion Points from the Session – Temperate Zones

The next steps in agricultural policy reform

- "Frameworks that support agriculture and deforestation and fail to protect nature have been analysed. Agriculture is the most important challenge for the environment and particularly for conservation in Brazil. Agricultural reform in Brazil actually penalises those who keep forest on land."
- "In the EU we have a comprehensive strategy to implement the Convention on Biological Diversity (CBD) within the CAP, such as reducing pollution and optimising biodiversity benefits. But first, what are biodiversity indicators? Hopefully the EC will soon adopt action plans to integrate biodiversity into agriculture. We know there are some negative impacts of CAP on biodiversity. We want to work together to provide real integration of concerns."
- "In general there is a great need to look at the experiences of countries on agricultural policy and their drawbacks in relation to the environment."
- "Agriculture in relation to polices in and around protected areas must be addressed. Agriculture development projects around protected areas are often small and badly implemented, resolving problems for a small minority. Families living on the outskirts of protected areas, and within, need agriculture for survival."

Biodiversity of *Medicago sp. pl. – Rhizobium meliloti* Symbiosis in Temperate Mediterranean Zones (Sardinia, Italy)

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Introduction

This presentation summarises the first results of the laboratory isolation of *Medicago-Rhizobium* germplasm collected in Sardinia in 1998/99 and the first description of microbial strains, analysis of soil samples and determination of *Medicago* species.

Medicago L. comprises a large number of species, annual herbs, herbaceous perennials and shrubs, many of which are markedly polymorphic. Recently, Small and Jomphe (1) have divided the genus into 12 sections and eight subsections composed of 85 species and 18 infraspecific taxa.

Many species of the genus ('medics') have significant and wide-ranging agricultural applications, e.g. alfalfa (*M. sativa* L.). Moreover, annual medics are of great importance in Mediterranean pastures, as well as in south-western Australian and South American rangelands. Biological nitrogen fixation may reduce the use of nitrogen fertilisers, thus providing a suitable tool for 'biological' farming and for reducing environmental nitrogen pollution. The 'self-resowing' capability of annual medics is another feature that leads to low input agricultural techniques, but also explains their behaviour as invasive aliens outside their natural range. The most important aspects of *Medicago sp. pl.* variability, as far as agricultural/ environmental applications are concerned, are mainly morphological, physiological and phenological, whereas *Rhizobium meliloti* variability relevant to agricultural/environmental applications is mainly related to its nodulating capability, effectiveness (N_2 fixing potential) and adaptability to a wide range of soil conditions (mainly pH and competition with native soil micro-organisms).

Sardinian *Medicago/Rhizobium* germplasm has already been taken into account in previous collecting surveys since 1977 (2, 3, 4, 5). The present research differs from previous studies because (i) the germplasm collected does not refer to a single *Medicago* species but to most of the annual/perennial medics present on the island, (ii) the collection avoided sites where there was more or less strong evidence of human habitat modification/degradation, and (iii) the collection aimed to investigate the ecological behaviour of single species and their symbiosis, and was not therefore concerned with a specific agricultural purpose.

Materials and methods

The *Medicago/Rhizobium* germplasm collection was carried out in Sardinia, Italy (6). It was followed by laboratory isolation of microbial strains, analysis of soil samples and determination of herbarium specimens of *Medicago sp. pl.*, according to Small and Jomphe's monograph (1). The network of sites was distributed all over the main island (and in the surrounding islets) in order to collect the highest number of native (and non-cultivated) *Medicago* species.

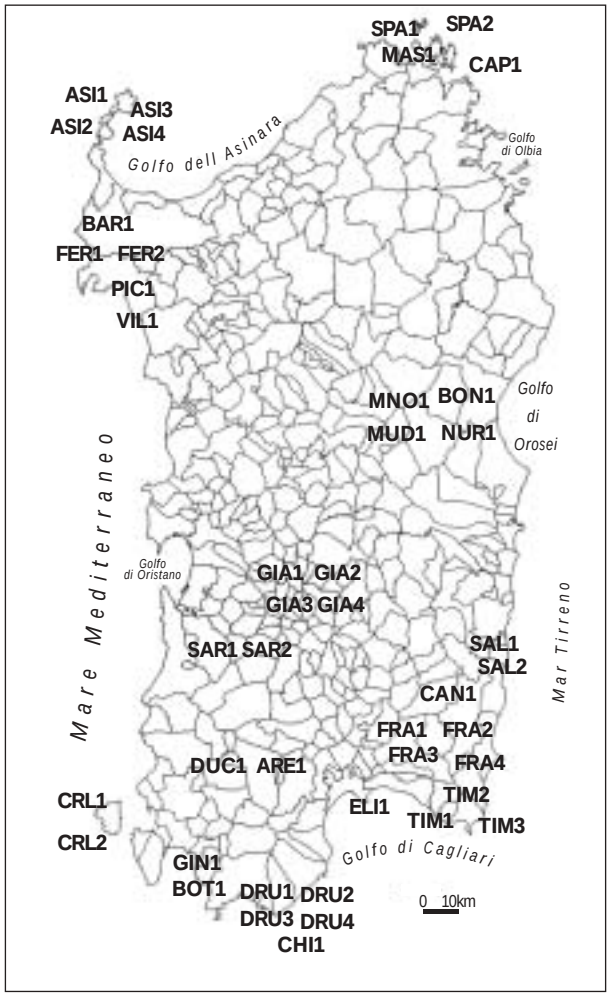
The main ecological characteristics of the sampling sites were taken into account in an attempt to collect samples from very different habitats/sites in terms of altitude, climatic parameters, parent materials and soil types, land use and vegetation physiognomy. The sites were located mainly in natural or semi-natural habitats (no roadsides or cultivated fields were sampled). The Regional Soil Map (1:250,000 – USDA Soil Taxonomy standards) was used as the main reference for planning the field activities at the landscape scale. The soil samples collected were analysed for pH, total organic matter and humic fractions (fulvic acids, humic acids and non-humified compounds) (7).

The microbiological analysis involved the isolation of microbial strains from the root nodules of the plants of *Medicago* and the purification of the isolates (8). Only isolates confirmed as belonging to *Rhyzobium* were included in the microbial collection and stored at -80°C in an ultrafreezer. Confirmation consisted of demonstration of

nodule forming ability on a test host legume under environmental (bacteriologically) controlled conditions (9). *Rhizobium* strains were physiologically characterised by analysing growth curves carried out in different environmental conditions: pH (4.5–5, 6.8–9), NaCl (2.5%), $MnSO_4$ (8.45 mg/l).

Figure 1

Distribution of the collection sites in Sardinia



Results and conclusions

Forty-six collecting sites, widely distributed in the most representative areas of Sardinia, from sea level to above 1,000 m, were sampled (see Figure 1). Nodules were collected from 15 species (13 annuals) out of the total of 22 *Medicago* species present in Sardinia. More precisely, 14 species out of the 19 native *Medicago* species were sampled (*M. arborea* L., *M. soleirolii* Duby and *M. sativa* L. subsp. *sativa* are considered to be alien to the native Sardinian flora). Many species of the genus easily adapt to different soil types (in terms of pH, organic matter content, soil water storage) and land uses. They spread even in degraded habitats due to their greater adaptability to the presence of spiny coils and to human intervention (e.g. *M. polymorpha* L., *M. arabica* (L.) Hudson). In contrast, other species are heavily site/habitat dependent and, consequently, more vulnerable to human influences, overgrazing, habitat fragmentation and degradation: e.g. *M. marina* L., *M. intertexta* (L.) Miller, *M. ciliaris* (L.) All. and *M. rugosa* Desr. *M. marina* L. grow exclusively on seashores, usually in loose sand; it is the only *Medicago* that has such habitat requirements, although seashore soils of more solid consistency may be colonised by other species. It is, therefore, endangered by tourism, cleaning of seashores, competition with exotic species (e.g. *Carpobrotus sp. pl.*), trampling and, sometimes, even by grazing. Many species present a high degree of morphological and phenological diversity, which is often related to different performances in terms of biomass and seed production, root systems, suitability for and resilience to grazing and browsing, and pest resistance.

One hundred and twenty-five *Rhizobium* strains were isolated from plant nodules sampled in the 46 sites. Seventy-four per cent of the strains were isolated from four plant species: *M. litoralis* (13.6%), *M. murex* (21.6%), *M. polymorpha* (23.2%) and *M. truncatula* (16%). Confirmation tests carried out on the isolated strains permitted characterisation of 29 strains capable of inducing nodulation in the host plants. The physiological assays demonstrated that strain biodiversity could be related to neither the site nor the plant species.

The high variability of the materials examined must be a warning that the introduction of exotic *Medicago/Rhizobium* germplasm may lead to a harmful reduction of biodiversity. Native materials should always be used in rangeland improvements planned in sensitive environmental areas such as Natural Parks or Special Areas of Conservation (Habitats Directive n. 92/43/ EEC). The use of selected competitive autochthonous materials rather than genetically modified organisms is desirable.

The introduction of exotic materials in rangeland ecosystems or in habitat restoration interventions may be harmful if not carefully assessed, and may lead to an impoverishment of the natural biodiversity of the site. The conservation of plant and microbial genetic resources is one of the main objectives of Regulation n. 94/1467/EU. Its first article stresses the importance of genetic plant resources, particularly forage plants, plants belonging to native flora with possible farming applications, and micro-organisms. The coordina-

tion and promotion of collecting activities and the conservation, evaluation and use of plant and microbial genetic resources are essential aids to achieving the main priorities of European agricultural and environmental policies.

Acknowledgements

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References

(1) Small E. and Jomphe M. 1989. A synopsis of the genus *Medicago* (Leguminosae). *Can. J. Bot*., 67: 3260-3294.

(2) Bullitta P., Bullitta S., Meloni C., Piluzza G. 1998. Risorse genetiche foraggere sull'isola dell'Asinara (Distribuzione, conservazione e moltiplicazione in situ). In: Gutierrez, M., Mattone, A., Valsecchi, F. (editors). *L'isola dell'Asinara. L'ambiente, la storia, il parco.* pp 223-229. Poliedro, Nuoro. Italy.

(3) Loi A., Porqueddu C., Veronesi F., Cocks P.S. 1995. Distribution, diversity and potential agronomic value of *Medicago polymorpha* in Sardinia. *Journ. of Agr. Sc.* 124: 419-426. Cambridge.

(4) Howieson J.G., Loi, A. 1994. The distribution and preliminary evaluation of alternative pasture legumes and their associated root-nodule bacteria collected from acid soils of Greece (Serifos), Morocco, Sardinia and Corsica. *Agr. Med*., vol. 124: 170-186.

(5) Francis C.M., Gillespie D.J. 1977. Ecology and distribution of subterranean clover and *Medicago* species in Sardinia. A report based on seed collection tour 1997. Western Australian Department of Agriculture. 9 pp.

(6) Meloni S., Brundu G., Caredda M., Camarda I., Deiana P. 1999. Collezione e valutazione di germoplasma sardo di *Rhizobium meliloti* e *Medicago sp. pl.* In: Agabbio, M. (editor). Biodiversità – *Germoplasma locale e sua valorizzazione*. Atti del 4° Convegno Nazionale, Alghero, 8-11 settembre 1998; pp. 957-960. Carlo Delfino Editore, Sassari. Italy.

(7) Ciavatta C., Govi M., Antisari V., Sequi P. 1990. Characterization of humified compounds by extraction and fractionation on solid polyvinylpyrrolidone. *Chromatographia* 22: 141-146.

(8) AA.VV., 1986. Secciones de Microbiologia de suelo de los programas de pastos tropicales y Frijol-Centro Internacional de Agricoltura Tropical. CalÏ, Colombia. Manual para la evaluacion, seleccion y manejo de la simbiosis leguminosa-rizobio para aumentar la fijacion de nitrogeno.

(9) Beck D.P., Materon L.A., Afand, F. 1993. Practical *Rhizobium*-Legume Technology Manual. International Center for Agricultural Research in the Dry Areas.

CHAPTER 4

BUSINESS INFLUENCE IN THE AGRICULTURAL SECTOR

Vertical Integration within the Agricultural Sector: the European dimension

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Abstract

This paper provides a basic understanding of the issue of vertical integration within the agricultural sector, and the influence this has on prospects for maintaining a harmonious relationship between agriculture and biodiversity. It examines what is meant by vertical integration and demonstrates a link between corporate strategies for vertical integration and the development of biotechnology. It raises the issue of political independence and policy control over the agri-food industry and addresses the relationship between vertical integration and trade patterns. Examples show how local problems elsewhere in the world are linked to the European dimension of vertical integration. Three core issues are: the relationship between government and the private sector; the consequences of oligopoly in the agro-industry; and the location of statutory control over the global dynamics of trade in seed, feed and primary agricultural commodities.

Introduction

Although there is considerable interest in agriculture as a means for promoting biodiversity and sustainable rural development, this multiple functionality of agriculture may increasingly depend on actors who have no direct interest in local economic welfare and who are not necessarily influenced by national land use and social development policies. These actors are the ones controlling markets and technology worldwide. In fact, when considering the role of governmental authorities in guiding the direction of agricultural practice within the recent historical period (Potter 1998), it is possible to deduce that ***government policy is reacting to, not leading, the evolution of agricultural markets and technology.***

Government policy is designed as if the farmer were the principal agent in the agricultural production system, and certainly farmers respond to signals from government when this will give them a degree of freedom ***from the other influences*** on their production practices. But the reality of farming is that prices for agricultural commodities are low, and in order to secure financial resources the farmer is committing himself to his future production strategy through forward contracting: he sells in advance a certain quantity of an agricultural commodity at a fixed price. There is very little difference between a farmer and hired labour in the definition of production strategy when the agent on the land – the 'farmer' – is operating under contract or simply taking orders from an industrial manager.

What are 'the other influences' referred to above? Except in the case of 'hobby' farmers, a farmer is an economic agent, who seeks to identify a particular production range that he has an adequate knowledge – and interest – to pursue, and for which he can recognise adequate market outlets. In principle, he will seek to maximise his ***net revenue*** by controlling the ***relationship*** between the primary factors of production (seed, land and its quality, machinery) and the variable factors of the production process (inputs and labour). To the extent that he ***loses control*** over any of the primary or variable factors of his production process, he loses independence in his agricultural production strategy; and to the extent that he has no market outlet to choose from, he equally loses his autonomy of action.

It would only be through ignorance that the importance of 'the other influences' on the primary

and variable factors of agricultural production could be discounted, as well as the crucial matter of market outlets. This is why ***taking into account the issue of the vertical integration of agri-industrial food production systems has to be the critical focus of a strategy to promote biodiversity through agriculture***. Taking wheat and bread as an example, if the seed stock, fertilisers and pesticides, grain elevators and bulk transport facilities, bakeries and distribution systems to the supermarkets are all part of one multinational firm, where in this chain can an individual farmer try to exert some influence on the price of what he buys and what he sells, and where can an individual government try to have some initiative in regulating production standards and product quality? The margin for manoeuvre is tight indeed.

Whether the interest is biotechnology and genetic manipulation of seed stock, or food quality, and therefore the production chain as a whole, the source of influence on decisions made by farmers is shifting from the farmstead to the corporate boardroom. This situation has already been documented (see Heffernan 1999) and the conclusion can only be that there is little point in trying to exercise a regulating influence on agriculture and biodiversity through public policy with leverage over the individual farmer if it does not at the same time have leverage over the other sources of influence. The dilemma is that public policy, at the present time, has little or no real fulcrum for leverage over multinational organisations which dominate the agricultural production system.

This is why, strange as it may seem at first, that the mission of an organisation founded to further the safeguard of nature and natural resources at the international level has to include in its scope of intervention those activities which will be likely to contribute to the proper operation of multinational agri-food industries. The context is global, and there are many stakeholders. ***IUCN is perhaps among the best suited organisations to encourage a common effort by all stakeholders to examine a wide range of possible measures***, and to adopt those measures which are called for, so that agricultural production systems can both ensure social welfare and be 'biodiversity friendly'. Not all stakeholders have the same power in economic and political circles, so the role of IUCN can be both that of mediator and *porte-parole*.

Several pathways exist. **The first is to examine the food production chain from human health and animal welfare perspective**: How many years of research are necessary to decisively demonstrate how safe for the human organism genetically modified crop material is? What is the toxicity of plant material modified to contain molecules which have pesticide qualities, that is, are composed of molecules which are toxins? What is the implication for human immune systems when antibiotics are systematically incorporated in animal feed? How do stress factors associated with closed livestock sheds affect animals? What is the implication for fertility of all species ingesting crop-related material when a terminator gene has become introduced into the DNA structure of a plant?

A second pathway is consumer awareness raising. What is the value to the producer of an agricultural commodity, compared – for example – with the shelf price of the delivered commodity (fruit) or a processed food derivative (coffee)? What is the nutritional status of organically produced food or of fresh products compared with those with a long delivery channel (and what is the energy balance of produce delivered from nearby compared with produce delivered across a continent or even the globe)?

A third pathway is political and economic. How can a government assure the welfare of its citizens when global commerce is regulated according to standards in which environmental norms are not considered as an explicit regulatory feature? How can an individual government promote sustainable development when a substantial part of the value of agricultural produce does not circulate in the same locality, but is siphoned off to the corporate centres of the multinational companies involved with an entire agricultural production chain ***from seed to shelf***? What are the implications for democratic decision-making processes when there is lack of transparency in corporate affairs due to an the absence of full disclosure, and when public reporting of actuarial data regarding corporate structures and markets is not required?

