Managing Agricultural Resources for Biodiversity Conservation

Case study Brazil, Cuba and Mexico.

Study commissioned by ELCI

Prepared

By

Ana Milena Varela

c/ o P. O. Box 30007

Nairobi, Kenya

e-mail: ***avarela@icipe.org***

September 2001

Summary

Latin America is one of the richest biodiversity regions, with megabiodiversity centres such as Brazil and Mexico, where many of the worldwide widely cultivated plants of economic importance originate. Agricultural production in the region, as elsewhere, has increased in order to meet the demand of the growing population. The use of unsound technologies, inadequate zoning and farming practices and, mechanisation and deforestation have caused considerable impact on natural resources, causing a reduction in biodiversity at all levels. The negative effect of agricultural systems on biodiversity has been, to large extent, the result of agricultural, economic and land policies. Policies with broad and long-term effect have been formulated without assessing their effect on the environment and biodiversity.

A decline in agricultural productivity due in large extent to resource degradation and increasing public awareness has led the countries to consider natural resource conservation in agricultural planning. Governments are now promoting sustainable agriculture production through the adoption of sound technologies. Efforts have been directed at natural resource conservation, but the importance of biodiversity in agricultural systems had not been fully appreciated. Current government policies emphasises the need to create new opportunities for economic development through diversification in agriculture and livestock production, based on germplasm conservation and utilisation of genetic resources. NGOs, social organisations and international centres also play an important role in the development and adoption of sustainable production systems and conservation of agrobiodiversity.

The National Biodiversity Strategies and Action Plans take into consideration the importance of biodiversity for agriculture but tend to overlook the value of biodiversity in agricultural systems. The degree of attention given to specific agrobiodiversity components varies between countries. Special attention is given to soil conservation and management of genetic resources. The value of traditional knowledge is also recognised and strategies proposed for conserving and using this knowledge.

Cuba is the leading country regarding development and adoption of alternative technologies for agricultural production, forced by a food crisis in the 1990's, which has benefited agrobiodiversity conservation. In Brazil and Mexico there have been significant developments, but are not generalised. Various policies impinging on agrobiodiversity need better interpretation. This is partially explained by the complexity and large size of these countries.

The adoption of sound policies and technologies leading to biodiversity conservation, including agrobiodiversity, has been hampered by several factors including lack of appreciation of the value of biodiversity in agricultural systems, deficient sectoral integration, financial factors, lack of, or deficient co-ordination and accuracy of existing legislation. These constraints should be considered when formulating or restructuring agricultural policies

1. Impacts of agricultural systems on the conservation and biodiversity

1.1. Introduction

The Latin American Region includes some of the megabiodiversity centres like Brazil Mexico and Colombia, which are among the world's most species-rich countries with high level of endemism. Brazil has between 10% and 20% of the world's biodiversity. The Amazon is one of the richest tropical biospheres, containing about half the world's species of plants and animals (Brazil, First National Report). Mexico is one of the 5 countries richest in biodiversity regarding ecosystems as well as genetic varieties (CONABIO, 1997). Cuba, the third country considered in this study, is the island with the highest biodiversity in the Caribbean islands. High population pressure is threatening biodiversity loss in the region. Production systems, such as agriculture, livestock, fishery, and forestry, have increased in order to meet the demand of the growing population. This has led to increasing demands of human in the environment, with a negative impact on agricultural and wild biodiversity.

Agricultural activities play an important role in providing food security and in the economy of the region. In Mexico, the participation of the agro-industry in the Gross National Product (GNP) is of 10% with a dynamic growth (Ramirez López, 1999). In Brazil agricultural activities **take 40**% of national territory, accounting for 8,4% of the GNP, with coffee, soybean and oranges representing 31% of Brazilian exports (Brazil, First National Report; *Avança Brasil*, 2001;). Cuba's economy is largely based on agriculture specially sugar cane for export. Agricultural products represented 83% of the total exports in 1994 (CENBIO, 1998; FAO, 1996).

In most countries in the region agriculture has been characterised by a skewed distribution of farmland**,** with dual agriculture. Policies that support the development of the rural sector, particularly in areas with high agricultural potential, have led to two types of agriculture. The agriculture for export uses the best land, with modern technologies and infrastructure and capital. Agriculture for production of the basic products for local consumption is mainly conducted by smallholder with low resources and relegated to less fertile areas and cut off from resources necessary for its growth and modernisation (World Bank, 1994; Loa Loza *e*t al. 1998; Enriquez, 2000). In the middle of these extreme types of agriculture traditionally farming systems have emerged over centuries of cultural and biological evolution (Altieri, 1999). Cuba is an especial case, where until early 90s agricultural development was based on a large-scale approach to production with crop specialisation on large state farms and agricultural production co-operatives. Since 1993, the Cuban government started promoting small-scale production for self provision by workers/co-operative members, and by private small holders (FAO, 1996; Enríquez, 2000).

The expansion of agriculture has caused disruption of natural systems. Major effects of agriculture on biodiversity include: - conversion of natural habitats into agricultural lands, which has led to habitat fragmentation; - reduction of genetic variability of the managed plant or animal; -changes of natural ecosystems where agricultural take place; -off-site pollution or alteration due to technologies and inputs used in agriculture such as fertilisers and pesticides.
The degree to which agricultural activities affect biodiversity varies with the different types of agriculture. Traditional agriculture is generally perceived to have less adverse impact than the models with high inputs and intensification. Modern intensive agriculture has caused a reduction in biodiversity at all levels**: at** the ecosystem level, at the species level and at the genetic level.

1.2. Alterations and fragmentation of habitats /ecosystems/landscapes

The most significant impact of agriculture on biodiversity in the region has been trough conversion of biodiversity-rich natural habitats into much simpler agricultural systems. This land-use conversion has led to loss and fragmentation of native habitats with consequent losses of vegetation, and dislocation or destruction of plants and animal and microorganisms resulting in biodiversity losses. Due to heterogeneity of the ecosystems the destruction of even a portion of an ecosystem may cause loss of plants and animal species, which are often providers of important services such as pollinators or biocontrol agents.

In South and Central America land–use changes have been rapid and widespread. Creation of pastures for grazing has converted some parts of the tropical rain forests into low-productivity pastures. Mexico, in particular, with an estimated deforestation rate between 300000 and 1 million hectares annually, has one of the highest deforestation rates worldwide. It has lost 95% of the tropical forest, over half of the temperate forests and of the arid regions (CONABIO, 1998). The land dedicated to livestock activities increased from 50 million ha to circa 130 million ha (about 2/3 of the national territory) between 1950-1990, at the expense of transforming tropical, temperate and arid ecosystems. In states with important tropical ecosystems such as Veracruz, Tabasco, Oaxaca and Guerrero, over 60% of the territory are dedicated to extensive livestock activities with low productivity (Peña Jimenez & Neyra Gonzalez, 1998).

In Brazil the conversion of forest into temporary pasture or land for agriculture has been the prime cause of deforestation. Total agricultural area increased from less than 130 million ha in 1950 to about 250 million ha in 1990. Brazilian livestock production is extensive; it uses roughly 200 million ha of pastures, which is more than three-fourths of the total agricultural land area (World Bank 1994). The best-known example of land conversion has occurred in the Amazon Region where about 15% of the entire Amazon Region have been converted to crop and pastures. However, land conversion has taken place in all ecosystems in the country. At the end of the 90s about 40% of the *Cerrados*, the largest extent of Savannah in any single country, has been converted to agriculture (mainly for soybean production) and cattle ranching. In the *Caatinga*, a vast semi-arid area in the Northeast of Brazil, the original vegetation has been reduced to less than 50% due in large extent to agricultural activities. The natural forests and the Araucaria forest have been adversely affected by livestock production and soybean production (Brazil, First National Report; Viana *et al*., 1998).

Cuba lost of 53.2% of its forests during the colonial time, until 1900, due to expansion of agriculture activities, mainly sugar production. In 1959 the area covered by forests was reduced to 14%. Reforestation programmes were then started and as a result the area covered by forested has increased to over 19% in the early 90’s. Cuba is nowadays recognised as the country with the lowest annual deforestation rate (0.1%) of Latin America. (Cuba, report 4th COP; CENBIO, 1998; Vales *et al*, 1998).

1.3. Effects of agricultural production technologies on biodiversity.

Traditional agricultural systems generally have less adverse impact than the models with high inputs and intensification. Indigenous farmers often maintain ecologically sensitive agricultural and natural resource management practices based on accumulated experiences of interacting with the environment, and without access to external inputs, capital or scientific knowledge (Altieri, 1999**.) S**mall holder systems that rely on natural regeneration of the vegetal cover are not viable under high pressure on the land. For instance the smallholder rainfed agriculture in Mexico presents high indices of soil erosion. Maize fields present the maximum indices of soil erosion, which is aggravated due to the increased use of steep land for maize cultivation. This is most noticeable in states such as Guanajato (43%) Michoacán (36%) and Jalisco and Mexico State (25%) (Peña Jimenez & Neyra Gonzalez, 1998).

The adoption of the so-called “modern” agriculture including approaches such as that of the ‘Green Revolution’ adopted by many countries in the region between the 60s and 80s, led to the replacement of traditional production systems in agriculture and forestry. The model of "modern" agriculture is characterised for its large scale approaches to production, expanded use of irrigation, mechanisation of production processes and a strong reliance on inputs such as chemical fertilisers and pesticides and specialised animal feed. These characteristics have caused loss of biodiversity at diverse levels.

1.3.1. Landscape level

Mechanisation led to the increase of large monoculture crops and plantations. This, together with the strong component of permanent crops, and the displacement of traditional systems and practices of agricultural such as polycultures, intercropping and agroforestry, has resulted in homogenisation of the rural landscape (Viana, 1998; Peña Jiménez & Neyra González, 1998). During the 1980s, as a result of policy mandates through Latin America, coffee production replaced traditionally diverse agroforestry coffee system with modern varieties that required elimination of trees and other diverse vegetation (Rice & Ward, 1996; Thrupp, 1998).

In Cuba 65% of the agricultural land is cultivated. About 50% are used for perennial crops, mainly sugarcane, and pastures for livestock . Sugar cane represents about 50% of the land under agriculture (Cuba, homepage; Vales *et al*., 1998)**.**

In Mexico nearly 50% of the vegetation cover presents a certain degree of degradation. In 1991, 28,7% of the agricultural land was dedicated to agriculture, 62% to livestock and 8.11% to forest. The percentage area under agricultural activity in Mexico has seemed to be constant during the decades of 80's and 90's with an about 20 million hectares. However, the areas under agriculture are not the same. Since some areas are abandoned and new areas opened (CONABIO, 1998).

In Brazil, total agricultural land increased from less than 130 million ha in 1950 to about 250 million ha in 1990, with a trend to large export-oriented states in the south and Southeast regions, (and more recently the Centre-west) for production of crops such as soybean and oranges for export, and sugar for energy production. In contrast, over 70% of the Northeast farms are smallholdings of less than 10 ha (World Bank, 1994).