A fourth pathway is technological. What is the difference to soil quality (organic structure and tilth) according to the way the soil is cultivated? What is the impact of irrigation systems on local and regional aquifers, and what are appropriate crops and agricultural practices for dry climates? How do different types of machinery design differ in environmental impact: soil compaction, noise, operating pollution?

These several pathways of analysis indicate that an integrated approach to comprehending agricultural production will shift the interest of an international organisation such as IUCN from looking at piecemeal aspects of a complex reality. What is the advantage of advocating individual government

financial support for a cluster of extensive livestock farms in an outlying rural area without at the same time advocating a European Union policy on the location of agricultural commodity production that will avoid intensive irrigation in climatically dry regions or the draining of wetlands in climatically temperate zones?

Why should governments concentrate only on global free trade without addressing the regulation of environmental externalities (which exist, according to economic theory, because of alleged market dysfunction), when the real issue is that markets are not adequate mirrors of environmental considerations (as the existence of aquatic and atmospheric pollution control regulations amply attest)? How do governments intend to treat the issue of sovereign rights, not with inter-governmental institutions but with regard to the pervasive influence of multinational corporate structures on national and local affairs?

Many issues are generated because of intellectual paradigms, and it is these which may be the most strongly entrenched enemy of the rational use of natural resources (Gray 1998). In this regard, IUCN has the intellectual reputation both necessary and sufficient to the task to examine, and contest when appropriate, a received knowledge that is most vigorously defended by those whose interests are served best by invoking liberal economic concepts to hide oligopolistic hegemony in the market place. True efficiency of markets is undoubtedly desirable; but then let them function correctly. Oligopolistic influence in market operations is in itself counter to liberal tenants, and contrary to the interest of individual governments – and farmers.

If in a market the true value for nature conservation can be integrated into agricultural produce, then this is the type of market situation IUCN should encourage; labelling schemes and primary produce price indications, etc., will all be useful instruments. If the market, on the other hand, encourages practices which have a negative balance sheet in terms of the overall use of natural resources, then regulation and land use planning are necessary to orient market response of individual farmers. When markets are controlled by financial structures that are outside the influence of both individual farmer and government alike, then an international governmental response is called for. Finally, when no market exists for an environmental good, such as the conservation of a natural area, then publicly or privately financed incentives may encourage the individual response necessary to maintain it … and then again, maybe not. Some element of change in natural conditions is inevitable, for such is the historical reality of nature itself.

The future of biodiversity within an agricultural context depends on a combined effort by governments and non-governmental organisations, with representatives of farmers and food processors, to address at the international level the need for a mix of financial incentives for land agents – the farmers – and financial controls, along the lines of anti-trust measures when necessary. This will allow markets to operate correctly and governments to intervene when markets do not provide an adequate financial reward for maintaining and enhancing biodiversity in the countryside.

The purpose of this paper is to provide a basic understanding of the issue of vertical integration within the agricultural sector, and the influence this has on prospects for maintaining a harmonious relationship between agriculture and biodiversity. The schema to be followed is to:

- present what is meant by vertical integration;
- demonstrate the link between corporate strategies for vertical integration and the development of biotechnology;
- raise the question of political independence and policy control of the agri-food industry;
- address the relationship between vertical integration and trade patterns;
- give examples about how local problems elsewhere in the world are linked to the European dimension of the vertical integration issue;
- draw ‘conclusions’ which may be used as the basis for discussion within IUCN fora.

Vertical integration

In order to grasp the issue of vertical integration within the agricultural sector, it is necessary to appreciate how two strands of the market economy are spun together. The first is the ***subsumption of agriculture to capital*** and the second is the ***interconnectedness between political and economic forces*** within the market economy. Our first task is to give flesh to these seemingly dry concepts. As a skeleton, let us first look at what uniquely characterises the relationship of agriculture to biodiversity, which can be summarised in two words: locality and heterogeneity.

Locality and heterogeneity

The surface of the earth is composed of an enormous variety of physical attributes concerning the basic substrate on which agriculture depends, the soil. So each locality where agriculture is practised presents a unique potentiality and a unique set of constraints for farming. Therefore, within the essence of agricultural practice there has been the association of locality and heterogeneity (Van der Ploeg 1992). If one further examines the implication of this association, it becomes apparent that the nature of commerce of agricultural products is in opposition to this association of locality and heterogeneity: at larger scales of economic activity, it is ***homogeneity*** which is required in channels of collection, processing and distribution of agricultural products. The requirement of homogeneity is a denial of the inherent essence of farming that has been typically associated with the evolution of biodiversity within Europe.

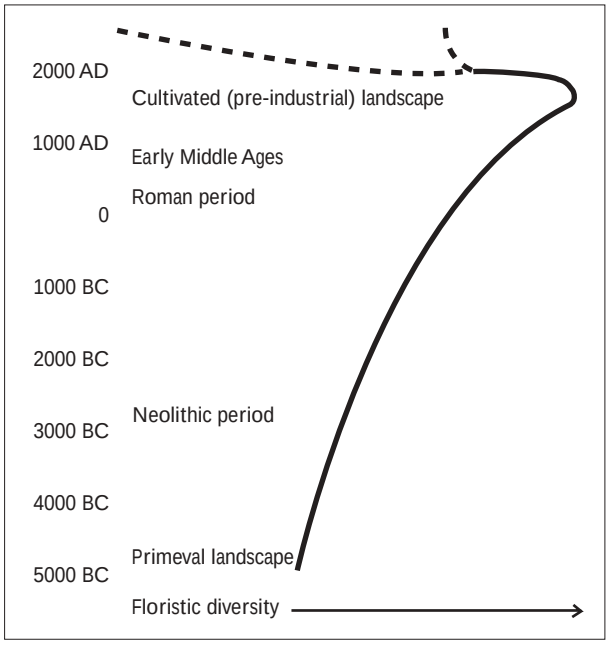
> The stranglehold of huge supermarket chains is driving uniformity and wiping out local varieties of fruits and crops with long histories (*New Scientist*, 18.12.1999).

Agriculture in the European continent has been a progressive adaptation since 8500 BC of know-how developed in the Near East. This progressive spread of agriculture, from east to west and south to north, has favoured adaptations in farming systems that correspond to regional environmental differences, both in climate, soil structure and topography (Nowicki 1996). The historical evolution of agricultural land use has resulted in a phenomenon quite specific to Europe (Nowicki et al. 1999), in which biodiversity related to agricultural practice at first increased and now is in marked decline (see Figure 1).

Figure 1

Floristic diversity of the European landscape over time

***Source*: Stanners and Bordeau 1995**



There is also a second trend visible in shifts of land use: agriculture becomes both more productive per hectare and, with relative market saturation, requires less space: there has been some shift to pasture and meadow; a greater shift to woodland; and the most significant shift has been to urbanised land (Eurostat 1995). The changes in land use – both through increasing 'intensity' of agricultural practice and through the amount of land involved – are accompanied by modification of landscape: field sizes are bigger, hedgerows have been removed, small woods and ponds have disappeared. This combined modification of landscape and land use is detrimental to biodiversity. What is apparent in the diagram above is that biodiversity has increased according to the development of niches, or biological 'windows of opportunity', associated with the advent and transformation of Neolithic agrarian technology over millennia. This diversity has begun to collapse relatively rapidly. The variety and geographical particularity of agrarian systems are disappearing, and so is the variety and geographical particularity of landscapes and the biodiversity associated with them.

The expansion of arable land use in the past has also been at the expense of some types of land cover. Forests have been cleared, for pasture, meadows and arable or permanent crops. There have been several cycles of increasing and decreasing arable land use, linked to human population fluctuations, agricultural trade possibilities and the market for timber. The current phase is that of intensification of arable land on a smaller area, accompanied by an increase in the area devoted to a more extensive livestock management. It is possible that this intensification of arable land use is linked to the regulated agricultural commodity market existing in one form or another throughout Europe. The extensification of livestock management may be linked to financial incentives also coming from public policies to support rural areas under economic hardship because of natural constraints on more intensive forms of agricultural land use.

Subsumption of agriculture to capital

What is also apparent is that the increasing importance of capital investment in agriculture has resulted in a negative impact on biodiversity and landscape values. This is linked directly to greater homogeneity in agrarian commodity production through an increasingly standardised production system, and it is also associated with an enlargement and conditioning of fields for the use of specialised machinery and soil amendments. The economist speaks of 'subsumption of agriculture to capital' as a way of expressing that all the variable factors of agricultural production are made as predictable as possible – in cost, quality and delivery – so that the production of crops can be controlled as an integral part of various production chains. This is not restricted to the food industry; rape-seed oil, for example, has an industrial use, and flax is a primary material for clothing.

Farming has become a business as in any other commercial and industrial sector, relying for survival on the capacity to generate a net revenue from the costs of production (capitalisation in land and machinery, and the regular use of inputs: seeds, fertilisers, herbicides and pesticides) and the income from the sale of the agricultural commodities on the market. Already in the past century there has been a considerable replacement of labour costs through capitalisation in machinery, and the result is an increasing level of loans taken out by the individual farm units to obtain the required capital. In this sense, capital penetrates into the organisation of farming enterprises, and the need to raise output to reimburse the borrowed capital increases the dependence of farmers on upgrading the technological support to their farming enterprises (therefore reinforcing the cycle of borrowing and repayment of capital). This situation is figuratively referred to as a financial and technological treadmill ... and the consequence is the implicit transfer of farm management decision making to those who control the external capitals, in terms of both of machinery and financial resources offered to the farmer (Goodman and Redclift 1985, Marsden et al. 1987).

> Indebted farmers or those under some other form of pressure are more dependent upon relations with both finance capital and, by virtue of higher levels of farming intensity, with agricultural input firms. But few farmers have yet been reduced to the role of the propertied labourer akin to that of a manager or worker of a productive process completely subsumed to outside capital (Winter 1986, p 253).

In terms of agricultural and biodiversity, the increasingly industrial character of agriculture means that the specificity of locality and the potential for heterogeneity are no longer relevant considerations within farm management strategies. This is why European governments have sought to protect or promote specific agricultural practices favourable to local contexts through policies of a regulatory nature.

The possibilities and limitations of a regulatory approach within Europe

A significant shift in agricultural production has occurred over the past 25 years, and the features of this shift are well documented in a recently issued compendium of information on agriculture published by the European Commission ('Agriculture, Environment and Rural Development: Facts and Figures'). Considering the effect of this shift upon rural areas, in terms of employment and environment (in particular, with regard to biodiversity and landscape), a renewal of policy instruments concerning agriculture and rural development is already taking place, both at the European and national levels.

Even if the economic horizons of the rural economy extend further than the immediately perceived presence of agricultural activity, the 'green' economic sectors (agriculture and forestry taken together) cover 76% of the EU terrestrial territory: permanent crops 4%, arable land 24%, permanent grassland 16% and wooded areas 32%. Many registered farmers are also involved in woodland management, and the separation of the agricultural and forestry sectors is no longer critical for an understanding of the driving forces behind rural land use change, the influence of the agricultural sector in this process, and the implications for biodiversity and landscape.

The financial mechanisms of the Common Agricultural Policy have encouraged the production of cereals, oil seed and protein crops through the establishment of intervention prices in the market for theses commodities that guaranteed a minimum price for sales. The establishment of quotas, particularly for milk, encouraged the meeting of maximum authorised delivery levels at the minimum possible expense. The conjugation of these two factors alone explains the decline in permanent pasture across the EU in those areas where it has been possible to increase the output of

product (milk) per unit of production (the cow) through genetic selection and protein enrichment of the diet. The latter leads to an increase in cereal production for feed and the conversion of grassland to high-protein maize silage.

When coupled with the increasing demand for meat, fertile areas have been increasingly devoted to the production of feed grains and silage, encouraging the seed selection making possible the extension north of the 45th parallel of both wheat and maize, localised in the fertile and temperate valley and plateau areas of the EU. In the handicapped regions a shift from pasture has not been possible, but the demand for grain and silage has also followed the same tendency as elsewhere. This leads to improved internal markets for grains as well as to the local practice of grass silage, using the plastic-cover technology, even in the valleys of the mountain areas where before only hay was taken off the fields.

While permanent grassland has decreased by 12% in the past 25 years, arable land has increased by the same amount. The process has not been a one-to-one phenomenon, but rather a complex pattern of specialisation in which many agricultural commodities have become localised in the particular regions best suited for them. The 'mixed arable' and 'mixed livestock' categories of farms have decreased (in number and surface area), marginal permanent crops have been removed (in particular vineyards producing low-quality wine, where vines have been grubbed up for other uses or returned to fallow), and the land under fodder has extended northwards.

Genetic selection and mechanisation have both played their part, and with the increasing commodity specialisation has come the trend for an increasing economy of scale in operations, meaning larger fields per crop and larger farming units. This reflects a financial necessity to lower costs per unit of output in order to successfully cover the depreciation costs of the sophisticated machinery, allowing both savings in production costs and the possibility to increase output per hectare. To the extent that machinery specialisation is correlated with basing a farm plan on a restricted range of commodities, there is also a tendency for repeating crops in the same field: a survey in France noted that for 1995 the successive cover under maize was 47%, wheat 14%, sunflowers 11% and potatoes 8%.

Translating these trends into straight-forward observations is simple: the variety of field sizes and crop types has disappeared, where ecologically rich permanent grasslands and field borders, along with the availability of labour that went into maintaining agricultural features (such as hedgerows) which create the habitat structures associated with biodiversity richness and landscape character in many parts of Europe. The rural economy has changed, and so have the landscape features which are a reflection of it. Not only have landscape features disappeared, but there is a long list of ecologically disruptive consequences, ranging from depleted soil organic material and minerals to depressed and/or polluted water tables; these also have direct consequences on the food chain and habitat conditions for innumerable species. The loss of local cultivars and 'rustic' species of domestic livestock in the process of increasing uniformity should not be forgotten either. Successive cover rather than rotation of crops accounts for increasing problems with pests, requiring ever larger doses of pesticides.

The recognition of the relationship between rural economy and non-agricultural vegetation structure is not new; indeed the CAP reforms of 1992 were intended to palliate the 'missing market' forces that had under previous economic circumstances been associated with ecologically beneficial land use practices on the farm. Certainly Council Regulation No (EEC) 2078/92, the agri-environmental regulation, has been successful in raising awareness. One in seven farmers are enrolled in an agri-environmental programme, which in one form or another covers 20% of farmland (in comparison with the 15% targeted for the year 2000 under the 5th Environmental Action Plan). As of the end of 1999, there have been 133 agri-environmental programmes submitted by member states, and in the same period there have been 218 modifications of approved programmes, suggesting that the complexity of the relationship between agriculture and the environment should not be underestimated.

Rather than dwell upon the shortcomings which the initial experience with agri-environmental measures has highlighted, it is interesting to observe the move by the Commission to adopt a horizontal approach for dealing with environmental considerations within the context of rural development, in which the agricultural sector remains a primary but not an exclusive actor. This continues the timid experiment made under Council Regulation No (EEC) 2080/92 (the Community aid scheme for forestry measures in agriculture) in which landowners other than farmers are eligible to receive assistance with environmentally valuable forestry practice. But the farming community remains the principal target for enlistment in rural development initiatives under

Community financial incentives, as seen in Article 22 of the Council Regulation (EC) No 1257 / 99 of 17 May 1999 (on support for rural development from the EAGGF and amending and repealing certain Regulations).

At the same time as the new Rural Development Regulation was being developed, national reflection on the integration of the agricultural community in rural development also matured. A good example can be seen in the Land Contracts which have replaced the agri-environmental agreements within France from January 1st, 2000. Although the specific measures for less-favoured areas continue to be employed, the general measures of an agri-environmental nature are now formulated within a whole-farm plan that addresses both economic and environmental objectives. In addition, these objectives are organised in regionally-specific 'menus' so that local community authorities and social forces can also participate in designating a range of objectives likely to reflect a global perception of the natural features meriting priority attention as well as the gaps in economic services which need to be filled.

These Land Management Contracts are established in the first part of the new Law on Agricultural Policy, voted on 9 July 1999. What is interesting is that the supporting documentation makes specific reference to the Community regulation on rural development being developed at the same time. This sort of tight relationship demonstrates a synergy which is possible in a situation where subsidiarity plays a complementary role to Community initiative. Another noteworthy feature is the association of multifunctionality with market added value. So a new dogma is taking shape: incentives to the agricultural community will be biased in favour of enabling market penetration for those goods and services which favour a labour-intensive relationship between the farmer and his use of natural resources. Furthermore, these goods and services are intended to give the farmer market leverage in the present in order to lessen his dependence on financial assistance in the future.

Because public policy is oriented to maintaining grazing enterprises, then it is logical that some sort of internal market preference would be given to compensate for the lack of economies of scale that are possible in lowland grazing situations. Although headage payments may not be recommendable, a premium on live-weight delivered to market could perhaps be a simple way to make up for the drop in prices at the market.

The matter is more complex, however, for some of the responsibility lies within the monopoly that large food distribution chains enjoy within the food commodity market structure, and thus on their control of the prices offered to suppliers. As an example, in some countries the distribution chains have horizontally organised meat delivery to the consumer, through ownership of slaughter-houses and transportation facilities to the retail outlets. There is no parallel pathway to the consumer, and no choice of market entry for the producer.

When power and wealth join hands ...

The principle of good governance is to protect the interests of the governed, so that they can maximise their opportunities of choice and action. For this reason, the interconnectedness between political and economic forces will always remain a subject for civic concern, as the desire for wealth incites powerful ambitions to control the political processes which have an influence on its distribution. Although the 'invisible hand' of the market is in theory the ultimate determinant of how the means of production circulate and wealth accumulates in society, the more visible joining of hands where power and wealth are concerned has been amply attested to by various examples which have come to public attention of subversion of public moneys or of conflicts of interest between politicians and corporate managers. Indeed, the political nature of market structures has to be recognised, and the fact that political orientations will be influenced by economic interests.

> If the principal focus of political conflict, at either domestic or international levels, concerns who gets what, when, and how, and setting out the rules and framework of the market in large part determines just this, ***then political interaction is the means by which economic structures, in particular the structures of the market, are established and in turn transformed***. (Underhill, 2000, p. 4). Understanding the global political economy therefore involves overcoming orthodoxy and understanding markets and political authorities as part of the same, integrated ensemble of governance, not as contrasting principles of social organisation.

It is in this context that the issue of vertical integration of the agricultural sector must be placed, and therefore the phenomenon of subsumption of agriculture to capital. For control of the agricultural sector is control over basic human needs for food

and clothing, and when the tendency of capital is not only monopolistic but oligopolistic, this entails both a conscious curtailing of competition and the integration of the factors of production through an influence over governmental processes. Vertical integration of the agricultural sector from seed to shelf also has, it must be noted in passing, a significant advantage in establishing a competitive hegemony, for there is a reduction of transaction costs at each step in the production process.

The issue of the interconnectedness between political and economic forces becomes particularly acute when examining the issue of biotechnology and its impact upon biodiversity when associated with farming practices. But first, it is now appropriate to give a more detailed description of what 'vertical integration' within the agricultural section means.

Vertical integration in the agricultural sector

Within a market economy, there are 'five basic control problems of capitalistic production and accumulation: control over labour, supplies, technology, capital, and distribution/consumption' (Ruigrok 2000, p. 326). The response, dating to the 1920s in large corporations such as Ford, has to been to integrate all these production attributes under the control of a unique management structure, the 'in-house' solution. But the globalisation of competition between firms means that management of these attributes must be more flexible to take advantage of economies available through increased competition at each level of the production process, and to provide greater strategic choice of which components of the production attributes should remain under direct company management control. This explains the simultaneous selling off of certain activities to create independent firms and the buying up of others, which has been common in the 1990s.

With regard to agriculture, the requirement for food product distribution companies has been to ensure a standard level of quality, respecting both consumer preference and regulatory measures, the latter in particular with regard to human health. The production of broiler chicken in the US, for instance, will normally be entirely controlled within one company, with only the pullets being 'farmed out' to agricultural enterprises specialised in rearing the fowl from chicks to birds for slaughter 90 days later. The laying hens and egg incubation systems, the shipping and the meat processing will be all under single ownership, and the provision of medical supplies will be provided to the farmer along with specifications as to when to use which treatments.

This type of industrial relationship between capital and labour has begun to be extended to other domains. It is already prevalent through both vertical integration and forward contracting arrangements for many commodities: eggs, meat (chicken, turkey and hogs), milk, and speciality crops (Coleman and Skogstad 2000). The move by large corporations to strategically choose complementary enterprises to exercise integrated control has brought a new variant of this relationship, involving biotechnology. It is not only the production of seed and the processing of maize in several industrial products – ranging from flour to starch – which is under unified corporate management control (see Figure 2), but the types of plant treatment products required.

Strategic association of complementary enterprises occurs in two ways: alliances and other forms of negotiated agreements for a specific period of time, and out-right purchase. The latter is far more evident than the former, and the association between chemical products and seed production is well known from examples such as Monsanto, Dupont and Dow Jones. When a company such as Monsanto moves into life sciences and acquires patents in genetically modified seed stock, the goal is to extend the value of its investment in a proprietary herbicide such as Roundup, for which the Roundup Ready canola, cotton and soybean seed stock had been specifically adapted.

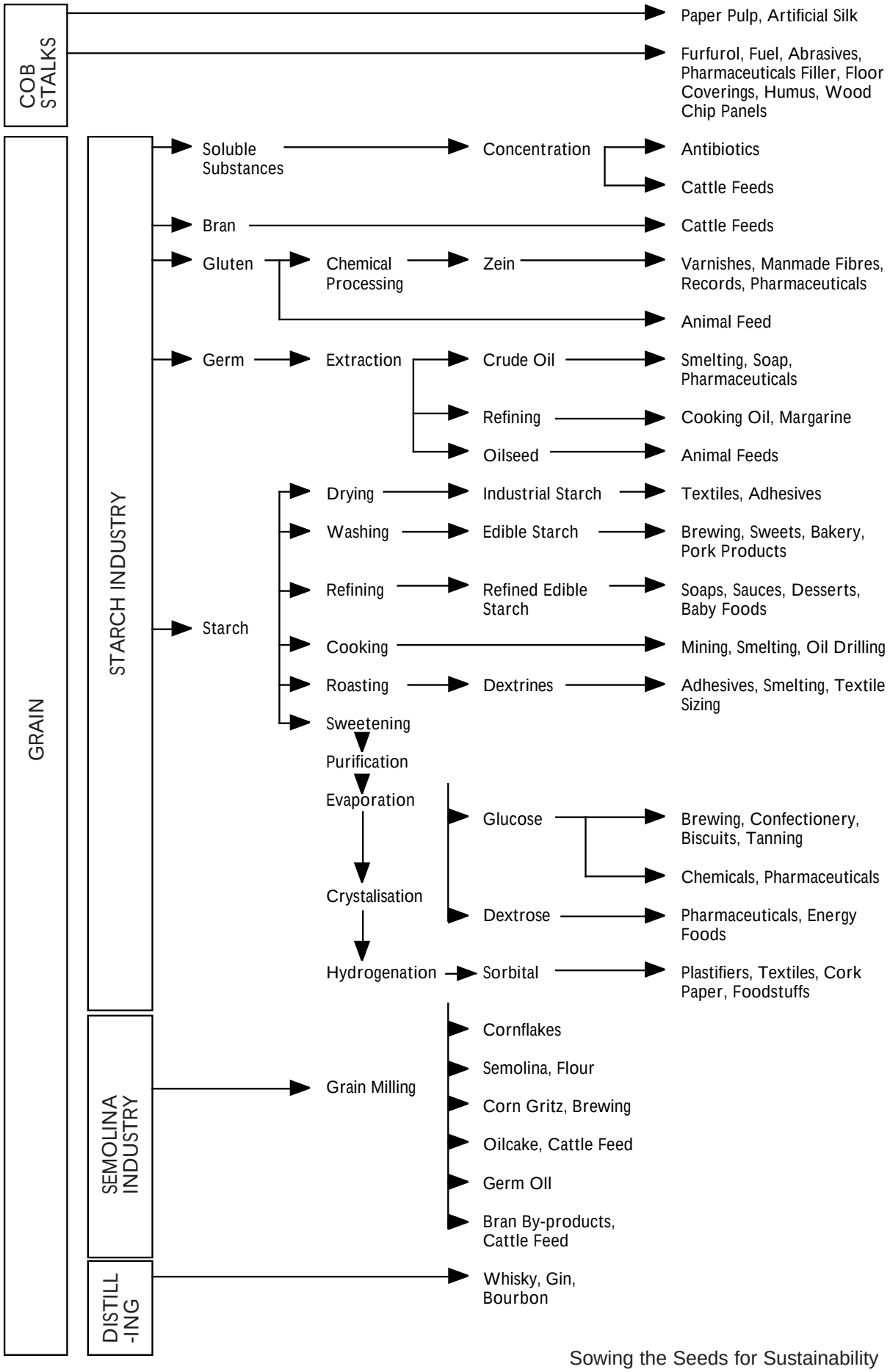
The planned merger between Monsanto and American Home Products would have created a USD 96 billion 'life sciences' company, according to the information on Monsanto's web site in 1998, combining pharmaceutical (human and animal health) products with nutritional/food ingredients and agricultural products. In any case, Monsanto has continued with an acquisition campaign aimed at seed producing companies, as witnessed by the following news brief from the Economist of 18 July 1998:

> Monsanto, an American biotech firm, will pay $525m to buy Plant Breeding International, Cambridge, a crop-breeding group, from Unilever, an Anglo-Dutch multinational.

Other examples of the complex international corporate strategy of this multinational giant come from Monsanto's web site under the heading 'Recent Transactions':

Figure 2: The industrialisation of maize

Source: OECD 1979



> Spun off Monsanto's former chemical business to existing shareholders as a new company called Solutia with revenues of $3 billion; spent $1.4 billion to acquire seed companies Holder's Foundation Seeds (US), Corn States Hybrid Services (US) and Sementes Agroceres (Brazil; other smaller acquisitions in Brazil (pharmaceuticals), Argentina (pharmaceuticals); launched joint ventures with local partners in Argentina (cotton seeds), India (genetically enhanced cotton), and Russia (pharmaceuticals).

The major European and North American multinational companies involved in the food market attempt to create synergies among chemical, pharmaceutical, and animal and plant processing enterprises. The range of elements include not only the production of fertilisers, herbicides, antibiotics, hormones, vaccines and seed stock, but also silos, livestock feed lots, terrestrial and maritime transportation facilities, slaughterhouses and meat-packing units, grain mills and 'food processing' factories.

All of these demonstrate a systematic vertical integration in both the plant and animal markets to create production chains from seed or chick to the bread or broiler which appears on the supermarket shelf; perhaps, more appropriately, one can talk of a production chain 'from gene to jello', as the new industry is that of food ***manufacturing***. Taking biotechnology as applied to plants as an example, the matter is well stated by the *Guardian* (24 August 2000):

> Biotech crops are ubiquitous, yet few consumers realise it. Here are a few examples of where you can find GMO products: soft drinks (GMO corn to make corn syrup), salad (GMO tomato, soy oil in dressing), hamburgers (engineered yeast in bun, rennet, soy isolates in cheese, delayed-softening tomato in ketchup, soybeans in mayonnaise, genetically altered tomato).

Why such an interest for investment in the food chain? *Le Monde Diplomatique*, May 1998, gives a good explanation:

> Les firmes Pioneer, Novartis, Monsanto, Hoescst Schering-Agro, Rhône-Polenc-Rorer, se livrent en effet, depuis deux ans, à des jeux d'alliances et de rachats, tant du côté des sociétés de biotechnologie que sur le versant agroalimentaire. An cadenassant aussi bien les gènes-clés et les variétés performantes que les débouchés alimentaires, elles sont devenues maîtresses des champs… et des assiettes.

The key factor is that costs are internalised, and the only point of 'price discovery' is at the point of final sale, as there are no transfer of ownership and resultant transaction costs along the production chain, and all the added value accumulated at each point of transfer in the production cycle is a source of profit to the agro-industrial company. There is an additional issue of monopoly in the food market, and the inherent social blackmail of 'pay my price if you wish to eat.'

The potential for economic disequilibrium that could be generated by the multinationals of the food industry is highlighted in an article (*The Guardian*, 19 June 2000) on the implications of GM seeds for developing countries, in which there is a passage presenting the views of Professor Pushpa Bhatrgava, head of the Centre for Cellular and Molecular Biology:

> Thanks largely to him, India has some of the best biotechnologists in the developing world, and many of its public agricultural institutes are working on applications for India. He thinks GM will change society, dramatically improving drugs, vaccines, plastics, food preservation, alcohol energy and agriculture.
>
> Where Europeans are concerned about the safety, environmental and consumer implications of GM foods, the debate in India mostly centres on neo-colonialism – who owns and controls the technology – economic dependency and "food security". The best reason for India developing biotech, he says, is that, if it doesn't, "the country will be exploited by others in a way that history has not known before". He has warned for years of the consequences of India becoming "dependent on other countries for ideas, know-how and products".
>
> And that, he believes, is happening now. "How do you dominate a country where 700 million people are directly dependent on farming? You infiltrate its agriculture. Who controls a country's food security controls that country".

In this context, the furore in India caused by the revelation of the existence of a patented 'terminator gene' is easily understandable, for it is the radical means by which seed firms impose a restriction on replanting seeds derived from GM plants that have been saved from a preceding harvest.

> India has a quarter of the world's farmers, and 85% of the 700 million people who live off the soil rely on home-grown seed, stored after every harvest. About 575 million barely manage to scrap a living, tilling less that a

> hectare of land, and would quite simply starve if they had to buy seed every planting season (*The Guardian*, 6 October 1999).

Even if most of the farmers in India are too poor to use GM seed stock supplied by the major multinationals, an ecological and economic catastrophe is nevertheless a possibility with the arrival of the 'terminator gene', for

> … scientists fear that the terminator gene could make other crops sterile by inadvertent cross-pollination, and threaten the diversity of seed stocks in India, making its farmers slaves to a few strains of imported seed (*The Guardian*, 6 October 1999).

From the point of view of the farming community, market presence in Europe and North America is often assured through cooperatives; and even these enter into the structure of alliances which form the agro-industrial clusters operating at the international level. One of the major agro-industrial clusters is Novartis (genetics, seed stocks and chemicals) and ADM (grain handling and processing). ADM has a major stake in A. C. Toepfer, one of the leading grain trading firms in the world market, and thereby via corporate agreements can claim to have EU partners that are among the 12 of the largest farmer' cooperatives in the world, allowing 'ADM to process 45% of the commodities entering Eastern Europe from the West in 1993' (Heffernan 1999). Biotechnology is the keystone to a relationship having global dimensions:

> The Novartis / ADM connection is … important because Novartis – while truly a global and powerful company with substantial sales in chemical, seed, animal health and human nutrition products [including Gerber baby food] – lacked access to further processing in either grain commodities of food products. Novartis will need ADM's grain handling and processing web to be able to guarantee producers using their seed stock a downstream market. ADM, on the other hand, lacked access to biotech and needs Novartis' genetics, seed stocks and chemicals (Heffernan 1999).

ADM also has a major stake in IBP, the largest beef packer and the second largest pork packer in the US, and through joint ventures has operations in food processing throughout the world; in 1997 IBP even started up a fully integrated pork production and processing facility in China. ADM is also a financial player in the world grain market through its US brokerage firm specialised in currency and grain futures trading.

Biotechnology and trade

There are several multinational clusters following the same logic as that of Novartis and ADM (such as Monsanto and Cargill); the common denominator is consolidation of food industry interests within global trade patterns. As suggested above with regard to India, such leverage over national agricultural products can be cause for concern, as demonstrated by the recent legal troubles of ADM in both the EU and the US concerning the marketing of lysine and citric acid, and ADM's increasing market share in 'new products as Vitamin E and soy isoflavones' (Heffernan 1999). The reach of such multinational clusters onto the supermarket shelf completes their strategy, illustrated by the fact that the Gerber baby food brand belongs to Novartis, Haldane of the UK belongs to ADM, and FoodBrands Inc. belongs to IBP.

The trade issue is therefore both about (brand-name) products and about market shares of raw and processed agricultural commodities in the human food chain and within an extended market for a wide variety of industrial products (such as those using oils and fibres from derived from plants and animals). To the extent that biotechnology enhances the place of agricultural commodities in the production and trade of an increasingly wide variety of items, biotechnology and trade are together an integral element when considering the extent of vertical integration within the agricultural sector.

Turning to the European dimension of the trade issue, which is also an introduction to later consideration of the relationship between vertical integration and politics, two well-known examples concern the 'banana war' and the 'beef hormone dispute'. An excellent résumé by *The Guardian* also brings us to the increasingly broader issue of the biotechnology component of the trade issue through the production and marketing of GM commodities:

> In the banana complaint, the US argued that the EU was treating its banana growers unfairly because of preferential treatment for exporters in the Windward Islands. Why the US launched a complaint on a product it does not grow may be explained by the half-million dollar donations made to US political parties by Chiquita Fruit, a US firm that is one of the largest Central American banana producers. The WTO later granted authority for the US to impose $200m of trade sanctions against European exporters. Chiquita's victory could lead to 200,000 small farmers in some of the world's poorest countries losing their livelihood.

> The row over the EU's refusal to import beef containing growth-promoting hormones shows how international trade law can challenge public health standards. A WTO ruling against the EU's assessment of the health risks of cattle hormone treatments suggests that even public safety is under threat from corporate muscle. And now the US accuses the EU of using spurious scientific arguments to slow down the proliferation of GM products (17 August 1999).

The contention that the EU is using 'spurious' scientific arguments has been belied by a publication in *Nature* (vol. 399, p 14, 20 May 1999) demonstrating the decline of Monarch butterflies feeding on the pollen of maize into which a toxoid *Bacillus thruingiensis (Bt)* has been genetically placed in order to a produce a 'pest resistant' crop. The same *Bt* toxin will enter the human food chain when the maize is harvested and processed, albeit normally through an intermediate stage as animal feed. The question remains, however, if bio-accumulation of a molecule having the effect of a pesticide will occur. Research has demonstrated that two out of three green lacewing larvae, natural predators of the targeted European corn borer, died after ingesting European corn borer which had fed upon transgenic maize containing the *Bt* toxin (*Environmental Entomology*, April 1998). And what will be the consequences for farmers seeking to safeguard their crop by using GM seeds – or for their neighbours employing conventional *Bt* phyto-sanitary products as authorised under 'organic' produce labelling legislation – when *Bt* resistant strains of targeted pest species develop? A foreshadowing of the extent of damage is the outbreak of the bollworm which developed a resistance to Bollgard® Cotton, destroying a large part of the cotton crop in the Southwest of the US in 1996 (Lappé and Bailey 1999).