1.3.2. Species level

The focus of modern agriculture on relatively few crops and the introduction of improved high yielding varieties, led to a considerable loss of plant diversity. This genetic erosion has occurred at two levels: in number of species, and in the genetic variability of the species, since farmers substituted their local varieties for genetically uniform varieties with high yield potential. In Mexico, for example, only 20% of the maize varieties reported in 1930 are currently used (FAO, 1996, cited by Thrupp, 1998). Similarly many traditional breeds have disappeared and 30% of the livestock species are under risk as farmers focus on highly productive cattle, pigs, sheep and chicken (Loa-Loza *et al*., 1998).

1.3.3. Biodiversity that provides services

The erosion of ecosystem diversity degrades valuable ecosystem services such as water and soil conservation, nutrient cycling, and natural pest control. The loss of diversity in crops and livestock and the spread of monocultures and plantations have resulted in an increased vulnerability to pest and diseases. This has in turn led to an increase in the use of agrochemicals with a subsequent detrimental effect on the diversity of the beneficial fauna such as parasitoids, predators, pollinators and other non-target organisms. It also contributes to soil degradation, and water contamination due to leeching of agricultural chemicals into water supplies. The intensive use of pesticides can disrupt and erode biodiversity in natural habitats near and far from agricultural areas as they accumulate in the food chain. The heavy use of chemical fertilisers usually results in run-off into neighbouring soils and water supplies. Pesticide pollution is a critical threat to biodiversity in the region, where regulations are poorly enforced and where crops using high levels of pesticides are being grown (World Bank, 1994).

1.3.4. Effects on soil biodiversity

Overgrazing, intensive use of irrigation, excessive cultivation, unsustainable agricutural practices such ploughing steep lands, increased tractor use and mechanisation in monoculture production has led to soil erosion and biological degradation such as increase of mineralisation of the organic material due, partially to the loss of the vegetation cover. Removal of forest cover allows rainfall to wash soils into rivers and streams. Consequently, nutrients stored in the soil are washed away, inhibiting regrow of vegetative cover or agricultural crops. Moreover, river siltation can damage downstream riverine ecosystems and fisheries. Soil degradation increases production costs and limits the possible uses of agricultural land. Studies conducted by the International Centre for Tropical Agriculture (CIAT) show that soil compaction in the Savannahs is already decreasing yields for monocropped rice (Garret, 1995).

In Mexico, 80% of the soils are affected by biological degradation. In the early 1990s only 14% of the cultivable land was in optimal conditions due to erosion and to soil salinisation caused by overexploitation of ground water for irrigation. 15% of Mexican soils are affected by leaching, which affects soil fertility especially in tropical zones with high rainfall (de Alba & Reyes, 1998, Loa Loza *e*t al. , 1998; Peña Jimenez & Neyra Gonzalez, 1998**)**.

In Cuba 82% of the highland landscapes are affected at different levels by soil erosion. Most Cuban soils are compact and lack organic matter as a result of excessive use of heavy machinery and chemical fertilisers. A large proportion of soils present salinity stress and erosion due to extensive monoculture (CENBIO, 1998).

The effects on soil are aggravated by the lack of stricter selection of land for agriculture, according to the soil characteristics. This has been one of the main factors affecting Cuban soils (CENBIO, 1998). In Mexico, poor soils have been used for grain production, or wetlands have been used for plantain cultivation as has happened in Tabasco state (Peña Jimenez, Neyra Gonzalez, 1998).

Cattle production can also be associated with occasional severe soil damage, as has been the case in the Brazilian rainforest where the level of management required to maintain pasture on cleared forestland is often not found (World Bank, 1994).

1.3.5. Effects on water biodiversity

Livestock production can also generate other types of soil and water problems resulting from concentrated animal waste. Nutrients from these sources are deposited directly in waterways, or indirectly through infiltration or run-off. This can cause serious harm to wild biodiversity. Excessive growth of aquatic plant life can deplete oxygen over large areas altering the ecosystem to the detriment of biodiversity and causing wetland degradation. In some states of Mexico with important tropical ecosystems such as Veracruz, Tabasco, Oaxaca and Guerrero, poorly managed livestock production is source of a considerable amount of organic wastes, which are important sources of contamination in soils and water (Loa Loza *et al*., 1996; Peña Jimenez & Neyra Gonzalez, 1998).

In Brazil, water pollution by agrochemicals is one the main threats to biodiversity in *El Pantanal*, one of the world's most significant wetlands. Wild life in *El Pantanal* has also been affected by disruption of natural seasonal water patterns caused by diversion of water for irrigation (Brazil, First National Report; World Bank, 1994**;** Viana *et al.,* 1998).

1.4. Indirect effects of agriculture

The establishment of supporting infrastructure for agriculture such as roads, irrigation systems, housing for farm families has often encouraged opening up new areas to pioneer farmers, which may have detrimental effects on ecologically vulnerable areas. This effect has been well documented in Brazil, where roads have been a major contributor to loss of biodiversity resulting from conversion of natural areas (Pagiola *et al*., 1997).

2. Status and trends of key aspects of agrobiodiversity:

2.1. Genetic biodiversity

Brazil and Mexico are among the richest countries regarding biodiversity. About 25% of the estimated 250000 species of superior plants worldwide are native from Brazil and 10 % from Mexico (Kageyama, 1998; CONABIO, 1997). Many of the widely cultivated plants of economic importance originate from the region like maize, beans, cotton, tomato, cocoa, cucurbits, chillies from Mexico and Central America, groundnuts, rubber tree, pineapples and cashew nuts from Brazil (Brazil, First National Report; CONABIO, 1998). Over 118 species of plants have been domesticated in Mexico alone, most of them for food. There are a huge number of plants with a potential for agriculture, which are not yet utilised. This is due partly to the lack of knowledge of their potential and of their taxonomy, ecology and genetic characteristics. Studies have been conducted mainly on domestic animals, cultivated plants and microorganisms. Studies of variability have been in general restricted to important domesticated species of importance for agriculture. The genetic variability of wild species is not well known, with the exception of some species with a potential for human use such as *Teosinte* considered the nearest relative of maize, and of *ayocote* (*Phaseolus coccineus*). (CONABIO, 1998; Loa Loza *e*t al. 1998). Basic research on genetic variability is normally conducted by the public universities and by governmental research institutes. This research is limited due to financial constraints. The private sector is most interest in biotechnology projects (Kageyama, 1998).

In Cuba several monographic studies on Cuban flora and fauna have been done since the decade of the 1930. There is also a record of useful plants. (CENBIO, 1998).

In Brazil, studies on genetic biodiversity are concentrated on relatively few species. There is a group working on biochemical genetics of bees in the University of Sao Paulo, ESP Riberão Preto. A group is working on legumes at the Federal University of Minas Gerais. The Brazilian Corporation for Research in Agriculture and Animal Production (EMBRAPA), which has 15 national programmes in the different areas of agriculture, cattle breeding and agroforestry, is involved on quantitative genetics related to artificial selection in native and cultivated plant species and to some extend on wild species (Brazil, First National Report).

In spite of the high plant diversity in the region, agricultural production is based in few crops. This is to large extent due to the modernisation of agriculture in the region, as presented in the previous section, which has caused the loss of local cultivars, replaced by improved varieties and the displacement of traditional systems and agricultural practices (Viana, 1998; Peña Jiménez & Neyra González, 1998). In Mexico, maize and beans constitute about 60% of the cultivated area. Other major crops include wheat, sorghum, sugarcane, tomatoes (Peña Jimenez & Neyra Gonzalez, 1998).

In Cuba, sugar cane covers 50% of the agricultural land. Other crops such as rice, tobacco, coffee, citrus and other fruits also takes a significant part of the cultivated land but their distribution is scattered (Vales *et al*., 1998). In Brazil there has been an important shift towards less labour-intensive crops such as cotton and soybeans and oranges for export (World Bank, 1994).

2.2. Conservation of genetic resources:

Most genetic conservation efforts of relevance to agriculture are *ex situ* through genebanks. However, abundant genetic resources are being conserved on farm, though not through formal conservation efforts. Only 25% of the Central American farmers regularly purchase fresh seed of improved maize mostly of hybrids. The rest plant seeds they have saved from a previous harvest either seed of local, unimproved varieties, or seeds of improved varieties. In Mexico, for instance, over 50% of maize seeds come from local crop cultivars and not through the formal sector. In some areas community farming groups have developed innovative, indigenous seed fairs, where local farmers display their conserved varieties (Jervis, D. I., personal communication; Thrupp, 1998; CIMMYT, 2000).

Traditional farmers or indigenous people have played an important role on preserving genetic variability. Traditional ecosystems, such as home gardens, are essentially *in situ* reservoirs of genetic diversity. A considerable proportion of the remaining natural habitats and biodiversity reserves are in indigenous lands. In Brazil indigenous reserves cover 7% of the country including some of the most important and best-conserved areas principally in the Amazon region. Similarly, 30% of the remaining forest in Mexico, with the greatest biodiversity, is on land controlled by indigenous people. In some regions, local knowledge of poor resource farmers has helped to preserve a great variety of varieties of maize, beans, avocado and chillies. Some farmers in Central America occasionally maintain a mix of modern and traditional varieties (Loa Loza & Durand Smith, 1998; Srivastava *et al*., 1996).

In Mexico, genetic resources are conserved in the experimental fields of the '*Instituto National de Investigaciones Forestales y Agropecuarias'* (INIFAP) including 49209 accesions of 213 species of plants of importance in agriculture (CONABIO, 1998). The interdicisciplinary *Instituto de Recursos Genéticos y Productividad* (IREGEP) at the *'Colegio de Postgraduados* (CP*)* has extensive experience in *ex situ* conservation (Jervis, D. I., personal communication).

In Brazil, considerable advances have been made in *ex situ* conservation, particularly in relation to genetic resources for agriculture, by EMBRAPA through the National Centre for Research on Genetic Resources and Biotechnology (CENARGEN). The latter co-ordinates a major network of 165 germplasm banks with more than 200,000 contributors. 24% of the accessions are native plants. There are 36 registered botanical gardens all involved in species' conservation and environmental education. There are about 200,000 records of plant germplasm being conserved through the country. Twelve animal germplasm banks maintain *in vitro* and *in vivo* specimens of animal populations for research, conservation and breeding, especially of domestic races (buffalo, cattle, mules, horses, goats and sheep) threatened with extinction. EMBRAPA co-ordinates and maintains 10 microorganism germplasm banks of agricultural interest. However, shortage of funds and lack of support constrain the maintenance and the activities of the germplasm banks. Thus, the production of the characterisation and evaluation of the preserved materials is still incipient, and 2/3 of them needs to be replaced (Brazil, First National Report; Kageyama, 1998).