Although the different types of risk associated with GM plant and animal production is outside the scope of the vertical integration issue, it is worthwhile to note that caution has been requested by statutory agencies, such as English Nature, concerned about the wildlife implications of genetically modified organisms in agriculture, in particular with regard to two major potential effects: ***gene introgression*** (the accidental or deliberate introduction of novel genes into native species) and ***changes in crop management*** (resulting from the widespread commercial use of GMOs) (Report to the House of Lords, UK, European Communities Committee, enquiry into the regulation of genetic modification in agriculture, June 1998). The changes in agricultural practices which biotechnology encourages is no minor concern, for intensive agriculture and the loss of grassland (and heaths) with the generalisation of silage has brought one out of eight European butterfly species to the verge of extinction; the risk is that 'the situation would worsen as the countries of central and eastern Europe joined the EU and abandoned their traditional agricultural practices' (*The Times*, 9 December 1999).

The fact that there may be a risk of unknown proportions involved, as biotechnology becomes integrated into the food chain, has fully entered the debate on liberating trade in agricultural products; and it has taken five years to negotiate the Biosafety Protocol to the Convention on Biological Diversity (CBD), agreed to on 30 January 2000. The issue has been whether the 'precautionary principle' advocated by the CBD could be used as a method of trade protectionism. In order to protect trading rights the WTO had up to this time required that safety bans be backed by 'sufficient scientific evidence'. There remains the issue of labelling, which the Protocol does not touch upon:

> Farmers and traders won't have to segregate products containing GMOs. The US argued that segregation would cost billions of dollars because GM varieties make up half of the nation's soybean and a third of its maize crops (*New Scientist*, 6 Feb 2000).

In response to this situation, the EU has regulated that agricultural commodities containing more than 1% of GM material must be labelled as such (Council Decision of 25 June 1999). Another decision, from 1990, regulates the introduction of GM seed stock within the EU. Yet both of these legal instruments are becoming increasingly difficult to regulate and to monitor because of the omnipresence of GM material within the trade cycle. In terms of maize seed, the EU obtains two-thirds of its seed stock from the US, and the refusal of US authorities to impose labelling on GM exports means that GM seed can enter the EU agricultural system without importers being aware of the situation. This has already occurred with regard to GM rape, which has been planted on 4,700 ha in the UK, 600 in France, 500 in Sweden and 400 in Germany (*The Guardian*, 18 May 2000).

GM labelling itself has become a *causus belli* between the EU and the US, precisely because of the implications for trade:

> Washington has warned the EU that it is considering making a formal complaint to the World Trade Organisation in Geneva on the grounds that labelling GM products is unfair discrimination against US goods and therefore

> a restraint of trade. The US says it will ask the WTO to impose sanctions against EU exports if GM labels are not removed from supermarket shelves. …
>
> A spokeswoman for the US food and drug administration, which insists that only nutritional information should be on the label, said: "This is getting extremely serious. We regard requiring GM labelling as economic fraud. Our view is that we would not have allowed these products on the market if they were not safe, they are the same as non-GM food, so they do not require a label. In fact, to label them is trade discrimination and therefore wrong." (*The Guardian*, 31 July 2000).

If GM food was as anodyne as the spokesperson for the US food and drug administration claims, then it would be unreasonable for *Scientific American* to specifically address the issue 'Do the risks of genetically modified crops outweigh the benefits?' (5 July 1999). No conclusion is given, and the opposing arguments are set out. But the fact is recognised that:

> In Britain, for example, a recent study showed that 30 of the leading food processors had either stopped, or were going to stop, using genetically modified ingredients. The latest among them is Northern Foods, one of the largest producers of fresh food products in the UK. Meanwhile, Paris-based Groupe Danone, the third biggest food producer in Europe, announced that it wouldn't use genetically modified ingredients. And both Unilever, the Anglo-Dutch company, and Switzerland's Nestle stated that they would limit or ban the use of genetically modified ingredients in selected countries (*Scientific American*, 5 July 1999).

This situation of strong dichotomy between the agro-industrial push for GM products in the world market and the European withdrawal from the use of GMOs will create tensions within trade that may result in commercial conflict among richer countries, but will also leave its mark in the relationship between the richer and the poorer countries. The major multinationals that are committed to promoting GMOs, along with the other derivatives of biotechnology, will concentrate their efforts of market penetration on societies less able to construct the social defence mechanisms as have been established within Europe (how many people in the world have access to a web site such as www.greenpeace.fr in which there is a downloadable PDF file listing food products which contain and do not contain GM material?).

Trade and bio-piracy

It is one matter to control seed stocks: a problem in resource availability could eventually be handled by creating parallel systems of provision – even if it would take several years, however, to free the EU from its dependence on importing maize seeds from the US. It is another matter to control the genetic structure encapsulated within seeds, for to defy legal proprietary rights would result in sabotaging the international structure of legal agreements in all domains (including trade, of course). Therefore there is some cause for concern that existing laws in the EU and the US allow the patenting of genetic structures, now that novel forms are made possible by biotechnology, as well as the possibility to accurately map genomes. The link between trade and what has become referred to as 'bio-piracy' is well illustrated in the following passage, written during the period leading up to the aborted WTO trade negotiations in Seattle:

> The US and Europe insist that corporations should be allowed to patent all plants and animals despite existing international laws and understandings which provide for protection of natural resources.
>
> India, Malaysia, Zimbabwe and other African and Latin American countries have accused the US and Europe of 'bio-piracy'. The Indians are particularly worried because US and European corporations have started to patent their traditional herbal medicines.
>
> In heated backroom talks in Geneva designed to iron out differences before the inter-governmental meeting, Mike Moore, the head of the organisation responsible for setting the world's trading laws, is reported to have dismissed developing countries' objections by saying that the WTO overrides all other international treaties.
>
> The US/EU proposals would force all countries to broaden their patenting laws, but the developing countries are resisting strongly. They say that patents on all life forms should be excluded from the negotiations of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement which is scheduled for renegotiation in the talks. …
>
> The problem which the US must overcome is that the patenting proposals clash with other international laws [notably the CBD]. Another sticking point is agriculture, with the rich countries trying to force a further opening up of

> markets to their goods. The developing world, say India and others, must be allowed to protect and support their farmers up to the point of self-sufficiency. (*The Guardia*n, 22 November 1999)

Bringing the double issue of trade and bio-piracy back into the focus of the European dimension of vertical integration within the agricultural sector is rather straightforward: what would happen to the commercialisation of Roquefort cheese if the bacteria responsible for the proper fermentation of sheep milk were to be patented by a European – or even US – agro-industrial multinational company? Where would control over this very culturally identifiable product lie? What would be the rights of the cooperatives in southern France currently producing the primary product? In whose interest would marketing decisions, that effect the competition between different sorts of speciality cheeses, be made?

It is hard to argue that this could not happen, if one considers the following passage from a communiqué jointly released by RAFI, the Berne Declaration and the Gene Campaign in January 2000:

> In September 1997 a Texas-based company, RiceTec Inc., won a controversial US patent (No. 5,663,484) on Basmati rice lines and grain. RiceTec's Basmati patent has become widely known as a classic case of 'biopiracy.' Not only does the patent usurp the Basmati name, it also capitalises on the genius of South Asian farmers who have for centuries selected and maintained Basmati rice varieties that are recognised worldwide for their fragrant aroma, long and slender grain, and distinctive taste (RAFI Communiqué Issue #65, www.rafi.org).

Biotechnology and politics

The relationship between the commercial interests behind biotechnology and politics is not only of an indirect nature when major multinational corporations make contributions to the political campaigns in democratic countries. There is a direct relationship between decisions regarding the public financing of research in biotechnology and the commercial application of such research. When on 16 May 2000, the UK multinational AstraZeneca reached agreement with the inventors on the commercial control of a Vitamin-A fortified rice strain, it pocketed the total public sector investment that went into the production of this strain (RAFI News, 20 June 2000). The same issue came up in the United States with the patenting of the 'Terminator Gene', as related in an article by *The Christian Science Monitor* (31 July 1998), entitled 'Terminator Seeds Threaten 10,000 Years of Farming History':

> Terminator seeds generated particular controversy because the US Department of Agriculture (USDA) contributed to the breakthrough.
>
> 'Here we are using taxpayers' money for a company that can afford to do the research,' complains Henry Shands, assistant administrator for genetic resources at USDA's Agricultural Research Service. Because Congress has kept the service's research budget essentially flat in recent years, government researchers are scrambling for funding.
>
> 'We see more and more of our scientists go out and compete for grants and try to get money from industry,' Shands says. 'And that makes us more beholden to industry.' One of the biggest dangers is that as corporations pour increasing amounts of money into genetic research, public funding could dry up.

There are three interconnected threads in the problematic posed by the relationship between public and private funding in agricultural research. First, to what extent does public research money contribute to private profit making? Second, to what extent are public science research agendas set by the research interests of private companies, according to their commercial strategies? Third, to what extent does the presence of private money for research dissuade public policy masters to reduce both public research budgets and, thereby, the guarantee of the intellectual independence of their research staff?

It has been the public investment in agricultural research which has provided the major breakthroughs in hybridisation of maize, for example, and so has contributed to the prosperity of the agricultural community, both in the US and in Europe. The independent yeoman farmer, so much valued in Europe along with the tradition of the family farm, has in fact benefited enormously from the work of public agricultural research stations. Although perhaps the mechanisms are different, there may be a double pressure for the collapse of the independent farmer: intellectual property rights on plant and animal genetics, and thereby control over the entire food processing chain by private corporate interests, through vertical integration within the agricultural sector. This situation might also herald the demise of the personal relationship with the countryside which has safeguarded Europe's natural heritage.

Looking to the future

Vertical integration within the agricultural sector is a phenomenon which has been taking shape for almost half a century, and the European dimension is not that much different from the reality confronting agricultural communities elsewhere. The mechanisms are technical, scientific, financial and political. Loss of control over agricultural is loss of control over the countryside.

What, then, remains to be debated? First and foremost, the relationship between government and the private sector:

- Who has control over the research agenda relating to agriculture?
- What is the justification, in terms of social utility, for establishing private property rights over genetic structures?

Second, the consequences of oligopoly in the agro-industry:

- When does it become justified to consider anti-trust measures to regulate the influence of private interests within the food production chain?

Third, the location of statutory control over the global dynamics of trade in seed, feed and primary agricultural commodities (both plant and animal):

- Are individual governments able to regulate the impacts of multinational strategies?
- If an inter-governmental seat for the regulation of global trade exists (the WTO), should it also have responsibility for affairs related to life sciences; or should a superior jurisdiction – perhaps under UN auspices – be established?

These issues are not purely scientific, nor are they purely economic, nor are they purely social. The fact that they are intimately interrelated means that if the IUCN is to be a proponent in the debate, which must occur, it has to be willing to take positions which are based in all three domains. In the modern world, science and policy go hand in hand.

Finally, the European dimension of vertical integration in the agricultural sector must be understood as having a global influence.

Bibliography

Coleman, William; Skogstad, Grace. 2000. Agricultural policy: regionalisation and internationalisation. In: Stubbs R., Underhill, G., editors. 2000. *Political economy and the changing global order*, 2nd edition. Oxford University Press.

European Commission. 1999. *Agriculture, environment, rural development: facts and figures*. Office for Official Publications of the European Communities.

Eurostat. 1995. *Statistical compendium for the Dobrís assessment – Europe's environment*. Office for Official Publications of the European Communities.

Goodman, David; Redclift, Michael. 1985. Capitalism, petty commodity production and the farm enterprise. *Sociologia Ruralis* 25: 231–247.

Goodman, David; Sorj, Bernard; Wilkinson, John. 1987. *From farming to biotechnology*. Oxford: Basil Blackwell.

Gray, John. 1998. *False dawn*. London: Granta Books.

Heffernan, William. 1999. Consolidation in the food and agricultural system, a report to the National Farmers Union. www.FarmCrisis.net.

Lappé, Marc; Bailey, Britt. 1999. *Against the grain: the genetic transformation of global agriculture*. London: Earthscan.

Marsden, Terry; Whatmore, Sara; Munton, Richard. 1987. Uneven development and the restructuring process in British agriculture: a preliminary exploration. *Journal of Rural Studies* 3(4): 297–308.

Nowicki, Peter L. 1996. Environmental benefits from agriculture in Europe. In: *Environmental benefits from agriculture: issues and policies*. The Helsinki Seminar. OECD.

Nowicki, Peter L. et al. 1999. Background study for the development of an IUCN policy on agriculture and biodiversity. IUCN ERO.

Potter, Clive. 1998. *Against the grain*. Wallingford (UK) and New York: CAB International.

Ruigrok, Winifred: International corporate strategies and restructuring. In: *Political economy and the changing global order*, 2nd edition. Oxford University Press.

Stanners, David; Bordeau, Philippe, editors. 1995. *Europe's environment – the Dobrís assessment*. European Environment Agency.

Stubbs, Richard; Underhill, Geoffrey, editors. 2000. *Political economy and the changing global order*, 2nd edition. Oxford University Press.

Underhill, Geoffrey. 2000. Conceptualising the changing global order. In: *Political economy and the changing global order*, 2nd edition. Oxford University Press.

Van der Ploeg, Jan Douwe. 1992. The reconstruction of loclity: technology and labour in modern agriculture. In: Marsden, Terry; Lowe, Philip; Whatmore, Sarah, editors. *Labour and locality. Uneven development and the rural labour process.*

Winter, David M. 1986. The survival and re-emergence of family farming: a study of the Holsworth area of West Devon. Doctoral thesis, the Open University.

Discussion Points from the Session – Business Influence in the Agricultural Sector

Vertical control – questions, concerns and future directions

- "We have cheaper and cheaper food, yet greater environmental demands on agriculture. What was possible before, when prices were higher, is no longer possible. Something must give."
- "How we can we redirect the global system so that we get the benefits of biotechnology while eliminating the negatives?"

  "It is a global scale issue and concerns the relevant research agendas. Products must be developed using public money so that no return on investment is needed."
- "Agro-industry has direct and indirect control over the farm. Can this change?"

"Presently, niche marketing is the only way, for example, organic agriculture. But organic farming is not the complete solution as it is good for soil, but not a complete solution for biodiversity."

"The ability for farmers to get out of the multinational grasp will depend on capacity building of farmers – social and community level work."

"Yes capacity building is vital as multinational corporations have a huge advantage in information provision and lobbying and this balance needs to be corrected."

"Dialogue with large corporations is needed to show them they have a responsibility and to work towards solutions, otherwise a regulatory approach is needed."

Invasion of Alien Seeds: Alien Species and Genetic Erosion of Indonesian Native Food Crops

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Abstract

Due to multinational advertising, a centralist agriculture policy, a lack of promotion of native crops and a lack of control on imports, many Indonesian people are now consuming alien food species. Consequently, local farmers are forced to plant alien species and native crops are becoming extinct.

About 80% of the food sold in Indonesian supermarkets and even traditional markets, especially in West Java, come from alien species. This demonstrates the wide gap between Indonesia's native richness of biodiversity and the actual condition of the market.

Many Indonesian people now consume food coming mainly from alien species. For example the Sundanese, one ethnic population living in the west of Java, have a traditional dish called *lalab*, made of fresh leaves and other part of plants such as fruits, nuts, and even flowers that are eaten with the main course / rice. Until ten to fifteen years ago, *lalabs* were prepared out of native cultivated plants, or picked directly from wild plants. However, eating habits soon changed, and nowadays *lalabs* are mostly composed of alien species with little variety. Many of the plants that were formerly used for *lalab* have become extinct. Suriawirya in his book titled 'Lalab' (1987), wrote that 'not one species used for *lalab* in the past is included in those consumed today'. As a consequence, Indonesian farmers are forced to plant alien species.

The concept of organic farming or ecofarming does not yet include enough indication on the use and development of native species, a case all the more important as it is related to the sustainability and conservation of native species and the environment they are part of. If organic farmers mainly grow alien species because of market demand, native species would be lost to the community.

Fewer and fewer native plant seeds are sown in Indonesian farms, and as a consequence many native plants have been lost. Just to quote a few documented cases; 1,500 varieties of native rice, about 30 varieties of mango and about 30 varieties of banana are reported to be extinct.

Why is this happening ?

1. The development of new lifestyles in which people see produce coming from outside Indonesia as better than their own resources. This phenomenon is more evident in big cities. Just by looking at vegetables and fruit in supermarkets, it is easy to find that most of them are alien species. Native species are seen as second rate, although they are cheaper than alien fruits. This attitude is spreading also to traditional markets, especially in big cities.
2. Centralistic agriculture policy.
3. Lack of promotion of Indonesia's native food crops due to the lack of local entrepreneurs and to the overwhelming promotional power of multinationals. The case of bananas in West Java is a good example of this trend. West Java is the largest producer of bananas in Indonesia. Many species of banana are planted here by locals, but one alien variety of banana was imported and sold in some of supermarkets. Within one year the high promotion of this banana by the producer influenced the consumers choice to the extent that consumers practically stopped buying native varieties of banana. Now, a smaller quantity and variety of native bananas are being sold in supermarkets because of insufficient consumer demand.
4. Lack of control on plant and animal imports.

What does YPBB want to do?

1. Research:
   a) Research on the impact of alien species on native ecosystems. A small amount of research is taking place on *Passiflora* sp. in the region of Gede Pangrango National Park, West Java.
   b) Research on the human activities that have resulted in the promotion and spread of alien species.
   c) Research on the status of alien species spread in Indonesia.
   d) Policy research related to the invasion of alien species and devaluation of native species.
   e) Research on people's perception about native versus alien species, to understand ways for promoting native species products.
2. Education, campaign and action:
   a) Promotion of native products, such as short messages on radio programmes about the uses of native species and the problems with alien species.
   b) Environmental education at city parks.
   c) Planting native species in city parks and in schools, or in private gardens.
   d) Promoting local resource-based development and entrepreneurship.
3. Developing a database of native species products and a programme to assist in the development of community-based native species production.
4. Policy dialogue and advocacy to promote proper policy framework and implementation, supporting alien species alleviation and the promotion of native species.

CHAPTER 5

THE TRADE DEBATE

Free Trade Versus Fair Trade

Summary of the presentation given by Vandana Shiva
Research Foundation for Science, Technology and Ecology, New Delhi, India

The liberalisation and globalisation of exports, imports and investment patterns all impinge on domestic production. Working in combination with current agriculture policies, trade liberalisation is forcing farmers in developing countries to stop growing local food for domestic use, but instead grow alien crops for an international market. Both cultural and environmental diversity are being lost as a result and large rural areas have been devastated during the last decade. The human cost has been estimated at 750 million present and future refugees. These trade policies and laws are a recipe for non-sustainability.

Trade liberalisation also cripples the ability of countries to make their own decisions and has no method for internalising costs. In India, shrimp farming in the mangrove forests has been carried out sustainably for many years before industrial farming systems were introduced in the 1990s. Local coastal communities campaigned against this, but to little effect. Now that the shrimp farming is part of a larger business operation for an international market, the mangrove forests are being destroyed at an increasing rate. They used to act as a protective shield against cyclones, but events like Hurricane Orissa in 1999 have a greater impact on shrimp farming areas. Every hectare of mangrove destroyed for industrial shrimp farming led to the loss of 200 hectares when Hurricane Orissa hit the area. Every 10 dollars worth of trade is matched by 10 dollars worth of destruction.

Companies from the developed world often dump their agriculturally destructive commodities on third world countries, leading to environmental damage and social and cultural losses. Until recently, India was the largest producer of a diversity of oil seed crops such as groundnut, coconut, sesame and mustard, which formed an integral part of sustainable food production in India. Within a year, cheap modified soybean oil from the US flooded the market. Production of this soybean oil is subsidised, a practice the World Trade Organisation is not stopping. The decline in demand for Indian oil seed crops has reduced the income of Indian oil seed farmers by about 20–30% and their profits are now too little to survive on. What must these farmers do?

A single business decision can lead to a major agricultural or environmental disaster in a sort of 'quantum jump'. Free imports of Nestlé milk triggered the collapse of the buffalo market, which could not be sustained without the sale of the milk, and many buffalo species have been lost as a result. India possesses a rich diversity of agricultural livestock, but trade liberalisation will soon wipe this out.

Trade liberalisation does not create more food where it is needed, and it is generally the poorest who lose out – in India people are even selling their kidneys to cope with the crisis that trade liberalisation has brought about. When all costs are considered, such as water and soil sustainability, industrial farms are not more productive: engineered crops can use up to ten times the level of water required by native species, but this is not accounted for in audits.

The globalisation of agriculture is not the solution. Biodiversity-rich agriculture is what creates resilience and productivity in the long-term.

Reconciling Agricultural Trade and Environmental Policy Goals

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Abstract

The main policy challenge facing agriculture in the OECD countries is to improve environmental performance and rural viability while meeting food demands in ways that are economically efficient, socially acceptable and compatible with trade and multilateral environmental agreements. Work on agriculture, trade and the environment in the OECD is ongoing and the intention is to provide more empirical evidence on the basis of in-depth studies on specific agricultural sectors. Preliminary conclusions are that further agricultural trade liberalisation is compatible with improved domestic environmental performance if complemented by domestic policy measures and actions to address market failure. Multilateral mechanisms and internationally tradable permits are also required to improve agriculture's performance on global environmental issues such as biodiversity conservation, greenhouse gas emissions and storage, and water resources.

Introduction

In recent years, in particular following the conclusion of the Uruguay Round multilateral trade agreement in 1994, there has been a vigorous debate about the effects of agricultural trade liberalisation on the environment, and the impacts of agri-environmental measures on trade.

That debate centres around such questions as: Is agricultural trade liberalisation on balance beneficial or harmful to the environment? Do different agri-environmental measures affect the international competitiveness of agriculture sectors? Which mix of agricultural, environmental and trade policies can best achieve sustainable development – economic growth, improved environmental performance and social equity?

Work in the OECD on agriculture and the environment has been addressing these questions in three main ways: examining the conceptual issues to clarify the linkages involved and develop a framework for policy analysis; reviewing the empirical evidence; and analysing the characteristics of appropriate policies and market approaches that can best achieve sustainable development. The overall goal is to use objective analysis to inform and advise policy makers to develop and implement policies that will contribute to improving global welfare.

The challenges facing agriculture

The primary role of agriculture and the agri-food sector is to provide safe and sufficient food and fibre as efficiently as possible. It has a very good record in producing sufficient quantities of food, as over time global food production has exceeded population growth, with some – albeit modest – increases in food consumption per head. However, those trends have sometimes been at the expense of the environment, and then have not been experienced in all countries and regions. Assuming that there will be 3 billion more people in the world in the next half century, who will also be richer, increasing production will present a major challenge to the agri-food sector as there are growing concerns about the safety of food and the environmental consequences of some agricultural practices.

Agriculture also has a role in contributing to balanced rural economic and social development. In most OECD countries primary agriculture accounts for a very small part of the overall economy in terms of output and employment, although when the ancillary industries dependent on agriculture are also taken into account, the importance of agriculture is much greater. But that is not the case in many non-OECD countries, or in some regions in OECD countries. With agricultural sectors across the world becoming more closely integrated into the domestic and international economy, and with rapid technological and

structural changes in the whole agri-food system, there are concerns in some countries about the future of agriculture in their rural areas.

Increasingly, public opinion in OECD countries is demanding more from agriculture than just economically efficient production of enough food. The sector is required to respect environmental quality, and provide environmental benefits and services. Consumers are demanding to know the origin of their food, the methods used in its production and the associated environmental impacts. That agriculture is expected to produce a wider range of environmental and social outputs than simply food is encompassed within the concepts of 'sustainability' and 'multifunctionality'.

The main policy question can be summarised as follows: What role is there for policy so that agriculture can contribute to the improvement in environmental performance and rural viability, while meeting food demands in ways that are economically efficient, socially acceptable and compatible with trade and multilateral environmental agreements?

Developments in agriculture and policy

Agriculture (with forestry) is the major user of scarce land and water resources. There is little spare capacity, but increasing demands are made not only for agricultural but also for non-agricultural uses. This in turn is leading to upward pressure on the costs of these resources and on the cost of improving the quality of environment, although there are wide variations across and within countries. But improvements in technology and resource management are offsetting these cost increases and offering the possibility to use resources in more economically efficient ways.

Historically, as part of the process of economic growth, the real price of food relative to the price of other commodities has steadily fallen, while output has risen over the long-term. For example, the real price of wheat has fallen by roughly 2% annually (with wide year-on-year variations) since the mid 1980s. Overall, in the OECD area agricultural output has risen by 15%, using 8% less farm labour and 1% less land, but with 5% more water over the same period. This increasing intensification of agricultural production has put pressure on the environment. An OECD report published in February 2001 on tracking the environmental performance of agriculture, 'Environmental Indicators for Agriculture – Volume 3: Methods and Results', shows a very wide range of environmental effects from agriculture across OECD countries and mixed trends in performance over the last two decades.

One of the most important facts that have exerted a major influence on agriculture is government intervention in domestic OECD agricultural markets, and in international trade. The OECD annually monitors and evaluates agricultural policy developments, using estimates of the support provided to agriculture in its 30 member countries. The latest estimates show that total support to OECD agricultural sectors reached around USD 360 billion in 1999, which represented about 1.4% of overall GDP. Over three-quarters of this amount was support to agricultural producers (as measured by the Producer Support Estimate – the PSE), which accounted for 40% of farm receipts, the same level as in 1986–88. The other quarter was support to services provided to the sector as a whole.

The gradual decline in support until 1997 was reversed in 1998. There has been a decrease over the last decade in 'production-linked support' and an increase in measures designed to improve the environment (including those for organic production methods), but over three quarters of support to producers remains linked to production. The polluter pays principle has been only weakly implemented in many countries in agriculture, but the impact of environmental regulations is increasing, as are food safety regulations, which often have implications for methods of production and environmental outcomes.

There are great variations on the composition and level of support across countries: for example, the percentage PSE in the European Union is currently around 47% while it is about 24% in the United States. Support is low in New Zealand and Australia, and high in Japan, Korea, Norway and Switzerland.

OECD countries have been committed to reforming agricultural policies – to reduce support, shift to less market distorting policies, and reduce trade protection – since 1987. The conclusion of the Uruguay Round trade negotiations in 1994 underpinned reform efforts, in particular those related to trade (import access, export subsidies and production and trade-linked domestic support). Nevertheless, domestic policy reforms are only gradually being implemented, and trade barriers remain pervasive for agricultural commodities. Negotiations on further agricultural trade liberali-

sation are now underway in the WTO, but any substantial progress is unlikely in the near future.

Agriculture and environment

A substantial amount of research – including that by the OECD – has analysed the effects of agricultural production and policies on the environment. One of the characteristics of agriculture (which is also shared in particular by forestry) is that agriculture generates both environmental harm and environmental benefits. The harm includes farming on environmentally marginal areas, soil erosion, excessive use of scarce land and water resources, and excessive chemical use (fertilisers, pesticides), water pollution, and degradation of biodiversity and wildlife habitats. The benefits include farming practices and systems that provide attractive landscape, protect wildlife habitats and biodiversity, contribute to flood control, and are a source of greenhouse gas sinks. Both the directions of harmful or beneficial changes (as measured by agri-environmental indicators, for example) and changing public preferences and priorities will influence standards and targets as to what is considered harmful and beneficial in each country.

It is evident that agricultural and environmental policies play an important role in determining the environmental impacts of agriculture. The environmental effects – pollution, resource depletion and amenities – are often closely linked to agricultural production and practices, which are affected by government policies. Markets are often lacking (public goods) or poorly functioning (externalities) for some environmental outputs, resulting in too much pollution and not enough environmental benefits from agriculture. And achieving the 'best' agri-environmental and trade outcomes to maximise welfare in one country can be at the expense of welfare in other countries. For example, where countries use protectionist measures (reducing imports and subsidising exports) to achieve their own environmental objectives, this imposes costs on potential exporting countries who thereby have fewer financial resources to achieve their own environmental goals.

Environmental consequences of agricultural trade liberalisation

Much work has been undertaken in the OECD on analysing the linkages between trade liberalisation and the environment. In the context of the agricultural policy reform, two studies have been recently completed in relation to agriculture. Their main conclusions are summarised below.[1]

Domestic and International Environmental Impacts of Agricultural Trade Liberalisation [Unclassified Document COM/AGR/ENV (2000)75/FINAL]

Agricultural trade liberalisation has the potential to contribute to overall improvements in the environmental performance of agriculture. Further reductions of barriers to agricultural trade (a scenario assuming an extension of the Uruguay Round commitments until 2004) will have both positive and negative impacts on the environment. The direction and magnitude of these effects will depend on the changes trade liberalisation induces in agricultural production patterns, the state of the environment, and the environmental regulations and policies in place to preserve and improve environmental quality. Given the considerable diversity of agricultural production systems, natural conditions and regulatory approaches in OECD countries, the environmental impacts will vary between countries, regions and locations. Indeed, many environmental effects are site specific.

A reduction of trade barriers will influence the overall scale of agricultural activities, the structure of agricultural production in different countries, the mix of inputs and outputs, the production technology and the regulatory framework. These adjustments, in turn, will impact on the international and domestic environment by increasing or reducing environmental harm and creating or destroying environmental amenities. International environmental impacts include greenhouse gas emissions, changes in international transport flows and the potential introduction of non-native species alongside agricultural products. Domestic environmental effects include water pollution from fertiliser and pesticide run-off, and changes in land use that affect landscape appearance, flood protection, and biodiversity.

This study illustrates the direction and magnitude of some of the environmental impacts by combining preliminary results on the commodity market impacts of agricultural trade liberalisation with agri-environmental indicators. The international

1. These studies follow on from a conceptual scoping study, *Agriculture, Trade and the Environment: Anticipating the Policy Challenges* prepared by Professor David Ervin and published by the OECD in 1997.

environmental impacts indicate that projected medium-term increases in ruminant livestock numbers could lead to substantial increases in methane emissions in some OECD countries. This warrants the attention of policy makers in the context of existing Kyoto Protocol commitments on greenhouse gas emissions.

With respect to domestic environmental impacts, the quantitative analysis suggests that agricultural prices and production intensity would decrease in countries that have had historically high levels of fertiliser and pesticide application, so that environmental stress in these countries would be relieved. Countries where increases in production intensity occur might be able to accommodate increased application rates of agrochemicals relatively easily, as their historical levels of fertiliser and pesticide use tend to be low. Projections on the effects of further agricultural trade liberalisation on land use do not suggest substantial changes in agricultural land. Yet the analysis does not allow us to derive firm conclusions on prospective changes in landscape appearance, soil and flood protection, and biodiversity, since the projections did not explicitly consider pastures and marginal agricultural land.

Under the assumptions of the scenario analysis, the environmental impacts of general economic developments are more important than those of further agricultural trade liberalisation, so that agri-environmental policies will need to be developed independently of trade policy reform. Environmental effects from changes in agricultural activities will most effectively be addressed through targeted policy measures that distort agricultural production and trade to the least possible extent. As far as transboundary effects on the environment are concerned, international cooperation, for example in the form of international environmental agreements, might be necessary to overcome the free-rider problem.

Production Effects of Agri-environmental Policy Measures: Reconciling Trade and Environmental Objectives[2]

This study discusses linkages between agri-environmental policies and trade with a view to informing the policy debates on the impacts of agri-environmental standards on farm competitiveness, and the effects of agri-environmental programmes and payments on international agricultural trade. The two debates are closely related. The first is primarily concerned with policy measures that aim to reduce environmental pollution from farming activities, while the second centres around remuneration payments to farmers for the provision of agri-environmental services. The discussion in the paper is based on general economic welfare analysis complemented by issue-specific conceptual and empirical investigations.

Like many other policies, agri-environmental policies have direct and indirect effects on farmers' production decisions. But not every effect from agri-environmental policies on trade will be distorting. A policy to internalise previously unaddressed externalities, for example, will increase environmental quality and societal welfare domestically, and possibly alter domestic production levels and international trade flows with positive and negative welfare effects for other countries. But if the overall global effect is welfare-improving, the changes in international production and trade patterns could overall be beneficial. On the other hand, if there is domestic or international policy failure, the trade effects from agri-environmental policies can be globally welfare-reducing, in particular if the welfare losses in other countries due to changes in trade flows and world prices outweigh the domestic welfare gain from higher environmental quality.

Agri-environmental regulations impose costs on farmers, and differences in process standards across countries are at the core of competitiveness concerns. Yet, a number of empirical studies have found that the impact of agri-environmental standards on farming costs is relatively small, accounting generally for less than 5 per cent of total production costs. Moreover, some standards that inflated production costs considerably in some sub-sectors (e.g. livestock production), regions or countries were found to be of little relevance in others. Given the generally limited importance of agri-environmental compliance costs and the diversity of socio-political preferences and natural conditions across countries, it seems questionable whether a general harmonisation of agri-environmental standards on a global scale would be welfare-improving. However, harmonisation seems desirable where transboundary environmental effects are concerned.

In the Uruguay Round Agreement on Agriculture a considerable number of policy measures were exempted from reduction commitments for domestic support because they were deemed non- or only minimally trade-distorting. The agreement did not provide a definition for what constitutes a trade distortion, but specifies criteria that eligible

2. Unclassified Document COM/AGR/ENV (2000)133/FINAL

policies have to satisfy. In order to qualify for the WTO 'green box', policies should be financed entirely from the government budget and not provide price support to producers. In addition, specific conditions applied to agri-environmental policies require that payments do not exceed the compliance costs or income losses of farmers and are dependent on the fulfilment of specific conditions under government programmes, including conditions relating to production methods and inputs.

Can agricultural trade and environmental policy goals be reconciled?

The work in the OECD on agriculture, trade and the environment is ongoing. In the future we will attempt to provide more empirical evidence on the basis of in-depth studies in specific agricultural sectors, and perform analyses of the characteristics of policies and market approaches that might contribute to a better definition of the WTO 'green box'. More attention will also be paid to the linkages and environmental effects between policy developments in OECD and non-OECD countries. The preliminary conclusions of the work to date is that further agricultural trade liberalisation is compatible with improved environmental performance. But this means that agricultural support needs to be further reduced and decoupled from commodity production, that policy measures are 'recoupled' to targeted outcomes, including environmental performance, and that there is greater application of economy-wide environmental measures (in particular the "polluter pays" principle) in the agricultural sector.

In brief, this means that trade liberalisation and agricultural policy reform will improve agriculture's ***domestic*** environmental performance if complemented with domestic policy measures and actions to address any market failure. This would mean that farmers would be liable for environmental damage caused, and have incentives to provide environmental public goods that would otherwise not be produced. But it also requires a 'multilateral' approach, in that trade liberalisation and agricultural policy reform will improve agriculture's contribution to transboundary environmental performance – biodiversity, greenhouse gases and sinks, water resources – if complemented with multilateral mechanisms, such as MEAs and internationally tradable permits.