Cuba has a network of research centres in charge of the genetic resources of plants, mainly cultivated, with a major emphasis on *ex situ* conservation. There are germplasm banks in 13 research institutions. Regarding livestock, public enterprises keep a reserve of each introduced and local genotype of livestock (cattle, pigs, horses, poultry, goats, sheep, and rabbits), at a strategic location aimed at protecting them from natural and biological disasters (CENBIO, 1998).

In general, *in situ* conservation has been considered more important for wild varieties and native species. A considerable number of protected areas have been established in the different countries. Mexico has a protected area of 23'067, 401 ha, representing 11,7% of the national territory (CONABIO. 1997). In Brazil 130.55 million ha, corresponding to 15% of Brazil are legally declared as protected areas (Brazil, First National Report). However, in most cases parks and reserves are not set up to protect species or population of agricultural interest. Recently, the importance of setting aside reserves to protect biodiversity of direct relevance to agriculture has been recognised.

In Mexico, there are several initiatives working on *in situ* conservation of plant genetic resources. For instance, efforts are made to protect particular species with potential for human use such as some Teosinte wild species of maize (genus *Zea*) and of *ayocote* (*Phaseolus coccineus*) (CONABIO, 1998; Srivastava *e*t *al.*, 1999). These wild species are important due to their traits of hardiness and resistance to pests and disease. In the last decade, *in situ* monitoring and collection of *Teosinte* has been intensified by the '*Instituto National de Investigaciones Forestales y Agropecuarias*' (INIFAP) in collaboration with CIMMYT and the USA Agricultural Department. (Loa Loza *et al*., 1998). Other important initiative is a farmer-scientist collaborative approach for conservation of maize genetic diversity in farmers field being developed at the Central Oaxaca Valley by CIMMYT and INIFAP (see example of best practices section 6.2.1) (CIMMYT, 2000).

Other on-going *in situ* projects in Mexico are: -the National Project to Evaluate the Native Maize Landraces of Mexico, directed by the Colegio de Postgraduados (CP), part of a nation-wide project for the improvement of local maize varieties, and funded by the *Concejo Nacional de Ciencia y Tecnología* (CONACYT); -the "Conservation of Genetic Diversity and Improvement of Crop Production in Mexico: A Farmer-Based Approach" financed by the McKnight foundation, which is being conducted at the Chalco-Amecameca region and Sierra Norte de Puebla. The work is being carried out by University of Guadalajara, and the '*Instituto Mananatlan de Ecologia y Conservación de la Biodiversidad*' (IMECBIO) (IPGRI, no date ; Jervis, D. I.,personal communication). In addition, the Mexico Country component of the International Plant Genetic Resources Institute (IPGRI) global project "Strengthening the Scientific Basis of *in Situ* Conservation of Agricultural Biodiversity" is conducting *in situ* conservation at the Yucatan State, on four crops: maize, beans, squash and pepper under the slash and burn agricultural system known locally as *Milpa*. Production in the state consists mainly on local varieties of maize. The use of improved varieties does not overpass 10 % of the sown surface. From a total of 12 improved varieties recognised by 1965, currently, only exist 5 of them. As a first step, documentation on the local seed selection system has been initiated. After this, in the case of maize, works on participatory plant breeding have been initiated (IPGRI, no date).

Producers in Mexico are doing conservation of some crops such as peanut and agave (Loa Loza *et al*., 1998).

In Brazil, the NGOs of the Alternative Technologies Project Network has worked with small farmers to seek alternative agriculture production, promoting *in situ* conservation and use of local maize varieties (Cordeiro &de Melho, 1994). For more details refer to the examples of best practices (section 6.2)**.**

International centres such as CIAT, the *Centro International de Mejoramiento de Maiz y Trigo* (CYMMIT) and the International Potato Center (CIP) play an important role in the management of plant genetic resources, particularly on *ex situ* conservation of plants of agricultural importance. For instance, CIAT preserves nearly 1000 species, including *Phaseolus*, *Manihot* and important tropical forage grasses and legumes. It works in collaboration with countries in the region such as Brazil, Costa Rica, Colombia, Mexico, and Peru in germplasm conservation (CIAT homepage). In 1992 CIP joined forces with several regional institutions to form the Consortium for the sustainable development of the Andean

Region (CONDESAN). This consortium, active in Colombia, Bolivia, Peru and Ecuador, is carrying out a large amount of agrobiodiversity management work with Andean roots and tubers (IDRC, 2000).

2.3. Genetic improvement

Studies on genetic have focused on biotechnology and on conventional plant breeding of crops such as rice, beans, maize, soybeans, wheat. Improved seed varieties have played a large role in increasing production of major crops. For instance, in Brazil, the development of new soybean varieties in Brazil has enabled production to expand into areas not previously able to support successful production. Beef cattle production has also benefited from improved breeding and genetics (Brazil, First National Report; World Bank, 1994).

The Mexican government has made efforts to promote the use of improved varieties. These are developed and marketed by numerous companies and sold as certified seeds. However, there has been a decline in the use of certified seeds in the last 15 years in all crops in the whole country (SAGAR, no date). Some areas in Mexico, such as the Yucatan, have been excluded or have had limited access to the reception of modern varieties distributed by commercial houses due to several agronomic, economic, and social factors. As a result, farmers have established their own informal seed supply networks, which have little or no relationship with the formal systems. Seed interchange has several sources, being most of them at the local and regional levels (IPGRI, no date).

The Mexican government is actively promoting use of certified improved varieties, through the programme '*Kilo por Kilo'*. Target groups are farmers in areas where improved seeds are not been used. The main target crops are maize and beans. Farmers are to give a kilo of their local seeds for improved varieties. The aim was to achieve 3 million ha planted with improved maize by 1999. The government is aware of the risks of using only improved seeds on plant genetic diversity of the country as expressed in the '*Programa de Desarrollo Agropecuario y de Desarrollo Rural'*. To minimise the risk the programme recommends the use of a significant proportion of open –pollinated varieties that are better adapted to local climatic conditions. However, there are concerns that this programme is a way to reduce genetic diversity, and that improved varieties are not adapted to the particular environment of the farms.

CIMMYT and its collaborative programmes in Central America have produced a wealth of improved maize and wheat varieties. The *Programa Regional del Maíz* (PRM), a regional network plays an important role in the development and promotion of improved maize varieties and farming practices, helping conserve natural resources, benefiting farmers and consumers. Nearly 150 maize varieties, with higher yields and tolerance to harsh conditions, pathogens and poor soils have been released through the PRM in Mexico and Central America. These resistant varieties have helped ensure stable yields for subsistence farm households, and allowed farmers to reduce or eliminated fungicide applications reducing costs and helping to protect the environment. The PRM has also been active in recovery of maize seeds lost in disasters in Central America. CIMMYT is also producing improved wheat bred to yield well under a wide range of cropping conditions in Latin America and elsewhere (CIMMYT, 2000).

2.4. Traditional knowledge

In many areas traditional farmers have developed complex farming systems adapted to the local conditions helping them to sustainable manage harsh environments and to meet their subsistence needs without depending on external inputs or technologies of modern agriculture. Using knowledge gained through experience, and locally available resources, indigenous farmers have developed integral and diversified production polyculture systems adapted to the different ecological systems**.** These agroecosystems, based on the cultivation of a diversity of crops and varieties in time and space, have allowed traditional farmers to maximise harvest security under low level of technology, and with limited environmental impact (Altieri, 1999**.** Traditional farmers' strategies emphasise crop diversification as a way of managing risks resulting from climatic vulnerability and market fluctuations. Additionally, they make use of resources available outside their fields. For example, as reported by Altieri (1999)"for some Indian communities in Mexico, gathering wild plants for dietary, medicinal, household and fuel needs, is part of a subsistence pattern based on multiple uses of the natural resources".

Some of these agroecosystems include: -the *Milpa* system, focused on the cultivation of maize, but, which may constitute a system of polyculture including up to 20-25 agricultural and forest species. It is in many cases combined with agricultural market-oriented products such as hot-pepper, rice, bans, sugarcane etc., -home gardens (agroforestry systems located next or close to households), -**"***chinampas***"** (multicropped, species-diverse gardens developed from reclaimed lakes); and - coffee in stratified forest systems (shade coffee).

Home gardens in Mexico and the Amazon display highly efficient forms of land use, incorporating a variety of crops with different growth habits, resembling in some cases tropical forests, especially in the more humid areas. As many as 376 species of cultivated plants have been recorded in the homegardens of the Yucatan Peninsula. In the Brazilian Amazon, homegardens can contain dozens of trees and shrub species. Home gardens have also a rich microfauna and microflora and beneficial insects that pollinates crops and control pests (CONABIO, 1998; Thrupp, 1998, Srivastava *et al*., 1999; Altieri, 1999). Traditionally managed coffee and cacao plantations (Figure 1) support at a significant larger number of bird species than on other agricultural lands as shown by studies in Southern Mexico (Rice & Ward, 1996).

Smallholding agriculture accounts for a significant share of traditional agriculture. It is estimated than in Latin America there are about 16 million peasant units occupying close to 160 million ha (Altieri, 1999). In the Brazilian Northeast, in 1980, smallholders accounted for 88.5% of the production of basic foodstuffs (beans, rice, maize and cassava) and for more than half of industrial staples mainly cotton, peanuts, castor oil seeds and tobacco (World Bank, 1994).

The value of the knowledge of traditional farmers or indigenous people has been largely ignored. However, recently there has been a trend to revalue traditional knowledge. Scientists are also increasingly starting to recognise the importance of biodiversity in agricultural systems. Diversified cropping systems have recently been the target of much research. There are several rural development programmes in Latin America aimed at the maintenance and/or enhancement of biodiversity in traditional agroecosystems (Altieri, 1999).

Cuba's scientists are relying on farmer's knowledge and innovation to complement their efforts towards the development of organic techniques. They learned from farmers how to use a predatory ant to control sweet potato weevil. The co-operative effort between researchers and farmers is building an increasingly effective natural pest control system (Rosset & Altieri, 1994; Meadows, 1997).

In Cuba there is a three-year on-going home garden study, part of a project co-ordinated by IPGRI, and also conducted in Guatemala, Vietnam, Ghana, Venezuela and Nepal. In Cuba the project is being conducted by, among others, the *Instituto de 'Investigaciones Fundamentales en Agricultura Tropical'* (INIFAT), the Sierra del Rosario Biosphere, and the "*Unidad de Medio Ambiente*" (UMA). The project documents characteristic features and types, structures and composition, inherent species and varietal diversity and the ecological and social settings of home gardens. An aim of the project is to understand how commercialisation and crop introduction/improvement affects species and varietal diversity in home gardens and which targeted development interventions enhance home garden biodiversity and improve family nutrition and income. Molecular diversity studies have being conducted to determine the levels of intraspecific diversity conserved by home gardens (IPGRI, 2001; Jarvis, D. I., personal communication).