Policies should lead to a demonstrated overall ***improvement*** in domestic welfare – economic, environmental, social – without imposing uncompensated welfare costs on other countries, or impeding structural adjustment and the search for cost-effective alternative approaches. In many cases appropriate policies should be implemented at the local rather than the national level, which means that attention needs to be paid to the institutional structure.

While trade liberalisation will tend to improve the environmental performance of agriculture, provided that complementary agri-environmental and environmental policies are in place, the resulting economic growth provides the means to finance the appropriate investments and actions. Whether or not the latter are undertaken is another question.

The author is responsible for all views expressed in this article, which are not necessarily those of the OECD or its member countries.

Discussion Points from the Session – The Trade Debate

'Free' trade?

- "Free trade today is not true free trade. It is only true if market costs reflect opportunity costs, but this isn't the case. Biodiversity loss and ecological integrity are not accounted for; for example, irrigation is subsidised. Hence, the way we are reorganising our resources is not helping redistribution, even for environment. Trade moderation which takes into account all costs is vital."
- "Free trade only benefits rich countries and little attention to loss of biodiversity is seen in western research."

  "Yes, OECD represents one sixth of world – the rich. But more and more, impacts are being examined in poorer countries of OECD (China, India, Brazil etc.) and beyond. OECD is calling for a cut in subsidies, internalisation of costs and changes in taxation to take account of environmental effects."

In a world of inequality

- "One of the major challenges in reforming trade liberalisation will be to see what so-called equal rules equate to in a world of inequality. The tiny amount of support to India farmers has been cut, while the West carries on. Protecting the livelihoods of farmers must come before multinational corporations. We must try again to make people recognise that agriculture is a multi-factor activity and not just for production."
- "It is not just in developing countries where there are problems. In Britain multinationals do not employ fair pricing mechanisms, which caused the collapse of lamb prices in the UK, for example. If there is market control there is no liberalisation."
- "When looking at trade, inequality is a valid point, but trade is just one of the problems."

Extrapolating situations from country to country

- "In North America, areas are at pesticide saturation, and so lower inputs of herbicides may seem vital; but in a tiny field in India, where farmers have a different system of pest control, this isn't nearly so relevant."

  "Yes, there is no one-size fit for policy and this is also the case for OECD, which includes Turkey and Mexico. Separating OECD countries from LDCs is not helpful as there are many common problems. We must also remember that, in general, open markets are better than closed markets. Take North and South Korea for example."

Re-assessing trade rules

- "It is time to re-examine global instruments on trade."
- "Trade rules should provide for and support cultural and environmental diversity?"
- "We need to look for win-win solutions. We must be cautious when addressing trade liberalisation, as we need to use tools such as full cost accounting. IUCN should look at corporate globalisation and intervene at the UN to oppose trade liberalisation measures that could impact negatively on the poor."

CHAPTER 6

GMOS: POTENTIAL VALUE AND IMPACTS

Organic Farming Approaches to Genetic Engineering and Biotechnology

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GMOs are contrary to the philosophy of organic agriculture, which respects the inherent nature of plants and animals and seeks to stabilise production systems using natural means. Organic agriculture is based on closed-cycle concepts, offers flexibility, is more energy efficient and less dependent on chemical inputs, and there is overwhelming evidence that it enhances biodiversity. Genetically modified plants generally require more chemical inputs and represent a direct threat to traditional breeding and biodiversity, with negative effects on organic as well as conventional agriculture.

Genetic engineering runs counter to the holistic principle of organic agriculture

It is a fundamental principle and reality of organic agriculture to optimise the production system as a whole by intensifying the power and creativity of nature. Genetic engineering, a reductionist approach, does not fit at all into the philosophy and principles of organic agriculture. The following short characteristics and brief reflections about the impacts of genetic engineering leave no doubt that this approach has no place – and never will – in organic agriculture.

Genetically engineered breeds and varieties tend to rely on a high input system of agriculture. Genetic engineering will result in more industrialisation and globalisation of agriculture, which conflicts with the objective of organic agricultural production and processing, as well as predominately regional marketing. Genetic engineering introduces a new and ultimate level of risk that is no longer limited in time or space. This is contrary to the philosophy of organic agriculture, which seeks instead to stabilise the production system with natural means.

Genetic engineering does not contribute to an overall reduction of chemical inputs. If we look at all these 'round-up ready' plants, we actually see an increase in chemical inputs. The required large-scale sale of genetic engineered varieties and breeds will further destroy what remains of biodiversity. Diseases and hereditary biases will spread much more quickly. 'Patenting of life' which accompanies genetic engineering represents a direct threat to traditional breeding and will therefore bring very negative consequences to organic farming. And finally, genetic engineering does not respect the inherent nature of plants and animals, since it treats living things as mere factors of production, to be reconstructed as if they were machines.

What organic agriculture has to offer 'instead'

The principles of organic agriculture by nature foster decentralisation and are based on closed-cycle concepts. Besides ecological aspects, the holistic 'nature' of organic agriculture includes economic, social, cultural and gender considerations. Organic agriculture offers flexibility, such as 7 to 12 year crop rotations instead of monocultures. Organic agriculture is also more energy efficient and thus less dependent on 'chemical' inputs (e.g. mineral fertiliser), and it maintains a balance between livestock and the land – cows on organic farms are fed, by and large, from what grows on the farm instead of mainly imported feed. There is overwhelming scientific evidence that organic agriculture enhances biodiversity, creating diverse and beautiful landscapes.

Organic agriculture does not further contribute to the ongoing pollution of the environment. As a

matter of fact, it offers a profound environmental risk reduction. As our societies look for solutions in this context, organic agriculture can offer 100% pesticide and GMO risk reduction! No form and practice of agriculture is more defined, controlled and certified (green label schemes) and organic agriculture is also economically more profitable for the farmer.

This short profile of the contributions of organic agriculture should give sufficient substance to our claim that 'organic agriculture is sustainable agriculture put into practice'.

Sustainable biotechnology?

Under the name 'sustainable biotechnology', the biotechnology industry has tried to sell a package of modern biotechnology products to countries in the South. Examples include 'bio' fertilisers such as Azolla, 'bio' pesticides such as pyrethrum, herbal veterinary products, etc. However, these so-called 'sustainable biotechnology' products are merely examples of existing ***non***-manipulated organisms that are used within traditional agriculture.

Transnational corporations are now very interested in exploiting these resources and traditional knowledge. This offers the possibility of bringing local, indigenous knowledge under industrial control through patents and the use of seed and gene banks. Production of analogous, synthetic products will be industrially organised, controlled and sold worldwide. These genetically engineered products are often sold as 'sustainable' products, although such a description is highly misleading.

Conclusions

Genetic engineering is not compatible with organic farming, and runs contrary to the fundamental principles of organic agriculture. Its application outside organic agriculture will also have negative effects on organic agriculture itself. That is why our movement generally opposes genetically manipulated organisms in food and agriculture.

So far there is no reason to presume that genetically engineered products contribute to a more sustainable agriculture. Indeed, the evidence leads to the opposite conclusion. It will lead to a worsening of existing problems, rather than offering a solution to any of them. Albert Einstein said: 'You cannot solve the problem with the same kind of thinking that has created the problem.' And that is why we do not need GMO technologies, but the radical paradigm shift that accompanies organic agriculture.

Genetically Modified Organisms (GMOs) and Food Security

Summary of the presentation given by Zhangliang Chen
University of Peking, China

1983 saw the advent of gene transfer into a single plant cell. In 1996 the first field trials of genetically modified organisms (GMOs) took place. Between 1996 and 1999 there was a great increase in the plantation of GM crops, but recently the percentage increase of GM crops has significantly declined as a consequence of concerns about environmental impact and food safety. At this stage, only the multinational corporations producing GM seeds can really profit from GMOs.

China now faces major GM crop import and export problems. For instance, EC countries will not accept GM soy sauce produced in China using GM soy beans grown in the United States. Obtaining permission to plant GM soy crops in China is also becoming increasingly difficult.

China already hosts 22% of the world's population and by 2025, 1.5 billion people are expected to be living in China. Over the last 50 years, grain productivity has increased from 100 million tons to 500 million tons a year. Existing farming methods would make it possible to feed 1.2 billion people by 2025 without dramatically increasing the arable area, which currently occupies 8% of the total land area. However, given the current rate in population growth, the increasing cost of pesticides and the decrease in farmers' income, other options such as GMOs need to be explored to feed the expected population without dramatically increasing the farmed area.

Crop resistance to insects is a major problem in China, particularly in rural areas. Cotton worms that destroy cotton plantations have developed resistance to pesticides. Children are often kept home from school to pick worms from cotton plants; the worms are then fed to chicken that often die from pesticide poisoning. Transgenic crops could help alleviate the problems posed by crop pests. Several GM crops including cotton (Bt – Monsanto), tomato, sweet pepper and petunia are currently undergoing trials. Trial plantations of GM cotton are unpalatable for worms and do not require the use of pesticides.

Health concerns on GMOs arose following laboratory tests, such as a test in 1997 in which the internal organs of rats, fed on GM potato, were impaired. This brought about doubts on the safety of GMOs. In spite of the fact that other tests reported no side effects, the hype surrounding GMOs led to a lack in public knowledge and awareness about their potential benefits, particularly in countries where food security is an issue.

GM crops already account for 50% of China's cotton plantations, which have been grown for the last two and a half years. Yet, cotton cannot be commercially harvested. 15 years ago the same concerns surrounded the use of *E. coli* for vaccine production – now we see its immense value. Perhaps in ten years time GM crops will be accepted.

Discussion Points from the Session – GMOs: Potential Value and Impacts

- "I never thought I would support GMOs. I agree mostly with organic agriculture, but I do not find there is a principle that makes me oppose this technology as a whole. The simplest way to have disease resistance and eliminate spraying, is to remove one gene from a resistant wild variety to cultivated variety. This can't be wrong. Legitimate concerns must be evaluated, but must we now dismiss whole technology which has great potential? I welcome IUCN's involvement."

Concerns over gene transfer

- "What about gene transfer from animal to plant?"

  "This needs investigation, and I respect the objections, but there is massive homology between humans and plants."

Nutritional value

- "All your GM crops look machine made. Are they nutritionally equivalent, especially in micronutrients? This is important."

  "If a gene is not related to content then there is no change to quality. I cannot say whether it is totally safe – nothing is. But over five years, more than 300 million people have been eating many types of GM food and there are no problems yet."

Precautionary Principle

- "There are legal factors, which must be considered. The Precautionary Principle says we should ere on the side of safety."
- "Yes, the Precautionary Principle is important, and in motion."
- "The EU has spent four years negotiating under the CBD Biosafety Protocol to bring together all interests under the Precautionary Principle. Can this protocol be ratified and be implemented practically? This will be a major challenge. There is a need for proper risk assessment. The IUCN family should really help us build this capacity, to help small developing countries to make risk assessments."

Rationale for GMOs

- "The big issue is the rationale for GMOs. In Botswana we produce enough but don't distribute. With western technology, we cannot even provide for our tiny population."

  "I agree that aim should not just be to produce more food."
- "The real key would be to look at the root of problems, not symptoms. GMOs are mainly about solving the symptoms of hunger, not addressing the causes."

The right to know

- "There are two combined legal agendas: environmental law and consumer law. Both say we have the right to know. Industry is currently denying consumers information."
- "There are many rights suppressing rights to know, even EU law. For example genetically modified soya occurs in 30,000 different food products sold in the supermarkets."
- "How can we trust industries any more? They have misled us so many times and this is so dangerous."
- "Yes, I am not against technology as such, but we have been against Monsanto and the soya bean and Roundup."

GMO Research

- "We need an even playing field in the area of GMO research. In Germany, 98% of research is spent on GMO development."

  "Yes, 50% of funds should stay with GMOs and the other 50% should be put into alternatives."

A dialogue for discussion is needed

- "GMOs are very, very significant, therefore IUCN should look at the scientific evidence for and against GMOs. Can IUCN provide this forum? IUCN should not call for a ban outright."
- "The introduction of any technology should involve social criteria. If it is difficult to explain genes to peasants, the same is true or policy makers and decision-makers. A certain knowledge and skill level is needed. Can IUCN help?"

The Impact of Biotechnology on Sustainable Agriculture Development in Latin American and the Caribbean Region: The Andean Countries as a Model

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Abstract

This paper outlines the wealth of biodiversity in the Latin American and Caribbean (LAC) region (a global centre of genetic diversity), and presents an overview of current biosafety regulations in the region. The adoption of biotechnology has increased in recent years and the demand in the region for transgenic cultivars is expected to rise. The countries of the LAC region must take advantage of these technologies if they want to move towards food security and sustainable agricultural development. However, they need to make objective technical evaluations of the possible risks to human health, the environment and agricultural production, and must continue developing and perfecting their existing regulatory instruments to bring them into line with international biosafety agreements. The competent national institutions need to develop the capacity required to manage and evaluate field trials.

Introduction

Since the beginning of the 20th century the wealth of biodiversity in the Latin American and Caribbean (LAC) region has been universally recognised and is of great strategic value for reducing the deficit in agriculture production in the region. Sustainable use of these resources requires an institutional capacity that will enable the countries to conserve, manage and use this resource appropriately.

The concept of sustainable agriculture development is based on the conviction that it is possible to increase agricultural production without unnecessarily depleting the world's finite natural resources. If yields per hectare cannot be increased significantly over current levels, then more wilderness areas, which are only marginally suitable for agriculture but are rich in biodiversity, will be utilised for food production.

The characteristics of modern biotechnology provide both opportunities and challenges. If LAC countries are able to build capacity in their national research systems, biotechnology has the potential to support national efforts to achieve food security, raise export potential and move towards sustainable development in the region.

The countries of the region require appropriate infrastructure to acquire, absorb, develop and efficiently manage biotechnologies. The creation of enabling conditions must be addressed to obtain the potential benefits of these new technologies and to minimise any possible adverse effects on the environment, on human health or on the agricultural productive systems.

The first step for a government in creating a suitable environment to harness the potential of biotechnology, improve agricultural productivity and mitigate concerns about potential adverse effects is to provide a regulatory framework that ensures safe use of biotechnology products in an opportune and effective manner.

This paper outlines the wealth of biodiversity in the LAC region and presents an overview of current biosafety regulations in the region.

Agriculture and biodiversity in the LAC region

The Latin American and Caribbean Region is made up of 30 countries: Antigua and Barbuda, Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Organisation of the Eastern Caribbean States-OECS, Panama, Paraguay, Peru, St Kits and Nevis, St Lucia, St Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay and Venezuela.

The region has an average per capita income of nearly USD 4,000 a year, the highest of all the developing world, and has large natural resources and great diversity of ecosystems. The region also continues to display extreme economic inequalities between rich and poor: in the wealthiest country of the region the average income is almost USD 9,000 a year, in the poorest it is just under USD 400 (World Bank 1999).

LAC countries are of strategic importance for global food security because they include three of the 12 global centres of origin of crops of major socio-economic importance and because of their enormous biodiversity (Leon 1987). Although representing only 7% of the earth's surface, the LAC region contains approximately 90% of the planet's biodiversity, which is concentrated primarily in 18 countries, nine of which are in the American hemisphere (Alarcón 1998).

The region's population is expected to increase from 490 million to nearly 680 million by 2025. It is possible that more than 30% of LAC cereal consumption will be imported by 2020.

Since 1950 25% of the world's topsoil has been lost and continued erosion at the present rate will result in the further irreversible loss of at least 30% by the year 2050. A similar percentage may be lost to land degradation. The Food and Agriculture Organisation (FAO) has projected that over the next 20 years arable land in developing countries could be expanded by 12% at acceptable economic and environmental costs (although such expansion would inflict damage on the remaining biodiversity). The increase in demand for food that is expected to occur in these countries during the same period is 61%. The only large tracts of land in the LAC that have the potential for conversion to arable land are the Brazilian Cerrados and the Llanos of Colombia and Venezuela (Kendall et al. 1997).

According to some theories, human beings appeared in America about 30,000 years ago. Agriculture began about 7,000 to 10,000 years ago in different parts of the hemisphere, where three centres of plant domestication have been recognised: Mesoamerica, the Andes and the Amazon. More than 45 groups of cultivated species originated in the Andean region, 12 were domesticated in the Amazon and 100 were domesticated in Mesoamerica.

Human beings have used about 5,000 of the 250,000 existing plant species. Today, no more than 500 are of economic importance, and only 15 are responsible for the production of about 80% of the calories produced by modern cultivars. In this regard, the Americas stand-out for the many crops they have contributed to world agriculture.

Genetic resources have been utilised intensely in agriculture. Genetic diversity has always been the raw material for both the food and pharmaceutical industries. Biodiversity is an indispensable resource for farmers to select and grow cultivars adapted to ecological, cultural and economic needs.

The challenges and opportunities for LAC are large, given the high participation of the agricultural sector in the region's gross domestic product. In addition, the LAC region possesses a rich flora and fauna, including micro-organisms essential to obtaining new products for the pharmaceutical and food industries.

Agricultural systems throughout the region are not homogeneous. Those in the temperate zones of the north and south differ from the those of the high mountain plains or those of the wet and dry tropical lowlands and medium-elevation hillsides, such as those in Central America, the Andean countries and some Caribbean nations.

Application of agricultural technologies is better in the temperate ecosystems than in the tropical areas. This is the case with soybean and wheat, where results achieved in other areas have been used, including the recent import of transgenics such as 'RR soybean'. In tropical areas, with the exception of rice, there is no available technological counterpart for the region. However, the technological gap with the world's leading countries is widening with respect to many crops (Table 1).