The government in Mexico has a policy priority to support the development of marginal communities, including the Indian communities. The line of action is to reform the juridical framework to protect the knowledge and the traditional practices for the management and conservation of natural resources. The '*Instituto Nacional Indigenista*', is developing programmes for agroecological production. The aims of the programme are:- to promote and facilitate the sustainable use of natural resources;-to promote and facilitate the use of organic inputs and alternative technologies; - and to support and facilitate the recovery and conservation of genetic material of flora and fauna, endemic and under risk, supporting existing germplam banks and promoting the formation of new ones. (Loa Loza *et al.*, 1998).

In Central America a number of institutions and researchers are trying to re-establish some of the polyculture systems such as '*chinampas*' and eco-friendly coffee, which makes more productive use of local resources and use organic fertilisers, as presented in one of the examples of best practices (section 6.1) (Thrupp, 1998).

In North-eastern Brazil, the Food and Health Education Programme (FHEP) is education people, in particular women on nutritional health issues, promoting interest in growing home gardens with the aim of enable them to improve their diets and the health of the families, and to introduce them to an agroecological vision of the environment. Especial attention is given to the promotion of home gardening practices adapted to the semiarid environment and to the rescue and validation of traditional knowledge on medicinal plants (The Agroecology Research Group, 1999a).

Brazil is also a strong member of the Community Biodiversity Development and Conservation (CBDC) Program, and its project on on-farm management of agrobiodiversity. The NGO '*Assessoria e Servicios a Projetos em Agricultura Alternativa'* (AS-PTA) is conducting inventory and survey on local genetic diversity of maize and beans in Paraná State. The project aims to reverse farmers' dependence on the purchase of seeds and varieties, supporting farmer management and utilisation of local varieties. It focuses on local seed supply and opportunities for supporting farmers' breeding (CBDC, no date).

2.5. Promotion of sustainable agricultural production:

The use of sound methods for agricultural production is becoming more important in the region. Cuban government had a remarkable change of agricultural policy, from highly modern, input dependant agricultural to sustainable agriculture, as a response to the food crisis after the collapse of its trade relation with the socialist block. One facet of the programme was the promotion of organic or near organic agriculture, and the use of non-chemical technologies. Already before the crisis some scientists had been working on natural ways to control pests and build soil nutrients and had an appropriate infrastructure for research. There was a drastic reduction in use of chemical pesticides and fertilisers, promoted by the ministries in charge of agriculture, sugarcane and forestry. By mid-1990s, Cuba was one of the world leaders in the production and use of many biopesticides with over 200 centres, located at co-operatives, for production of biopesticides and natural enemies of crop pests. IPM technologies, based on monitoring systems, crop rotation, green manuring, intercropping and soil conservation with incorporation of organic manure, have been incorporated into polyculture farming. (Rosset & Altieri, 1994; Rosset, 1996; Meadows, 1997; UN, 1999a**;** Pretty & Hine, 2000**).**

The Cuban model also emphasises the diversification of agriculture. There is a trend to increase crop diversification influenced by changes in the policies for land tenure and in the production systems. The large monoculture states farms are being broken up and converted into rural co-operatives. The co-operative members are given the right of using the land, normally consisting of smaller production units. Although most of the land is still in sugar production there is a trend towards increased diversification . There also efforts to strengthen research to establish crop rotation for sugarcane, traditionally planted in monocultures, and polycultures systems combining agriculture with livestock, fishery etc (Meadows, 1997; UN, 1999a; Enríquez, 2000).

Two lines towards sustainable agriculture have emerged: intensive organic gardens in urban areas and sustainable agriculture on both large and small farms in rural areas. Community gardens are appearing on vacant rural land. There are reportedly about 7080 gardens producing vegetables. Both the number of gardens and the productivity per area have increased. Production has increased from about 4200 tonnes of food per year in 1994, to 727,000 tonnes in 1999. It is estimated than 200000 farms on about 150000 hectares have adopted sustainable agriculture practices. They have made a significant contribution to total food production while conserving biodiversity (Rosset & Altieri, 1994; Rosset, 1996; Meadows, 1997; UN, 1999a; Enríquez, 2000; Pretty & Hine, 2000). The ' *Grupo de Agricultura Orgánica'*, which brings together farmers, field managers, field experts, researchers and government officials, has been at the forefront of the transition towards sustainable agriculture. This group is now encouraging farmers of large-scale rice, potatoes, sugar cane and citrus to reduce their use of pesticides and fertilisers (Pretty & Hine, 2000).

At a federal level in Mexico, policies for IPM have focused on controlling the use of pesticides and toxic substances in agricultural production and the promotion of use of natural enemies. Alternative methods are being promoted by social organisations that use mechanisms such as the social-environmental certification in order to provide incentives for the use of sustainable technologies that harmonise the use and conservation of natural resources. Researchers, institutions and initiatives are actively promoting marketing of environmental-friendly coffee (see example in best practices, section 6.1).

In Mexico *the Instituto Nacional Indigenista* has developed a programme for ecological friendly production, which include training in use of organic inputs and alternative technologies (Loa Loza, 1998). There are also efforts to improve the slash-and-burn agriculture through the use of sustainable practices, which allow its intensification, accordingly to the environment and within the frame of productive diversification (UN, 1999b). "*Del Cabo"*, a producers' co-operative in Mexico that began experimenting with organic practices in the mid- 1980s, is a successful commercial producer of a wide variety of organic crops for export throughout the year. Plant diversity and soil improvement are important aspects of the group's pest and fertility management (Thrupp, 1998).

In Brazil there are several certification initiatives for forestry and agricultural organic production, one of them is the "Selo Orgánico" given to 1500 producers in 1998 (Viana *et al*., 1998). The Government, NGOs, and researchers are increasingly taking into account family farming, organic agriculture and cattle-raising activities as essential elements to be considered in restructuring production systems aiming at sustainable development. There is a growing market for green products among more affluent consumers in urban centres. The opening of fruit processing plants in several parts of amazon has stimulated the diversification of farms for example toward commercial agroforestry. (Srivastava *et al*., 1999).

Institutions are being strengthened to support biodiversity friendly agriculture and sustainable production systems. A number of research and development projects and programmes led or facilitated by EMBRAPA are promoting sustainable agriculture through, for example reduced use of pesticides, use of natural enemies, cultural practices and increased use of local genetic resources**.** Biological control of key pests of important crops such as maize, soybean, tomato, is being developed. It is estimated that biocontrol of *Anticarsia gemmatalis*, a key pest of soybeans by means of a baculovirus developed by EMBRAPA, and used in over 10 millions hectares since 1983, has saved farmers over US$ 100 millions in agrochemicals. The National Centre for Forestry Research (CNPF) and the Centre for Agroforestry Research of the Eastern Amazon (CPATU) are developing production systems for the management of forestry and agroforestry systems, and programmes for environmental education, and for the dissemination and transfer of technologies (Brazil, First National Report; EMBRAPA, 2001).

2.6. Soil biodiversity and conservation:

Much effort has been dedicated to the study of diversity of micro-organisms related to biofertilisation of soils in Brazil, particularly with the objective of reducing dependency on chemical inputs. For instance, the use of N-fixing bacteria inoculates in soybean production has resulted in considerable saving in costs and reduction in the use of chemical fertilisers (EMBRAPA-CNPSO, 20001). EMBRAPA and several universities, institutes and foundations are involved in research or training programmes of soil micro-organisms of importance for agrobiodiversity. However, there is a lack of interinstituional and interdisciplinary integration (Brazil, First National Report ; Perez Canhos, 1998).

Agroecological zoning studies for the southern and southeastern regions of Brazil have allowed an increase in productivity whilst diminishing the impact on soil and living resources trough stricter selection of soils for agriculture. Minimum tillage of soils, which is increasingly expanding, has also helped to conserve soil conditions and biodiversity of soil organisms (see example of best practices section 6. 3) (UN, 1998; EMBRAPA, 2001). Agroforestry systems managed using natural succession have been tested as a strategy for improving degraded soils and as a sustainable production system in the rainforest region, South of Bahia, Brazil (The Agroecology Research Group, 1999b).

In Central America the adoption of conservation tillage, being promoted by the '*Programa Regional de Maíz'* (PRM) Network has allowed farmers to raise maize yields while halting erosion. Farmers in many areas use maize-legume systems to improve soil fertility and avoid erosion. (CIMMYT, 2000).

In Mexico, the '*Direccion General de Restauracion y Conservacion de Suelos'* created in 1995 has addressed soil conservation giving emphasis to preventive conservation especially in relation to production activities of farmers. Some of the responsibilities of this body include: -updating the legal and regulative framework; -design and implementation of mechanisms for reorientation of incentives to promote soil conservation; -validation of technologies for soil conservation; -monitoring soil degradation; and elaboration of programmes for land management (Peña Jiménez *et al.*, 1998).

In Cuba, systems for soil improvement and conservation are being developed. These include minimal tillage, rotations, organic fertilisers, green fertilisers and green cover, and the breeding of oxen to replace tractors. Salinity in rice fields is being addressed by using *Sesbania* in rotations, which provides organic matter in conditions with salinity stress (Rosset & Altieri, 1994; Rosset, 1996; UN, 1999a; Pretty & Hine, 2000).

2.7. Pollinator conservation

Until recently, little attention had been given to the role of pollinators and their conservation. There have been some initiatives of using pollinators in agriculture. Thus Argentina, Chile and Uruguay have imported *Bombus terrestris* for pollination of tomato. In Brazil there is information available on indigenous pollinators for wild plants, and some research has been done on the use of pollinators in crops, but their use is not a common practice among farmers. (Fonseca, B., personal communication). Brazil presented a proposal for the conservation of pollinators to the 5th Conference of the Parties of the Convention on Biological Biodiversity

(CBD), based on the São Paulo Declaration on Pollinators (1998), which gave basis for an international initiative for conservation and use sustainable of pollinators in May 2000. The aims of the initiative are to address the issue of decline of pollinator diversity and provide mechanisms for the governments to monitor pollinators, assess the economic value of pollination and the economic impact of the decline of pollination services (CRIA-BDT). Researchers from several countries in the region including Argentina, Chile, Colombia, Costa Rica, Cuba, Mexico and Venezuela have joined the initiative.

In Mexico, there are efforts to protect migratory bats, which are important pollinators and seed disperses of important crops such as tequila agave and fruit trees, and regulators of insect pests. The Programme for Conservation of Migratory Bats was started in 1994 with participation of the Institute of Ecology of Mexico's National Autonomous University and the Bats Conservation International (BCI). The programme focused on research and environmental education to protect bats by conserving habitats along migratory corridors. Other conservation measures included amendments of Mexico's Federal Law of Wildlife to encompass all caves and crevices as protected areas (Walker, 2001). The Arizona-Sonora Desert Museum in conjunction with the Turner Endangered Species Fund and the Pollinator Conservation Consortium have begun a project to protect four migratory species (butterflies, doves, bats and hummingbirds) along the nectar corridors of western Mexico and the southwestern United States (Pronatura, no date). Mexico is part of the North American Pollinator Campaign (NAPPC) (including also the US and Canada), with participation of researchers, state and federal agencies, private industry and conservation and environmental groups which has been recently started with the aim of ensuring sustainable populations of pollinators (NAPPC, 2001).