Table 1

Current yields of basic cereal crops in the LAC region and world leaders

Products	*Av. current yield in LAC (tonnes/ha)*	*Current yields of world leaders (tonnes/ha)*	*Annual growth rate in LAC 1985–1997 (%)*
Rice	3.2	6.2	2.9
Beans (dry)	0.6	1.8	0.6
Maize	2.7	7.7	2.9
Wheat	2.4	6.7	1.8

Source: IICA, Technical Management, Area II. Supported data from FAO STAT.

In the years to come global, regional, and national development will undoubtedly be influenced by the rise of new biotechnologies. The commercialisation of genetically modified products by biotechnological techniques not only has the potential to increase production and productivity but will also alter the characteristics of the supply of agricultural products. The significant impacts on production and productivity caused by commercially available transgenic crops are widely recognised, but strong controversies have arisen over possible adverse impacts on natural resources, the environment, agricultural productivity and human health.

The Andean region comprises five countries: Bolivia, Colombia, Ecuador, Peru and Venezuela, with a total area of 4,104,816 km^2 and a total population of 103 million. As mentioned above, three of the 12 centres of origin and domestication of species are located in the LAC region. Numerous plants that have provided food for humanity came from the Andean Region, including potato (*Solanum tuberosum*), sweet potato (*Ipomoea batatas*), maize (*Zea mays*), tomato (*Lycopersicon esculentum*), beans (*Phaseolus vulgaris*), cassava (*Manihot esculenta*), peanut (*Arachis hypogea*), pineapple (*Ananas comosus*), cocoa (*Theobroma cacao*), peppers (*Capsicum annum*, *C. pubescens* & *C. frutescens*), papaya (*Carica papaya*), la mora de castilla (*Rubus glaucus*), cotton (*Gossypium hirsutum* & *G. barbadense*) and tobacco (*Nicotiana tabacum*).

The full nutritional and medicinal value of many other plants of LAC origin has not yet been determined. These include cereals such as quinua (*Chenopodium quinoa*), kañiwa (*Chenopodium pallidicaule*) and amaranthus (*Amaranthus caudatus*); tubers such as bitter potato (*Solanum juzepczukii*), oca or ibia (*Oxalis tuberosa*), ulluco (*Ullucus tuberosus*), mashwa or cubio (*Tropaeolum tuberosum*); roots such as arracacha (*Arracacia xanthorrhiza*), achira (*Canna edulis*), jicama (*Pachyrhisus tuberosus*), yacón (*Polymnia sonchifolia*), mauca or chago (*Mirabilis expansa*), maca (*Lepidium meyenii*) and ajipa (*Pachyrhisus ahipa*); legumes such as cacha (*Phaseolus polyanthus*), tarwi (*Lupinus mutabilis*), torta (*Phaseolus lunatus*), pajuro (*Eritrina edulis*) and pacay (*Inga feuillei*); vegetables such as zapallo (*Cucurbita maxima*) and achokcha (*Cyclanthera pedata*); and fruits such as pitaya (*Acanthocereus* sp), pepino (*Solanun variegatum*), uchuva (*Physalis peruviana*), tomato tree (*Solanum betacea*), granadilla (*Passiflora ligularis*), curuba (*Passiflora mollisima*), curuba de indio (*Passiflora mixta*), tin-tin (*Passiflora pinnastistipula*), curuba antioqueña (*Passiflora antioquiensis*), badea (*Passiflora quadrangularis*), cherimoya (*Annona cherimolia*), and ciruela de fraile (*Bunchosia armeniaca*).

The potential contribution of biotechnology to sustainable agriculture is truly great, but the introduction of new transgenic varieties in tropical ecosystems deserves careful oversight and monitoring. In the LAC region progress in biotechnology research on some of the most valuable crops of the region has been particularly rapid. Scientists hope that the development of transgenic plants will help to alleviate both the heavy use of pesticides and the susceptibility of traditional cultivars to a number of pest and a biotic stresses.

Another important fact that needs to be considered is that the LAC region, and in particular the Andean region, is the centre of genetic diversity. For a large number of the species mentioned above, however, an issue directly referred to in the Convention of Biological Diversity is that the Andean region must respond to questions about the likelihood of genes spreading from transgenic crops to wild relatives and uncertainty about the possible impacts on genetic crop diversity.

Regional status

The adoption and expansion of biotechnology in the LAC region has increased in recent years. One indicator used to measure the progress in the biotechnology sector is the number of field tests of transgenic crops, which is estimated to be near 870 in the region since 1997. Nevertheless, with very few exceptions, transgenic crops tested in the agroecosystems of the LAC region have been developed in northern industrialised countries.

If we take into account the fact that the cultivated area for the majority of conventional crops is greater in the developing countries than in the industrialised countries (14.5 times greater for rice, 3 times greater for cotton, 2 times greater for maize and almost all cassava and sweet potato) we can assume that the demand for transgenic cultivars will increase in developing countries.

The countries of the LAC region must take advantage of these technologies if they want to move forward in agricultural development. However, the region must also make an objective, technical evaluation of possible risks for human health, the environment and the agricultural and cattle production that could result from the introduction of these technologies into tropical ecosystems.

In line with the global trend, national seed companies are being acquired by multinational companies. This is accentuated by the weakness of LAC governmental institutions dedicated to scientific

and technological development in the agricultural sector, which makes national capacities to generate value from indigenous crops more vulnerable. For this reason it is necessary to develop specific transgenic crop varieties for the LAC countries. Since 1987, applications for experimental tests with transgenic crops in laboratory or greenhouse conditions have been approved in the region.

Experiments in countries or regions that are centres of origin and diversity are important owing to the presence of natural pests of the crops being field tested and to the great environmental diversity in these regions. The demand for research on small plots and in different ecosystems (especially tropical and moderate) indicates the importance that research centres and multinational companies place on the experimental information obtained in these areas.

Cotton and some types of maize are of great economic importance in the LAC region. In certain areas of Mexico transgenic varieties of cotton resistant to insects or herbicides are grown commercially and more than 100,000 hectares have been planted in Mexican cotton regions since 1995. This experience is of great importance, allowing other countries in the region to determine the level of monitoring needed, especially with respect to the behaviour of insect populations and to the development of resistance by insect pests.

As for the incorporation of these technological advances in production systems, Argentina and Mexico are noted for their rate of adoption of transgenic soybean resistant to glyphosate (Roundup). Relative to the total soybean production, transgenic soybean has increased rapidly from 6% (36,735 hectares) in 1996 to 25% (1,756,000 hectares) in 1997, 60% (4,800,000 hectares) in 1998 and 80% (5,760,000) in 1999. In 1999, Bt-Cotton and Bt-Maize in Argentina were grown in 15,000 and 192,000 hectares respectively (Asosiación de Semilleros Argentinos 1999).

It is necessary to conduct research that furthers our knowledge of ecosystems, the expression and stability of incorporated genes, the botany and geographical distribution of those species for which the LAC region is the centre of origin, and the technical basis for risk assessment and risk management for human health, the environment and agriculture production. This will allow field trials, production, and commercialisation of transgenic crops to develop more smoothly. These strategies require infrastructures, trained personnel and monitoring to identify early potential problems.

National regulations

While some countries in the LAC region have biosafety regulations, the majority do not. What is even more critical is that many do not have the sort of multidisciplinary and interdisciplinary personnel needed to carry out risk analyses and risk management within a methodological framework as stipulated by modern regulations. This means that their potential advantages cannot be utilised to guarantee the necessary biosafety requirements to protect the environment, human health, agricultural production and the equitable distribution of the benefits for the welfare of their inhabitants.

The LAC region represents close to 6% of the total field trials now taking place in developing countries worldwide. The largest number of trials have taken place in Argentina, Brazil, Chile and Mexico, and these have been increasing steadily since 1987 when the first field trial took place in Chile (Table 2).

Table 2

Total number of transgenic crop fields trials in the LAC region (1987–1998)

Country	*Crops*	*Total no. of field trials*
Argentina	Canola, Maize, Cotton, Potato, Sugar beet, Sunflower, Wheat	170
Belize	Wheat, Cotton, Soybean	8
Bolivia	Cotton, Soybean	18
Brazil	Cotton, Cassava, Maize, Sugar cane, Soybean Tobacco, Tomato, Bananas, Sunflower, Cabbage, Carrots, Rice, Eucalyptus	115
Chile	Canola, Maize, Soybean, Sugar Beet, Tobacco, Tomato, Wheat	47
Colombia	Carnation, Cotton, Rice, Cassava, Forage Grasses	8
Costa Rica	Bananas, Maize, Cotton, Soybean	17
Cuba	Cauliflower, Canola Potato, Sugar Beet, Tobacco	78
Guatemala	Cabbage, Tomato	8
Mexico	Maize, Cotton, Cucumber, Melon, Potato, Rice, Cabbage, Tobacco, Tomato, Soybean, Canola, Papaya, Cooking Bananas	138
Total		607

Source: International Service for the Acquisition of Agri-Biotech Applications (1996) Global review of the field testing of transgenic plants, and personal communications

Fifty-two countries in the world, including some of the LAC countries, have biosafety legislation. The biosafety legislation adopted by these LAC countries differs in scope. Some have a wide scope and with legal coverage for transgenic plants, animals and micro-organisms, as is the case in Argentina (Resolution 124/91), Brazil (Law 8974/95), Cuba, Mexico (Official Mexican Norm 056-FITO/95), Peru (Law 27104) and Bolivia. In others the scope only covers plants: Costa Rica, Colombia (Resolution 3492/98), Chile (Resolution 1027/93), Paraguay and Uruguay. The Chilean, Costa Rican and Uruguayan legislation alludes to 'Winter Nurseries': transgenic seed production for export.

With the exception of Colombia and Uruguay, the legislation of all these countries covers research and development for greenhouse and field trials, and regulations for commercialisation. Bolivia, Brazil, Colombia, Cuba and Peru have established biosafety legislation under the Convention on Biological Diversity. Chile, Costa Rica and Uruguay have adapted existing legislation for seeds and plant health inspection services.

The biosafety legislation and regulations in the region vary in status from laws (Brazil, Costa Rica, Chile, and Cuba) to decrees (Argentina and Bolivia) to resolutions (Colombia and Uruguay).

LAC biosafety commissions or councils are advisory in character, with the exception of Brazil's Technical Commission for Biosafety, which can make recommendations to the Ministry of Agriculture, which in turn has the final decision on issues regarding crop commercialisation. The agriculture ministry, though, cannot authorise any field trial without the agreement of the Technical Commission for Biosafety.

Different agencies have been involved in forming biosafety committees in the region, including representatives of the agriculture, health, environment, commerce and foreign affairs ministries and related bodies, such as the scientific community, civil society, agriculture producers, non-governmental organisations, consumers, environmentalists and the private sector.

The Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Venezuela, and the majority of the Caribbean countries have no biosafety legislation.

It is clear that the LAC countries must continue to develop and perfect their existing regulatory instruments to bring them up to par with related international agreements to prevent or minimise possible risks derived from the use and handling of transgenic products. To do this the competent national institutions must develop the institutional capacity required to manage and evaluate field trials. Only then will countries in the region be able to take full advantage of transgenic crops capable of enhancing agricultural production and improving food security.

References

Alarcon E., Gonzales L.J., Carls Y.J. 1998. Situación institucional de los recursos fitogenéticos en América Latina y el Caribe. IICA-GTZ, Serie de documentos de discusión no. 6 (ISSN 1027-2623).

Alston J.M., Pardey P.G., Roseboom J. 1998. Financing agricultural research: international investment patterns and policy perspectives. *World Development* 26(6): 1057–1071.

Anonymous. 1995. Biosafety, report to the panel of experts on biosafety. Cairo, Egypt. 25p.

Anonymous. 1995. Son las plantas transgénicas una amenaza a la biodiversidad. Leticia, Amazonas. Instituto Sinchi. 75 p.

Anonymous. 1998. Las inversiones futuras en biotecnología, su mercado mundial. Bogotá: Instituto Colombiano Agropecuario (ICA). 35p.

Anonymous. 1999 Los elementos centrales de la negociación del Protocolo de Bioseguridad. Bogotá: Instituto Colombiano Agropecuario. 27p.

Artunduaga S.R. 1998 AGRO en el siglo XXI. El rol de las plantas transgénicas en el desarrollo del sector. Bogotá: Instituto Colombiano Agropecuario (ICA).

Atsaf E.V. 1994. Biotechnologies and developing countries. Council for tropical and subtropical agricultural research. Report on research work of institutes in Germany, USA, European Union. Bohn. 57 p.

Bongaarts J. 1998. Global population growth: demographic consequences of declining fertility. *Science* 282: 419–420.

CID (Centre for International Development). 1999. Agricultural research in Africa: technological opportunities and institutional challenges: report of a seminar. Centre for International Development, Harvard University.

Doyle D., Persley G. 1996. Enabling the safe use of biotechnology: principles and practice. Washington DC: The World Bank Environmentally Sustainable Development Studies and Monographs Series No 10. 74 p.

Fielding L.M. et al. 1992. Pesticides in ground and drinking water. Commission of the European Communities Water Pollution Research Report. 27p.

Greenpeace. 1994. A selection of transgenic plant patent applications from three database searches using the world patents index. Database patents online 1991, 1992, 1994.

Instituto Interamericano de Cooperacion Para La Agricultura (IICA). 2000. Regional forum for agricultural research and technology development – Foragro – in LAC. Its role for regional and global cooperation. San Jose, Costa Rica. 37p.

Jaffe W. 1992. Armonización de la bioseguridad en las Américas. Construyendo Capacidades Institucionales. Memoria. IICA. Serie ponencias y recomendaciones de eventos técnicos (ISSN 0253–4746).

James C., Krattiger A. 1997. Global review of the field testing and commercialisation of transgenic plants. ISAAA (International Service for the Acquisition of Agri-Biotech Applications). 31p.

Anonymous. 1997. Insect Resistance in crops: A case Study of *Bacillus thuringiensis* (Bt) and its transfer to developing countries. ISAAA (International Service for the Acquisition of Agri-Biotech applications). 42 p.

Kaveira P., Parker I. 1994. Environmental risk of genetically engineered organisms and key regulatory issues.

Kendall H., Beachy R., Eisner T., Gould F., Herdt R., Raven P., Schell J., Swaminathan S. 1997. Bioengineering of crops: report of the World Bank Panel on Transgenic Crops. Washington DC.

Koziel M.G., Beland G.L., Bowman C., Carozzi N.B., Crenshaw R., Crossland L., Dawson J., Desai N., Hill M., Kadwell S., Launis K., Lewis K., Maddox D., Mcpherson K., Meghji M.R., Merlin E., Rhodes R., Warren G.W., Wright M., Evola S.V. 1993. Field performance of elite transgenic maize plants expressing an insecticide protein derived from *Bacillus thuringiensis. Bio/Technology* 4(11): 194–200.

Leon J. 1987. Botanica de los cultivos tropicales. San Jose, Costa Rica: IICA. 445p.

Mihm J.A., editor. 1997. Insect resistant maize: Recent advances and utilisation. Proceedings of an international Symposium held at the International Maize and Wheat Improvement Centre CIMMYT, Mexico D.F. 302p.

NCB (Nuffield Council on Bioethics). 1999. Genetically modified crops: the ethical and social issues. Nuffield Foundation, London.

OECD. 1994. Field releases of transgenic plants. 1986–1992 analysis. 85 p.

Presidencia de la República de México. 1999. Organismos vivos modificados en la agricultura Mexicana: desarrollo biotecnológico y conservación de la diversidad biológica. Mexico: Conacyt y Conabio. 32p.

UNEP / CBD / BSWG. 1996–1998. Informes y documentos relacionados con cada una de las reuniones de trabajo respectivas.

UNDP. 1999. Human Development Report 1999. Globalisation with a human face. New York: UNDP.

UNESCO. 1998. World Science Report. United Nations Scientific, Educational, Scientific and Cultural Organisation.

The Cartagena Protocol on Biosafety: Implications for Development Cooperation

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Abstract

The industrialised countries that have signed the Cartagena Protocol on Biosafety are under an obligation to help developing countries meet the institutional and technical requirements for implementing the Protocol. Development cooperation programmes for capacity building on biosafety should be coordinated by the bilateral (e.g. EU member states and the Commission) and multilateral (e.g. GEF) governmental organisations. The capacity building instruments to be used fall into four main categories: provision of policy advice; institution building for administration and implementation of the protocol; basic and further training of decision makers and experts; and public awareness raising, education and public participation.

Introduction

The effective implementation of the Cartagena Protocol on Biosafety (CPB) requires a whole range of institutional and technical preconditions. Developing countries as a rule find it difficult or even impossible to meet these under their own steam. This means that those industrial countries that have negotiated and signed the treaty are under the obligation to support developing countries within the framework of their development cooperation. This should not wait until the entry into force of the CPB, but start immediately by identifying the needs of the developing countries for further capacity building on biosafety, and encouraging effective efforts to prepare for the entry into force of the CPB.

By signing the CPB, governments express their will to create the basis for the following rights and obligations:

- Take the necessary and appropriate legal, administrative and other measures to implement the Protocol (Art. 2.1).
- Ensure that the development, handling, transport, use, transfer and release of living modified organisms (LMOs) are undertaken in a manner that prevents or reduces the risks to biological diversity, also taking risks to human health into account (Art. 2.2).
- Obtain the general right to take measures that are more protective than those envisaged by the Protocol, provided such actions are consistent with the Protocol and other international obligations (Art. 2.4).
- Establish and maintain appropriate mechanisms, measures and strategies to regulate, manage and control risks identified in the risk assessment provisions of the Protocol associated with the use, handling and transboundary movement of LMOs (Art. 16.1).
- Endeavour to ensure that any LMO, whether imported or nationally developed, has undergone an appropriate observation before it is put to its intended use (Art. 16.4).
- Create notification and institution of proper emergency measures for unintentional transboundary movements of LMOs (Art. 17).
- Fulfil obligations relating to the effective administration of the Protocol (Art. 19 and others).
- Promote and facilitate public awareness, education and participation, including access to information on LMOs, identified in accordance with the Protocol, that may be imported (Art. 23).
- Prevent, and if appropriate, penalise illegal transboundary movements of LMOs (Art. 25).

Development cooperation aims to provide effective support to developing countries in establishing the necessary environment for implementing the CPB at the national level. This should enable them to guarantee their own national biological safety and avoid the negative impacts on man and the environment of the transboundary transport

and use of biotechnology products, consistent with the CBD, national priorities and sustainable development.

Inadequate manpower and institutional competence and a lack of pertinent legislation and participation by the public in decision-making processes often hamper the development of a suitable context for biological safety in developing countries. This is precisely the point where development cooperation comes in, especially technical cooperation with its instruments of capacity building. These mainly consists of:

- Policy advice;
- Institution building;
- Basic and further training of decision makers and experts;
- Public awareness raising, education and promotion of public participation.

In the context of implementing the CPB any capacity building effort has to guarantee that it enables developing countries to deal with following legal and administrative aspects:

- The right to regulate the transport of LMOs through a Party's territory, and obligation to communicate such transport to the Biosafety Clearing House (Art. 6.1).
- The right to set out standards for all contained use within a Party's jurisdiction (Art. 6.2).
- The application of the advanced informed agreement (AIA) procedure for intentional transboundary movements of LMOs for introduction into the environment of the importing Party, including such elements as notification, acknowledgement of receipt and decision-taking within the required timeframes and review of decisions (Art. 7-10, 12).
- The notification of any final decisions regarding domestic use, including placing on the market, of an LMO that may be subject to transboundary movements for direct use as food, feed or for processing (LMO-FFP) (Art. 11.1).
- The notification of decisions on domestic regulatory or administrative measures in relation to the domestic use or placing on the market of LMO-FFP, or notification of the use of the Protocol provisions for intentional transboundary movements of LMO-FFPs, as appropriate (Art. 11.4 – 11.6).
- The assessment of risks pursuant to the Protocol in a scientifically sound manner in accordance with the provisions in the Protocol and its Annexes (Art. 15).
- The formulation of risk management decisions based on the risk assessments (Art. 16).
- The right to take a decision without scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of an LMO on the conservation and sustainable use of biological diversity in the Party of import, taking the risks to human health also into account (Art. 10.6, 11.8).
- The identification and analysis of options for employing risk management strategies to the extent necessary to prevent adverse effects (Art. 16).
- The implementation of the risk management decisions (Art. 16.1).
- The application of appropriate measures to prevent unintentional transboundary movement of LMOs (Art. 16.3).
- The application of necessary measures to require that LMOs that are subject to intentional transboundary movement within the scope of the Protocol are handled, packaged and transported under conditions of safety, taking into consideration relevant international rules and standards (Art. 18.1).
- The sharing of information and ensuring the accuracy of information, including mandatory requirements in relation to the Biosafety Clearing House (Art. 20 and others).
- The notification of, and protection of, confidential information (Art. 21).
- The inclusion of socio-economic considerations arising from the impact of LMOs on the conservation and sustainable use of biodiversity in a risk assessment and decision-making process (Art. 26).

Capacity building is to be understood as a continuous and interdisciplinary process which will only succeed if the developing countries do their very best to ensure sustainability of the measures implemented. All measures must take adequate account of the prevailing social, economic, ecological and political environment in the developing countries where measures are jointly carried out, with great importance being attached to transparency and the effective participation of civil society.

Development cooperation programmes and projects on biosafety should be coordinated by the

bilateral (especially EU Member States and the European Commission) and multilateral (especially GEF) governmental organisations, and possible partnerships between such organisations should be explored.

Instruments of capacity building

Policy advice

A process of ratification is required to put the CPB into effect nationally. As a rule, the CPB becomes national law when relevant legislation is adopted by parliament. Moreover, regulatory instructions must be issued which govern the administrative implementation of the CPB.

During the first phase of the implementation of the CPB, in which capacity building can play a crucial role, developing countries will examine whether and to what extent existing national regulations (laws, decrees, guidelines) already fulfil the requirements set out in the CPB, and where these must be supplemented in accordance with the CPB. Such efforts were undertaken in several countries during the UNEP / GEF Pilot Programme when a National Biosafety Framework was elaborated.

During the next steps of implementing the Protocol, national capacities have to be built up that allow a Party to undertake risk assessments, develop risk management strategies and introduce an effective surveillance system. In the light of several innovative legal elements which the CPB introduces into international law, the following development cooperation priorities have to be established:

- Strengthen existing capacities in the field of environmental and health protection, and establish new capacities where needed, to assess the presented risk assessment documents and, if necessary, to perform or to commission independent risk assessments;
- Establish decision mechanisms and structures responsible for the AIA procedures concerning LMOs and LMO-FFPs independent of those public and private institutions which promote and apply modern biotechnology, to avoid conflicts of interest and to lay the basis for public confidence in governmental decisions;
- Base governmental decisions regarding the import of LMOs and LMO-FFPs on the precautionary principle as laid down in the Protocol, where necessary;
- Facilitate public participation in the establishment of biosafety frameworks and regulations, in the AIA procedure and in the decision procedure;
- Include socio-economic considerations into decision-making.

In cases where no national regulations exist for the handling of GMOs, developing countries can be supported in preparing bills in conformity with the CPB. The following instruments might be of use here:

- Short-term secondment of experts (national or external) to give advice to the respective bodies of the legislative and executive branches in their work;
- Political education measures on politically and legally relevant aspects of the CPB for decision makers in parliament, government and administration; representatives from civil society should take part in further training measures so that they can participate at an early stage in national policy formation.

Institution building

Public administration

According to Article 19 of the CPB, each member state is obliged to nominate at least one authority which is responsible for the implementation of the functions required under the Protocol (e.g. evaluate and perform risk assessments, observe the precautionary principle, ensure public participation) and which takes on the necessary administrative work. Moreover, the states are also obliged to nominate a Focal Point for the CPB. This is the official international contact for the implementation of the CPB and it liases with the Secretariat of the Convention on Biological Diversity (CBD). Both functions may be fulfilled by one governmental body.

Developing countries can be supported when taking the measures required for the establishment and / or development of the administrative units needed for CPB implementation. Here, the focus should be on measures strengthening the provision of the necessary expert knowledge on risk assessment, risk management and monitoring along the lines of the CPB, and on evaluating information received from the Clearing House

Mechanism. In line with a holistic approach, competence must be developed in the areas of environment, health, agriculture and life sciences, with the aforementioned principles (precautionary principle, public participation and consideration of socio-economic aspects) again playing a prominent role.

The following instruments might be of use here:

- Long-term secondment of experts to advise on the establishment and further development of the administrative units needed for CPB implementation;
- Support from the partner country for the development of effective instruments which include the participation of the civil society;
- Further training measures for the administrative unit entrusted with CPB implementation and representatives of the civil society.

Biosafety Clearing House Mechanism

The CPB requires the member states to set up the Biosafety Clearing House Mechanism (Biosafety-CHM). National Focal Points of the worldwide information network are to be set up in each Protocol member state. Information along the lines of the 'prior informed consent' principle are to be made available worldwide through the Biosafety-CHM.

National approvals of LMOs for food, feed, and processing in the Parties of the CPB will be made known via the Biosafety-CHM. Furthermore, information on national legislation and guidelines of member states on biosafety, pertinent authorities and national and international experts is to be rendered transparent (Article 20 of the Protocol). The Biosafety-CHM is to be used especially to publish violations of the CPB regulations.

The following instruments might be of use here:

- Secondment of short-term experts to accompany, and advise on, the setting up and further development of the Biosafety-CHM;
- Technical and financial support in the establishment and equipment of the Biosafety-CHM;
- Further training measures for the Biosafety-CHM Focal Point and representatives of civil society in the use of EDP tools, especially the internet;
- Advisory support in fulfilling the national obligation to report to the CBD Secretariat.

Monitoring, evaluation and inspection services

The Member States must either establish national laboratory capacities or have secure access to regional laboratory facilities to ensure ongoing supervisory activities within the framework of a regular monitoring and inspection, and for the required evaluations. Member States must have access to the relevant technologies needed for establishing an inspection and monitoring system.

Development cooperation can support the dialogue between policy/administration and science/industry and can be of help in the development of the necessary monitoring and inspection infrastructure. In countries where no monitoring or inspection infrastructure is to be established, development cooperation can also provide support in setting up the necessary contacts with trustworthy, regionally active scientific institutions.

The following instruments might be of use here:

- Short-term secondment of experts to advise on the establishment and further development of the pertinent monitoring facilities;
- Technical and financial support for establishing and equipping the required laboratories;
- Further training measures for institutions entrusted with monitoring or inspection;
- Support for the establishment and further development of regional network structures.

Basic and further training of decision makers and experts

The national authorities responsible for CPB implementation must be adequately and competently staffed. In addition to the head of the administrative unit responsible for the CPB – and it would be expedient if this were also the Focal Point – another two or, better still, three staff members should be recruited. They must have undergone the comprehensive training needed for the technical assessment of an import request, i.e. for the assessment of potential risks of LMOs. Such training must deliver the expertise needed for the application of the AIA procedure:

- Risk assessment;
- Application of the precautionary principle;
- Labelling responsibility;

- Consideration of socio-economic aspects.

Under the last item, particular consideration must be given to aspects of maintaining and developing agro-biodiversity (e.g. protection of land varieties as well as of regionally adapted varieties for sustainable food security). Of special importance is support for small-scale farming and organic agriculture.

Incoming requests must be properly assessed and, if necessary, additional investigations carried out by independent experts. This requires technical know-how in natural science disciplines (environmental impact, ecological risk management, identification of LMOs), in the socio-economic field (consideration of these aspects in legislation, approvals procedures etc.), in public relations work and participatory approaches. Further, training along these lines will combine these aspects in the form of an interdisciplinary concept. Enhancement of institutional competence is also required for the establishment of the Biosafety-CHM.

Public awareness raising, education and promotion of public participation

An essential element in ensuring acceptance of modern biotechnology is an open discourse with civil society. The open dialogue with non-governmental organisations in the field of environment and consumer policy plays a prominent role in this connection. Only an honest debate involving critical voices and minority opinions in society will ensure the necessary acceptance in the long-term. This should not be limited to the national level, but include the promotion of regional and sub-regional cooperation and exchange of information and experience.

Nature's Matchless Seeds – or Monsanto's Colonised Crops?

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Cash-cropping in developing countries and the use of bioengineered varieties – a system that is accompanied by widespread poverty and hunger – should be abandoned in favour of indigenous crops. These do not require expensive foreign fertilisers, pesticides and heavy machinery. Moreover, the genetic diversity of native crops is a valuable resource for the rest of the world.

In essence, biotechnology is the shuffling of genes from one species to another. The primary business idea behind such a hazardous manipulation and colonisation of life is to create (invent) a valuable product – for instance, by adding foreign genes to soybeans in order to make them behave in a certain desired and profitable manner. Its owner then reaps a harvest of money and power.

Global corporations and biotechnology

Monsanto is one of a handful of global corporations pushing biotechnology to its limits, especially in agriculture where it has bioengineered certain food crops to tolerate the killing power of its own toxins or to resist certain diseases or insects. Monsanto has been selling its bioengineered seeds aggressively in the United States and throughout the world, including the tropics, arguing that its modified crops are great weapons to fight hunger. This is a dubious claim. First, because hunger is primarily a political problem, and second, because nature has always been unmatched in its exquisite design of seeds to fit the limitations and potentials of land, climate and human culture.

Consider Africa, a hungry continent with an extraordinary legacy of agricultural biological diversity. Monsanto is trying to gain a foothold in Africa for its food engineering. But does Africa need Monsanto? Growing luxury crops like tea, cocoa and coffee for export in sub-Saharan Africa is probably the strongest legacy of European colonialism – a legacy that in the dawn of the 21st century translates into hunger for about 200 million people. Africans do not need coffee, tea and cocoa. They grow them entirely for the gastronomic pleasures of Europe and North America. Africans need more food. Gambians, for example, produce peanuts which they export for money to import food, and this is by no means exceptional.

Cash-cropping

The cash-cropping road to development condemns Africa to impoverishment and hunger, and is pushing Africa's extraordinary variety of indigenous food crops to the verge of extinction. Africans eat less of their own food and eat more imported wheat, rice and corn. Why Africans eat less and less of their own food goes to the very heart of their hunger and dependency on others. Europeans heaped scorn on the fantastic variety of Africa's cereals and Western scientists classified African grains as cattle feed. That is why many of the more than 2,000 varieties of indigenous grains, roots, fruits and other food plants have been lost – at least from the daily diet of most Africans.

But these foods still exist in Africa, and they are the answer to the tremendous food insecurity of so many millions of human beings in Africa and elsewhere in the world. In a 1996 study called 'The Lost Crops of Africa' the US National Academy of Sciences says that Africa's native cereals like rice, finger millet, fonio, pearl millet, sorghum, tef, guinea millet and dozens of wild cereals present a 'local legacy of genetic wealth upon which a sound food future might be built'.

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Lost crops of Africa

Resurrecting Africa's food plants would heal the ecological wounds of the continent. Africa's cereals are tolerant of heat, cold, drought, and water-logged or infertile land. And they are also nutritious and tasty. The Academy study says that Africa's 'lost' plants may benefit more than Africa because 'they represent an exceptional cluster of cereal biodiversity with particular promise for solving some of the food production problems that will arise in the twenty-first century'.

The lost crops of Africa present Africa, the rest of the world and the international development community with a great opportunity to practice applied sustainable development and join the African peasants, who still use many of these indigenous food plants, in building Africa's food security around these overlooked resources.

This is also a challenge for the United States. The US Agency for International Development (AID) funded 'The Lost Crops of Africa'. Under proper leadership, AID can move decisively in Africa to support the resurrection of Africa's own crops. It is almost certain that such a strategy would have lasting implications for the relations between Africa and the United States.

More food from Africa's own crops for Africa's own people will be the best medicine and solution to local hunger. It will probably be the best antidote to the surviving cash cropping plantations, which occupy the choice land to satisfy the thirst of Europeans and North Americans while Africans starve. An Africa without hunger will be a grateful Africa, thankful to the American people for their support. An Africa without hunger will be better prepared to promote democracy, international trade and sustainable development.

Genetic riches

Undoing the cash cropping of colonialism by bringing back from obscurity Africa's own crops – instead of the precarious bioengineered crops of Monsanto – is bound to sow a plentiful harvest for Africa, without the expensive and hazardous foreign fertilisers, pesticides and heavy machinery. These native crops are also valuable to the rest of the world because of their genetic richness. They could be useful in broadening the dangerously narrow path of agricultural biodiversity in the United States and other industrial countries.

So Monsanto is barking up the wrong tree in Africa and the tropics. It failed to convince the Grameen Bank of Bangladesh (the lender of last resort for impoverished Asian women) and the American relief organisation CARE to make its farm biotechnologies accessible to the peasants of Asia, Africa and Latin America. This is a signal that the world is not ready to abandon its food security to Monsanto – or anybody else for that matter.

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Acronyms

AIA	Advanced Informed Agreement
BSE	Bovine Spongiform Encephalopathy ('mad cow disease')
CAP	Common Agriculture Policy (EU)
CBD	Convention on Biological Diversity
CECA	Circulo de Estudios Cientificos Aplicados (Panama)
CFO	Conservation Farm Option (US)
CIS	Commonwealth of Independent States
CHM	Clearing House Mechanism
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPB	Cartagena Protocol on Biosafety (CBD)
CPRM	Common Property Resources Management
DTRE	Disequilibrium Theories for Range Ecology
EC	European Community
EEC	European Economic Community
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
ERA	Environmental Risk Assessment
ERO	European Regional Office (IUCN)
EU	European Union
FAO	United Nations Food and Agriculture Organization
FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIS	Geographic Information Systems
GM	Genetically Modified
GMO	Genetically-Modified Organism
IBA	Important Bird Area
ICRISAT	International Crop Research Institute for the Semi-arid tropics
IFOAM	International Federation of Organic Agriculture Movements
IPM	Integrated Pollution Management OR Integrated Pest Management
IUCN	The World Conservation Union
LAC	Latin American and Caribbean
LDCs	Least Developed Countries
LFA	Less Favoured Area
LMO-FFPs	LMO for direct use as food, feed or processing
LMO	Living Modified Organism
LTPS	Long-Term Perspective Study
MEA	Multilateral Environmental Agreement
MRC	Mekong River Commission
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
PSE	Producer Support Estimate
RSPB	Royal Society for the Protection of Birds
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNSO	United Nations Office to Combat Desertification and Drought
USD	US dollars
USDA	United States Department of Agriculture
WHO	World Health Organization
WRI	World Resources Institute
WTO	World Trade Organization
WWF	Worldwide Fund for Nature