In Cuba efforts are being directed to the development of the apiculture for honey production and for its value in pollination that helps reduction in application of chemical products (UN, 1999a). Two species of bees are utilised as pollinators, though their use is not very common. The knowledge on wild bees and their use is restricted. The National Group of Urban Agriculture is promoting the use of *Melipona beecheii* in vegetable gardens. There are several decrees and laws related to the protection of *Apis mellifera* (Leon Diaz, A., personal communication).

3. *Approaches to conservation and management of components of agrobiodiversity, in national agricultural plans and in national biodiversity strategies.*

As part of the commitment assumed by signatory countries of the Convention on Biodiversity, the countries have to develop a strategy and plan of actions contained in the National Biodiversity Strategy and Action Plans (NBSAPs). Cuba has presented its NBSAP in April 2000. Mexico presented its Strategy last year and the Action Plan is being undertaken by one state, *el Estado de Morelos* (J. Soberon, personal communication). Brazil's NBSAP is underway and the documents prepared in 1998 to be fed into it are available on the Internet.

Cuba's NBSAP covers topics related with sustainable agriculture, such as integrated pest management, soil degradation and conservation, plant nutrition and biodiversity. A series of action at short, medium and long terms are proposed with the institutions and bodies responsible for their implementation.

Note: The agricultural plans for Brazil and Cuba were not available. Information was obtained from the government homepages.

3.1. Pollinators

With the exemption of Brazil there is no consideration of pollinators in the NBSAPs. Brazil presented a proposal for the conservation of pollinators to the 5th Conference of the parties of the CBD, which started an international initiative for conservation and use sustainable of pollinators as described in the previous section.

Cuba's NBSAP mentions that efforts are being concentrated on the development of bees for apiculture and for their value as pollinators.

Mexico has a programme to promote apiculture as a complementary activity to agriculture, but no aspects of pollination are considered in the agricultural plan or in the national strategy.

3.2. Soil biodiversity

Considerable attention is given to soil conservation by the countries.
In Cuba soil conservation and improvement, including soil biodiversity is stated as one of the functions of the Ministry of Agriculture in order to comply with the policy of the government. This is to be done through regulation of the use of soils according to its characteristics and capacities, to avoid soil exhaustion and erosion and through the use of biofertilisers and compost to replace chemical fertilisers.

Cuba's plan of actions to be carried out under the responsibility of the Ministry of Agriculture (MINAGRI) and the Ministry of Sugar (MINAZ) and the Soil Institute include:

Short term actions	Medium term actions
- Update the biological characterisation of soils, assuring the implementation of an adequate plan for the management (conservation and sustainable use) of biodiversity - Strengthen the control of soil contamination	- Guarantee that aspects related to conservation and sustainable use of biodiversity are taken into account when designing and formulating the planing and regulations for land use.

The Brazilian government recognises the importance of soil biodiversity. Soil biodiversity was one of the key aspects, together with pollinators, of a proposal on agrobiodiversity presented by the Brazilian Government to the second SBSTTA in 1996.

The main constrains identified in the strategy are: deficient institutional capacity, lack of integration between different groups working on given topics, insufficient information exchange, and lack of education of the population to appreciate the value of the soil biodiversity. To overcome these constraints the following goals and strategies are proposed (Perez Canhos e*t al.*, 1998):

- Establishment of a network of laboratories, scientific collections and technical centres.
- Programmes for education of specialists (post-graduate programmes in the country and abroad and short courses in the country)
- Definition of standard sampling protocols
- Definition of indicators of soil quality
- Develop models to measure the economic value of the biodiversity of microorganisms and creation of fiscal incentives.
- Establishment of specialised discussion groups of researchers
- Establish thematic networks on soil and microorganisms biodiversity.
- Education targeting the appreciation of the value of the biodiversity of microorganisms and their sustainable use and development.

Mexico recognises the importance of soil conservation for the development of sustainable agriculture, although there is not explicit consideration of soil biodiversity. The line of action presented in the Programme of Agriculture and Rural Development emphasises the need to invest in programmes for soil conservation. All components of the programmes should take into consideration the characteristic of the soil. Thus, crops and agricultural technologies to be used should be selected according to the characteristic of the soils, using existent knowledge of the agroecological conditions of the regions. Renovation of agricultural equipment and machinery is planned as a way of increasing production, and contributing to soil conservation.

The National Project on Conservation Cultivation has a holistic approach, which combines fertilisation, soils coverage and pest and weed management, to increase production, to diminish production cost and to protect the soil (SAGAR, no date).

3.3. Biodiversity that provides mitigation of pests and diseases.

The use of natural enemies and bio-pesticides is a common practice in Cuban agriculture.
The Agricultural Environmental Strategy takes into consideration the need of using IPM, with the use of biological methods such as use of natural enemies and the judicious use of pesticides, which protects biodiversity of parasitoids, predators and microrganisms (UN, 1999a). However, the NBSAP does not deal with conservation of biodiversity of these organisms, but it is more concerned about safety issues on introduction of biological agents. It presents the following short term actions under the responsibility of the National Centre of Biosecurity (*Centro Nacional de Seguridad Biólogica*) and The National Centre of Biodiversity (CenBio):

- Carry out a national inventory on installations, biological agents modifies, and releases of organisms to the environment.
- Establish a methodology to evaluate the risk of biological agents, genetically modified organisms and exotic organisms.
- Create a commission that gathers and provides information on viruses and microorganisms and join the National information network on biodiversity.

Mexico' agricultural plan mentions natural enemies as components of IPM programmes for the main crops. Biodiversity of natural enemies in particular is not considered in the strategy for biodiversity conservation.

3.4. Crop and livestock genetic resources

The policy of the Cuban government regarding genetic resources is reflected in the mission of MINAGRI: "…corresponds -the protection and growth of the cattle, patrimony of the country, their genetic development, the preservation of the genetic richness of all species of domesticated and wild fauna, as well as the registration and control of the heavy livestock raising, - the enforcement and control of the protection policy, - the conservation and use of the phytogenetic resources and of seeds in the non-sugarcane agriculture and forestry "(Cuba homepage).

In situ conservation, complemented by *ex situ* conservation is the main strategy for preserving genetic material in wild species as well as domesticated species in Cuba. The action plan for genetic resources management takes into consideration the regulation of the access to genetic resources and the international exchange of germplasm (NBSAP, 2000). The proposed actions under the responsibility of MINAGRI, MINAZ, the National Commission of Genetic Resources, the National Centre of Biosecurity, the National Botanical Garden, the Centre for Information, Documentation and Environmental Education (CIDEA) and the Ministry of

Science, Technology and Environment (CITMA) with participation of the Centre of Research in Biodiversity are presented in table 1**.**

The Brazilian Government is particularly interested in the use and conservation of genetic resources. The mission of the National Research Centre for Genetic Resources and Biotechnology (CENARGEN) is "to maintain the diversity of genetic resources and develop the biotechnological methodologies and processes for this purpose". The Programme for Biodiversity and Genetic Resources (BIOVIDA) promotes the use and conservation of genetic resources. EMBRAPA coordinates the use and conservation of native and non-native, genetic resources of importance to agriculture. The Programme for the Development of Basic Research in Biotechnology provides support for basic research on biological pest control and the application of biotechnology in agriculture **(**Brazil, First National Report; '*Avança Brasil*, 2001**).**

The Brazilian strategy for genetic resources conservation considers *in situ* conservation as the main strategy complemented by *ex situ* conservation. The strategy addresses the following constraints: -lack of a legislation to promote the creation of germplasm bank *in situ*; -deficient public knowledge on the importance of genetic resources; and -lack of co-ordination, exchange of experiences and articulation in search for funding among the different researchers groups. It also emphasises the imbalance between the available human resources and the huge task of protecting biodiversity in such a biodiversity rich country. It proposes the following strategies:

- Establish a national committee responsible for planning, co-ordination and support of policies and initiatives regarding genetic resources.
- Establish a priority line of research at federal level as well as on the states to promote the development of sustainable agriculture. Sustainable agriculture meaning low input agriculture, including high species diversity, and *in situ* conservation by farmers. Assuring the continuous satisfaction of the human needs for present and future generations. This should be economically viable, socially acceptable, technically adequate, and environmentally sound. The programme should consider the vocation and characteristics of each region. To achieve this the agroecological zoning of the country is a prerequisite.
- Training at the scientific and technical level to increase the capacity to use available knowledge about the use, study and conservation of genetic diversity
- To create a policy of extension in rural areas for diffusion of appropriate technologies, identify viable agroforestry systems, IPM, and to control the exchange of genetic material.
- Study (biological characterisation) and catalogue the accessions available in the germplasm banks, and make the information available through informative services.
- Establish fair conditions for exchange of genetic materials, and distribution of benefits and costs of conservation.
- Establish a programme for inventory, characterisation and evaluation of genetic resources present in agricultural lands, including Indian lands, in order to conserve the remaining genetic variability of domesticated plants.
- Convince the society of the value of conserving biodiversity. Assuring that economic returns benefit a broad sector of the population could do this.

Regarding biosafety the strategy presents the need to address movement of organism within the country. Brazil has one of the most advanced legislation for biosafety, but it is mainly concerned with genetically modified organisms (GMOs) and to some extent with import of exotic organisms. There are no regulations for movement of organisms within the country. There is a need of establishing mechanisms of control on introduction of exotic species in natural habitats. The aim is to strengthen the legislation on the use of biodiversity and to establish a research programme of the economic potential of local flora and fauna as an alternative to introduction of exotic species. The strategies to achieve these goals are: -an increase in the control and financial support to study the effects the exotic fauna and flora on Brazilian biodiversity, and - revision of the legislation to address import or movement within the country of wild or domesticated organisms (Kageyama, 1998).

In Mexico, promotion of genetic improvement of crops and livestock is one of the main strategies to increase production in the Programme for Agriculture and Rural Development. This is being done through programmes such as '*Kilo por Kilo'* as mentioned above.

Biotechnology, especially genetic engineering is considered a very useful tool to increase production conserving the environment. Considerable resources have been invested in the development of biotechnology. The National Programme of Agricultural Biotechnology has been established to manage these resources.

Diversification in livestock and agriculture based on conservation of germplasm and use of species with economic potential is another approach to achieve economic development.

The strategy of Mexico emphasises the need to support the role of rural communities, including farmers, in keeping areas dedicated to *in situ* conservation or who contribute to protection of biodiversity in the area under their management by creating mechanisms of verification and support. It also deals with biotechnology issues, in particular biosafety. Proposed strategies include:

- Establish mechanisms to regulate the manipulation of genetic resources.
- Evaluate the benefits and risks of transgenic organisms in the environment and in human health.
- Establish a national programme that assesses the economic value of the local natural resources, promote and guide the research in bioengineering of native species, establish control criteria and security indicators.

3.5. Diversity at the landscape level

The Cuban strategy expressed in the NBSAP is to develop programmes for the management of wild and domesticated populations of the biota in ecosystems and landscapes, giving priory to ecologically fragile or endangered zones. The recommended medium term actions under the responsibility of MINAGRI and CITMA include:

- Promote the introduction of agroforesty as ecological-sound agro-production systems.
- Elaborate and carry out programmes for conservation and rehabilitation of landscapes, ecosystems and habitats affected by exploitation, erosion, salinisation, etc.

In Brazil, the government through the Institutions of Research and Development in Agriculture, are developing strategies, and activities directed towards environmental protection and sustainable productivity (EMBRAPA, 2001). Some of them, related to diversity at the landscape level include:

- Promote the rational management of forestry and agroforestry systems
- Rehabilitation and conservation of riparian vegetation to prevent reduction in water quality and availability essential for agricultural activities.

- Promotion of practices for conservation/rehabilitation of pastures lands such as conservation /planting of suitable species of trees.

The Brazilian strategy presents the need to promote highly diverse production systems including agricultural systems by increasing funding for multidisciplinary studies. These studies should be directed to solve concrete problems of the producers and the results should be disseminated in such a form that they reach decision-makers, small medium scale agriculture and traditional producers. Credit programmes should create special conditions for credits as incentives to promote sustainable systems such agroforestry and polycultures (Kageyama, 1998; Viana, 1998; Viana *et al.*, 1998).

The strategy also considers efforts to increase agricultural production concentrating on restoration of degraded agricultural land and not on expansion of the agricultural frontier on natural ecosystems (Kageyama, 1998).

Mexico’s approach, contained in the Programme of Agriculture and Rural Development, is to diversify production according to the potential of the different regions of the country. This is to be done by:

- Introduction of new species and varieties
- The use of marginal lands no appropriated for agriculture for livestock production.
- Promotion of plantations of perennial crops, where Mexico has competitive advantages. The rubber tree *Hevea brasisliensis* is considered an alternative for productive reforestation in the tropical forest.
- Replacement of coffee for other crops in marginal areas for coffee production.
- Promotion of polycultures combined with livestock activities especially for smallholder farmers in the rural area.

The development of pastures is to be planned according to the agroecological zones. There is a programme for pasture management in each ecosystem (for the arid, semiarid, temperate and tropical ecosystems).

Mexico’s strategy gives attention to the conservation of disturbed areas, or permanently managed by humans through:

- Promotion of practices for restoration or rehabilitation such as the establishment of zones that favour the continuity of the vegetative cover (corridors) and conservation of trees in pasture lands as source of colonisation and natural regeneration (Figure 2).
- Promotion of the use of *alcahuales* (secondary vegetation) for agroforesty, combined with activities compatible with the rehabilitation of disturbed spaces, such as controlled hunting activities, and including small projects at family level for conservation of soil and water. This would be compatible with the rehabilitation of disturbed spaces while generating employment and income for the local inhabitants and restoring the wild flora and fauna.

3.6. Wild-biodiversity in agroecosystems

There is no particular approach to conservation of wildlife in agroecosystems, but in general to wildlife for the three countries.

It is the task of the Ministry of Agriculture in Cuba to direct, control and execute the national policy regarding conservation, rational use, management and sustainable development of the resources of the forest patrimony and of the wild fauna and flora of the country (Cuba’s agricultural homepage).

Brazil's strategy states the need to establish a national programme to generate information in a co-ordinated way on native flora, in view of preservation of germplasm for potential use in plant breeding programmes.

3.7. Traditional knowledge of agrobiodiversity.

The value of the traditional knowledge is recognised in all studied countries. It is also agreed that the knowledge of the traditional communities has to be valued and used to its full extend as an additional tool for conservation and sustainable use of biodiversity.

In Cuba the government has formulated programmes to collect and compile traditional knowledge in the agricultural and other sectors. Surveys of the perception of farmers regarding production technologies, their efficacy and availability are being conducted and the effect of innovative technologies and incentives on family incomes is analysed (UN, 1999a). The objectives, presented in the NBSAP, are to rescue and promote the use of traditional knowledge and practices in relation to conservation and sustainable use of biodiversity. The proposed actions (short and medium term) under the responsibility of CITMA with participation of MINAGRI, MIP, MINAZ, the National Association of Small holders (ANAP) and ONGs are:

- Include etno-biological and social studies on the community knowledge of biodiversity in the priority research of programmes of science and technological innovation.
- Promote the rescue, dissemination and implementation of traditional practices, in the planning and development of schemes for the conservation and sustainable use of biodiversity.

Brazil's approach is to develop and establish mechanisms that value and take advantage of the traditional knowledge on the diverse systems of use of biodiversity resources, with participation of the holders of this knowledge and a fair distribution of the benefits. For that the government should define research programmes (through EMBRAPA) to study and develop traditional production systems. This implies investment of governmental funds for studies in ethno-science (da Fonseca *e*t al. , 1998; Kageyama, 1998; Viana *e*t al. 1998). The strategies proposed are:

- Definition of the Indian areas and protected areas in terms of their contribution to conservation of biodiversity.
- Develop programmes, such as bioprospection, to add value to protected areas.
- Include information on the knowledge of traditional communities on biodiversity in courses at all educational levels to address the lack of appreciation of the value of this knowledge by the community.
- Reward traditional communities for using and conserving biodiversity. This could be done by directing financial support to agricultural initiatives that favour biodiversity conservation.

Mexico's agricultural plan does not take into consideration the knowledge of traditional communities. It is concerned with supporting poor resource farmers including indigenous communities by promoting activity diversification and facilitating access to technologies to increase crop productivity with a sustainable use of natural resources and conservation of the environment. This is to be obtained through a technological change in traditional forms of production, adoption of improved varieties, and technical assistance and training.

Mexico's strategy recognises the importance of traditional knowledge. Its objective is to revalue and revive the popular knowledge of the selective use of biodiversity. One of the priority actions is to know and to systematise the existing traditional practices and technologies (in agriculture, forestry, etc) that are compatible with biodiversity conservation. Once identified the development and promotion of these practices need to be supported.

Special attention is given to property rights related to traditional knowledge, and to the importance of stimulating the systematisation of the knowledge about traditional uses and alternatives of biodiversity considering cultural, social and economic aspects associated with the management and use of the resources.

4. *Policies, regulatory mechanisms and the implications of agricultural development plans on agrobiodiversity management:*

The agricultural policy until the 60s in the region was directed to guarantee the abundance of cheap food, through the expansion of agriculture. This was followed by agricultural intensification with the objective of improving productivity to achieve food security as a response to increasing populations and to promote export of agricultural products (World Bank, 1994; Coelho, 1999**).**

The expansion of the agricultural frontier was encouraged by several agricultural policies such as subsidised credits, fiscal incentives, and labour and land tenancy laws.

The expansion of the Brazilian frontier was promoted by: 1-taxes on agricultural income, 2-rules of land allocation, 3- land taxes, 4-capital gains and commodity taxes, 5- regional and sectoral taxes, 6- provision of credits. In Brazil, until 1985 government policies provided substantial incentives for the expansion of the agricultural cattle-ranching frontiers. Tax incentives and subsidies stimulated the occupation of enormous areas in the Amazon and the *Cerrado*, resulting in widespread deforestation and the degradation of the natural environment (Brazil, First National Report). Frontier states also offered incentives through fiscal policy designed to encourage production and investment into the forest (World Bank., 1994). Insecure land tenure has also been a major casue of deforestation. In 1987 unusually large areas of forest in the Brazilian Amazon were cut and torched because of land tenure laws regulations, which stated that 'unproductive lands' could be expropriated. This was aggravated by land taxes with higher rates on uncultivated than on developed land (World Bank, 1994).

Government policies to promote agriculture were, in many cases, biased against smallholders, who make up the great majority of producers. In Mexico, credits favour producers with high incomes, who have more access to the financial system (SAGAR, no date). In Brazil, the provisions sheltering agricultural income from income land taxation put small holders, with low incomes at competitive disadvantages in the market for land relative to large farm owners whom benefit from the tax shelter (World Bank, 1994). For small producers it was difficult to obtain credit unless they produce cash crops (in which case they could obtain pre-financing from buyers/exporters (World Bank, 1994; Garret, 1995). This contributed to deterioration/exhaustion of natural resources by poor farmers trying to earn a living day by day. Even for larger farmers, the availability of credit at negative interest rates has encouraged land speculation that encourages deforestation (Garret, 1995). Similarly in Mexico, the lack of right policies for colonisation has contributed to the deterioration of the ecosystems and loss of biodiversity (CONABIO, 1998).

To increase production countries adopted modern agricultural models such as 'the Green Revolution' that encouraged the use of improved varieties, monocultures and high input technologies, and the subsidy of inputs such as of fertiliser and pesticides that are especially well suited for use with improved varieties. The widespread policy of promoting the use of modern varieties has led to genetic narrowing of crop production. Farmers have been encouraged by extension programmes, credit and agricultural policies and market forces to replace traditional diverse practices with new uniform varieties, standardised livestock breeds, and monoculture crop systems. Generally credit is only available for approved varieties that have been certified by national seed boards; as a result many farmers have abandoned traditional varieties. Similarly, livestock production policies often promoted the spread of major beef and dairy breeds leading to extinction of local breeds. The driving force behind selection has been rapid weight gain or volume of milk production. Countries in the region pursued agricultural product pricing policies focused on a few standard crops, and favouring monocropping. For instance in Mexico grain prices were kept artificially high through government subsidies making annual grain crop production artificially attractive **(**World Bank, 1994; CONABIO, 1998**).**

In Mexico governmental policies were directed to regulate prices and land use, inputs supply and access to markets. During the 1970 and early 80s credit availability, and the investment on agricultural development experienced a considerable growth, with a substantial decline thereafter. In the 90s the government redefined its role in the agricultural sector, with a new policy based on participation and opening for private investment and less participation by the government (UN, 1999b).

Other factors (besides public policies that promotes the expansion of the agricultural border, and do not stimulate the management of natural ecosystems) that affect conservation of biodiversity have been identified as: the fact that the economic system does not value the services provided by biodiversity, lack of economic support for the development of sustainable production systems, and juridical and institutional systems that promote the unsustainable use of natural resources (Viana *e*t al. , 1998).

The severity of some resource degradation and the unsustainability of the production systems have prompted government action to regulate natural resources. In the case of Brazil, since 1988, with the constitutional reforms, significant improvements have been made to address the impact of agricultural taxes and subsidies on sustainability of natural resource use. These involved a substantial reduction of levels of regional and sectoral tax incentives and the nearly elimination of subsidised agricultural credits. Special fiscal incentives for development in the Amazon region have been substantially restricted. This has resulted in the re-conversion of much of the land used for extensive ranching activities into forest.

Fertilisers and pesticides are not longer provided with special incentives under the income tax code, whereby a multiple of their costs could be subtracted from gross revenue to arrive at taxable income. The diminishing volume of official credits and reduced subsidies tend to reduce the intensity of use of fertilisers and pesticides in agricultural production. Nevertheless neither the tax code nor the expenditure programmes has been systematically used to encourage sustainability of agricultural production and natural resource use (World Bank, 1994).

The new constitution (1988) introduced various changes in land reform and expropriation procedures. According to the Constitution expropriation could only be applied to large "unproductive" farms, which implies increased ownership security for large productive farms and for small and medium farms. The Constitution also states that all farms, regardless of size, must perform their " social function". They must, among other conditions, guarantee rational and adequate use of the land, adequate use of natural resources and preservation of the environment. Reforms in progressive land tax, aimed at encouraging large owners to sell land to small-scale farmers. However, there has been a *de facto* neutralisation of the progressive land tax by the way of reduction factors associated with the degree of utilisation of land use and crop productivity. A perverse side of the legislation was to encourage farmers to clear forests in order to be eligible for tax reduction. This perverse effect has been eliminated by exempting areas forested with native species or areas under permanent forest or natural reserves from the land tax (World Bank, 1994).

In various states, the government has obliged landowners to officially register their area of permanent conservation to guarantee their permanence in case of sale or division of the property. In 1996 the Federal government issued a presidential provisional measure, which increased the obligatory area for the conservation on each property from 50% to 80% (Brazil, First National Report; World Bank, 1994)

As signatories of the CBD the countries have set-up a number of mechanisms, policies and bodies to co-ordinate natural resource management and biodiversity use and conservation.

In Brazil, primary responsibility for setting policies for conservation rests with the ministry of the Environment (MMA). The Institute for Environment and Renewable Natural resources (IBAMA) is responsible for implementing federal environmental policy. It has a broad mandate for environmental protection and management of the country's natural resources. The Brazilian constitution gives the federal and state' governments concurrent responsibility for environmental management. IBAMA has the authority to step in and enforce regulations (Brazil, First National Report; World Bank, 1994)

The National Biodiversity Programme (PRONABIO), was created in 1994, to promote partnership between the government and society in the conservation of biodiversity, the sustainable use of its resources and the sharing of the benefits derived. PRONABIO activities are legally backed by the Federal Constitution, which devotes an entire chapter (article 225) to the environment. The public attorney office has powers to take legal action for the enforcement of environmental laws. Brazilian legislation makes provision for a National Environmental Policy. There are between others, a law for protection of cultivars and a law for biosafety (law No 8.974/95). The introduction of exotic species and of GMOs is regulated by the Ministries of Agriculture, Science and Technology, Health and of Environment (Brazil, First National Report; da Fonseca, *e*t *al*., 1998**)**. The National Technical Commission for Biosafety (CTNBio) gives guidelines related to scientific development and to the code of conduct and ethics in biotechnology and environmental conservation (da Fonseca *e*t al., 1998). The project of a law of access to biodiversity resources ' *Lei de Acesso aos Recursos da Biodiversidade"* (PLS No 306, 1995) was under consideration. This law would regulate the use of native germplasm, establishing the intellectual rights of use of germplasms developed by indigenous or rural communities (Kageyama. 1998). Another important mechanism for biodiversity conservation is the "Green Protocol", co-ordinated directly by the Presidency of the Brazilian Government, created in 1995. Its aim is to include environmental assessment processes as fundamental criteria for private funding agencies to give credits for maintenance and/or investment in agricultural properties and projects (Brazil, First National Report).

A review and updating of agricultural policies is underway through the establishment of a National Forum of Agriculture (UN, 1998). Brazil's strategy envisages the use of economic incentives like the reduction of taxes on rural territory and subsidies to conserve biodiversity. These should be offered to producers who are developing systems for sustainable use of biodiversity.

The Governmental Plan for the period 2000-2003, known as "*Avança Brasil*" makes emphasis on the importance of sustainable development, giving especial consideration to the agricultural sector, with particular support to infrastructure development, development and dissemination of sound production technologies, and education through the Programme "*Apoio ao Desenvolvimento do Setor Agropecuário'*. The importance of rational use of natural resources and environmental conservation is emphasised. Some other programmes been started/continued under "*Avança Brasil*" are: the Programme for Agro-environmental Development in the Mato Grosso State (PRODEAGRO), the 'Agricultural and Foresstry Plan for Rondonia', (PLANAFLORO), 'Sustainable Amazon", 'Programme for the Development of Cerrados' (PRODECER), a programme for soil conservation in agriculture (PROSOLO) with socio-economic and ecological zoning, and community projects (*Avança Brasil*, 2001).

Mexico has undertaken efforts to conservation of biodiversity especially in the institutional capacity, legal framework, declaration of protected areas and sectoral participation. Several organisations to address key issues such as awareness over biodiversity, management of natural resources, conservation, and law enforcement have been created at the federal level: the '*Comision Nacional para el Conocimiento y Uso de la Biodiversidad*' (CONABIO), the '*Secretaria del Medio Ambiente, Recursos Naturales y Pesca'* (SEMARNAP), the '*Procuraduria Federal de Proteccion al Ambiente*' (PROFEPA) and the *'Instituto Nacional de Ecologia'* (INE). In addition, the 32 federal states have their own environmental legislation and administration in charge of environmental issues. The participation of the academic sector, of the private sector and the non-governmental organisations and the social sector has increased considerably in the last decade (CONABIO, 1997).

The national strategy for sustainable agriculture and rural development is present in the Program for Agricultural and Rural Development, under the guidelines given for the sector in the National Development Plan (PND) the leading document of the national policy of the federal government. The Secretary for Agriculture, livestock and Rural Development (SAGAR) is responsible for its implementation and has a regulatory capacity. The federal states are in charge of planning and implementation of programmes for development at the state level.

The current agricultural policy recognises that the promotion of agricultural production based in expansive use of natural resources and of agricultural lands is not viable. The agrarian reform modified the land tenure to favour the development of the sector, aiming at larger production units and stimulating the association between the private capital and producers (SAGAR; no date; Ramiro López, 1999).

The main objectives of the agricultural policy are to contribute to the food security and income generation and to increase production above the population growth with rational use of natural resources. For this purpose, several programmes, e.g. PROCAMPO, have been established to promote crop diversification and rural development stressing the rational use of natural resources. In aspects related to conservation and rehabilitation of lands, SAGAR works together with SEMARNAP, in order to incorporate criteria of sustainability in agricultural activities and land conservation (UN, 1999b). Programmes for land management and the Inter-Secretarial Programme for Sustainable Agriculture and Productive Re-conversion (*Programa Intersecretarial Agricultura Sostenible y Reconversion Productiva)* promote the incorporation of sustainable production processes and aim to replace detrimental agricultural practices such as slash-and-burn for slash-and-chop (UN, 1999b). The present governmental policy for the agricultural sector, points out the need to favour new opportunities for economical development through diversification in agriculture and livestock production, based on germplasm conservation, and utilisation of genetic resources. The policy also considered the importance of a managerial orientation and long-term vision of the producers on the use of sound technologies. The strategy of the PND also envisages improving the accessibility to credits in faire competitive conditions (SAGAR, no date; UN, 1999b).

The legal framework is based on the article 27 of the Constitution of the United States of Mexico. This article gave directions for the elaboration of the *'Ley General del Equilibrio*

Ecologico y la Proteccion al Ambiente' (LGEEPA) created in 1988 and revised in 1996. This has served as a base for the design of regulatory mechanisms (laws, norms and rules) for conservation of natural resources. In 1996 it was modified giving more emphasis to the sustainable use and conservation of natural resources. Additional regulatory norms were created dealing with environmental issues, of which less than 5% deal with issues related to conservation of natural resources. In general there are over 385 legal tools (*instrumentos juridicos)* applicable to biodiversity (CONABIO, 1997).

The article 5 of the second chapter of the LGEEPA include regulations for land conversion of forests, jungle and arid zones. Authorisation by SEMARNAP, based on environmental impact evaluations, is needed in order to convert any of these zones to agricultural activities except when it involves activities for family subsistence (with some limitations);for organic agriculture, or modifications of agricultural soils to forestry or agroforestry through the use of native species. SEMARNAP conducts inspection and surveillance through PROFEPA, which is also responsible for the enforcement of the established sanctions (CONABIO, 1997; SEMARNAP, 2000). In 1996 a law to protect the rights of plant breeders was created '*Ley de Variedades Vegetales'*.The interpretation and enforcement of this law corresponds to SAGAR. There is an initiative to create a law to regulate access to genetic resources (CONABIO, 1997).

The federal government has developed a policy for water management for agriculture. The National Water Commission (CAN) co-ordinates several programmes, with collaboration of SAGAR and participation of the state's governments and the users. The aim of the policy is to promote the sustainable development of irrigation systems, avoiding contamination, reducing the overexploitation of ground water. CAN has transferred responsibilities to the users through water market systems. The users are co-responsible, through acquisition of users right, for covering the costs of operation, conservation and administration (UN, 1999b).

Cuba has conducted one of the most remarkable co-ordinated policy efforts on sustainable agriculture. Up to 1990 Cuba's agriculture and food sector was heavily dependent on external inputs and support from the Soviet Union. Around half of the chemical fertilisers and over 80% of the pesticides were imported. After the collapse of the trade with the Soviet Block, which led to severe shortage in all imported goods, and the strengthening of the economic sanctions imposed by the USA, imports of foods and of inputs such as petroleum, fertiliser, pesticides, fell drastically within two years. The government declared an "Alternative Model of Agriculture" as the official policy, changing from highly modern, input dependant agriculture to sustainable agriculture. The model focuses on resource conserving technologies and use of local knowledge, skill and resources. It also emphasises the diversification of agriculture, use of oxen to replace the tractors and the use of IPM to replace pesticides (Rosset & Altieri, 1994; Rosset, 1996; Meadows, 1997; UN, 1999a**;** Pretty & Hine, 2000).

One of the goals of the new agricultural model in Cuba is to secure food production while preserving the environment and conserving natural resources. This policy is reflected in the definition of the mission of the Ministry of Agriculture: "to direct and control agricultural and forestry production, in order to meet the needs of the population (food and others); the demands of the industry and tourism; to substitute imports and to promote exports with maximum efficiency, leaning on the rational use of land, water and available technologies; preserving the soils, the genetic resources of domesticated and wild fauna,; the conservation and use of phytogenetic resources and seeds in the non-sugarcane industry and forestry; to guarantee the services of the vegetable and animal sanitation systems; and to protect the environment looking after an appropriate attention to the workers and their directive officers (Cuba Homepage)"

The Ministry of Science, Technology and Environment (CITMA) created in 1994 is in charge of the evaluation and inspection of the status of the components of biodiversity in the Cuban territory. MINAGRI, through the "*Empresa para la Protección de la Flora y la Fauna*", the Vice-ministry of Forestry and the *"Dirección deCciencia y Técnica*" is in charge of the *in situ* management of the land under its control, rehabilitation of affected areas, care and control of the genetic resources for food production and agriculture, of the management of forests and institutional collaboration (Cuba, report 4th COP).

The Environmental Strategy for Agriculture, created in 1999, emphasises on the need to guarantee food security through sustainability in agricultural production. For that purpose the strategy and its action plan cover topics such as integrated pest management and plant nutrition, soil degradation and rehabilitation, and biodiversity including plants and animals (UN, 1999a).

The Environmental Law (*la Ley del Medio Ambiente)* (Law 81/1997) constitute the base of the Environmental Strategy for Agriculture, with a chapter on conservation and sustainable use of biodiversity. Regarding soil conservation the decree No *179 /1993* establishes the priority of using soil according to its capacity for sustaining agricultural activities. There are regulations of the Ministries of Agriculture and Sugar establishing principles and norms for proper nutrient application in different crops (UN, 1999a). Due to the importance of sugarcane, the large areas cultivated, and the impacts it may have on the environment a separate Environmental Strategy for sugarcane is being developed. Similarly, an environmental strategy is being formulated, for the management of water resources, including use of water for agricultural production (UN, 1999a).

Cuban agricultural transformation has been accompanied by a number of other reforms in economy policy since mid-1993. Some of them include the elimination of subsidies on some items of popular consumption and a move towards implementation of a system of taxation. The new strategy has also required changes in the agrarian policies and a reorganisation of the research, extension and educational systems, with major participation of farmers. All these changes are expected to have a notable impact in the recovery of specific sectors of the economy such as agriculture (UN, 1999a; Enríquez, 2000).

5. *Constraints to the use of sound policies and practices*

Notwithstanding the disposition of the governments to carry out the determination of the CBD, and concerns about natural resources degradation and loss of biodiversity, which is reflected in the degree of regulations and of activities being planned/conducted, the use of sound policies and practices is constraint by several factors. The following factors, although in most cases identified as constraints to biodiversity conservation in general, are also applicable to agrobiodiversity.

- Lack of or weak sectoral participation was found to be an important constraint in all studied countries, with the exception of Cuba, where, reportedly, decisions are taken with participation of all involved sectors. This has improved during the development and formulation of the strategy and actions plans, which, according to the reports, has been conducted with participation of all sectors.

There has been a contradiction and lack of conciliation of interests between environmental and land policies and a weak integration between strategies for conservation and sustainable use of biodiversity and activities of economic development. In most cases no assessment of the environmental consequences of economic and agricultural development policies has taken place.

- Fiscal resources and real expenditures: All countries covered by this study considered that funds available from the fiscal budget for conservation are not sufficient to attend the most urgent problems of conservation. There are two aspects to be considered: the size of governmental expenditures in the agricultural and natural resource sector and the allocation of expenditures within the sector. Countries in the region have been going through phases of harsh policies for fiscal adjustment, which are not conductive to the allocation of funds for research or to establishment of programmes addressing environmental issues. For instance, the IBAMA in Brazil has lost federal budgetary support (in real terms) as a result of attempts by the federal government to reduce expenditures and curb inflation. In Cuba, in particular, the difficult economic situation has been aggravated by the sanctions imposed by USA and the lack of international financial support (Brazil, First National Report; Cuba**,** Report 4th COP; World Bank, 1994; UN, 1999a,b, c; CONABIO, 1997, 1998).
- Difficulties involved in countries the size of Brazil and Mexico are considerable. Decision making for concrete action in biomes such as the Amazon and *'El Pantanal'* requires a major and complex infrastructure for planning, execution, monitoring, and local involvement of the community. For instance, the Republic of Brazil is comprised of the Federal Districts, 26 states and more than 5000 thousand municipalities, each constitutionally entitled to formulate and carry out their own economic, social and environmental policy, the articulation of which, along the sharing of responsibilities, and joint implementation results in considerable additional demands (Brazil, First National Report; CONABIO, 1998).
- High degree of centralisation of the federal governments has led to low development of the capacity and structure of the federal and municipal entities in Mexico (CONABIO, 1997).
- Lack of continuity in the institutional framework. For example, in Brazil the Ministry of Environment was created in 1992 to replace the Secretariat of Environment (SEMAM), which itself was created only in 1990. Since 1989, responsibility for implementing federal environmental policy has rested with the Institute for Environment and Renewable Natural resources (IBAMA). Serious difficulties have impeded IBAMA to function effectively, largely as a result of high turnover of its senior management and weak policy articulation with SEMAM (World Bank, 1994).
- Deficient co-operation between universities, institutions, governmental bodies, extension bodies and companies regarding generation and diffusion of data and technology (Kageyama, 1998).
- Lack of a continuous research programme and strengthening of the research institutes on issues related to biodiversity. This is partly due to the lack of long term and continued financial support for appropriate research and technology dissemination. Between 1977 and 1992 investment in research in Latin America grew by only about 1.5 per year, down from almost 6% in the period 1967-77. In every Latin America country, except Argentina and Colombia, the resources available per researcher fell substantially (Trigo, 1997).
- Insufficient number of people with adequate training to apply agroecological and environmental perspectives. Although some countries such as Brazil have achieved a high level of scientific research with an established and extensive system of academic and research institutions, they are concentrated in certain regions of the country (Brazil, First National Report). Cuba has a relatively high proportion of scientists, with only 2% of the Latin America's population but 11% of its scientists. However, there is a need for formation in agro-ecology. The urgency of finding alternatives to chemicals inputs has not

allowed the development of an agenda for agroecological research (Rosset & Altieri, 1994; Meadows, 1997).

- Lack of knowledge in certain areas, which hamper the assessment of the situation at a global level, although there are some studies/monographies conducted, these are punctual.
- Lack or insufficient capability at the farm level and support services, required for management of alternative technologies.
- Ignorance about the importance and value of biodiversity, including agrobiodiversity, as well as lack of organisation of the existing knowledge. The society does not have the information required to learn to value, manage and conserve the components of biodiversity (Loa Loza & Duran Smith, 1998).
- There are few incentives or rewards to offer for protection of biodiversity (World Bank, 1994).
- Effectiveness of regulations in preserving the environment is limited for several reasons including:
  - The objectives underlying the regulations are often unclear. For instance the Brazilian law requiring that 20% of any rural property remain under native forest (50% in Amazon) was poorly conceived because it did not correspond to a specific ecological value on a given property (World Bank., 1994).
  - Regulations are seldom targeted at specific issues. For instance in Mexico some legal instruments are not applicable because they are obsolete or are very general (CONABIO, 1997, 1998).
  - Lack of co-ordination between laws and regulations.
  - Lack of control on enforcement of existing regulations and legislation. The interpretation and enforcement of regulations is left to the discretion of the authorities. This leads to no observance of these regulations by the population due to ignorance or to the little importance given to them. (CONABIO, 1997)
  - Regulations are frequently in direct conflict with the economic incentives driving the private sector, making them difficult to enforce (World Bank 1994).
  - Regulations that are appropriate in one region of the country may be inappropriate in other regions (World Bank**,** 1994).

6. Examples of best practices

6.1. Shade coffee production

When introduced to Mexico at the end of the 18th century, the coffee was incorporated to the polyculture systems practised by different indigenous groups. It was grown under shade either under trees from natural vegetation or under fruit trees or pulses for home consumption. Under this agroforestry system, nearly no agrochemicals were used.

These traditional coffee systems resemble natural ecosystems keeping a great diversity of animals and plants in relative small areas. The trees provide a habitat for birds and animals that benefit the farming system. These coffee agroforests have high species diversity, especially for forest generalists. Bat species and terrestrial mammal species in shade coffee plantations in Veracruz, Mexico has been shown to be higher than in adjacent agricultural fields, though lower than in forests. These systems are also important in soil conservation and in keeping the balance in the water reservoirs. The foliage from trees helps improve soil fertility maintaining a healthy microclimate for soil micro-organisms, and reduces or eliminates the need for agrochemicals (Rice & Ward, 1996; Thrupp, 1998**).**

In the 1960s the government policy promoted the introduction of technological packages, which included use of improved varieties, higher density of plant per hectare and high input use. This system substituted to a great extent the traditional way of growing coffee, especially in large holdings. Many coffee plantations are now intensifying production introducing higher-yielding sun-tolerant coffee varieties that do not need the tree canopy.

Sun-tolerant coffee is planted at high densities, it starts yielding earlier as shaded-coffee, but plantation life span is less. Production is much higher than shade-coffee, but involves high input (agricultural chemical costs). Sun coffee has a greater risk of soil erosion and an adverse effect on biodiversity with a much lower number of species of invertebrates, such as beetles and ants, than shade coffee. Shade coffee plantations can support over 180 species of birds compared 6-12 species in a technified coffee plantation (Loa Loza *e*t *al*., 1998).

The importance of these traditional coffee systems is being revalued. In order to make shade-coffee competitive, researchers concerned with agricultural sustainability and biodiversity have developed a system for growing *Cordia alliodora* in coffee at densities of 100 trees per hectare, which achieves very high growing rates, has minimal impact on coffee yields and raises farm income substantially (Rice & Ward, 1996; Loa Loza *e*t al. , 1998; Mc Neely & Scheer, 2001). Marketing of environmental-friendly coffee that provides a financial premium to the farmers is being actively promoted by several organisations. Environmental protection is a central element of the "*Coordinadora National de Organizaciones Cafetaleras*" (CNOC)'s strategy. The CNOC was funded in 1988, as an autonomous national network of 126 regional peasants organisations that unites over 75000 smallholder coffee producers from seven states in Mexico. It promotes sound production strategies to increase production and to improve options for funding. Nearly 10% of the members produce organic coffee. Farmers typically opt for mulch and integrate into their coffee farms different leguminous trees, fruit trees and types of fuelwood and fodder (CONABIO, 1997; CNOC, 2001). Conservation International has a similar Sustainable Coffee Initiative in Mexico and other Latin American countries (Conservation International, 2001).

6.2. *In situ* conservation of local maize varieties

6.2.1. The Oaxaca Project:

This is one of the first projects to be set-up in Mexico for in-situ conservation of maize genetic diversity. It is being conducted by CIMMYT in collaboration with INIFAP and farmers communities of the Central Valleys of Oaxaca. The project focuses on generating opportunities for small-scale farmers to share and benefit from the genetic diversity of the landraces that they have bred in their communities for generations. Farmers play an active part by selecting the seed for planting. The project provides an innovative approach through participatory germplasm improvement. Breeders solicit input and opinions directly from traditional, small-scale farmers about the traits they value in their maize varieties, and how they select for these traits. The breeders focus their breeding programmes to address the needs identified by farmers as well as agronomic characteristics that they themselves value. Interested farmers are trained in the principles of plant breeding so that they are able to preserve and maintain the characteristics they appreciate in the maize populations they plant. In the initial phase 17 landraces were selected and demonstration fields planted in farmers fields. Many farmers have purchased seeds to conduct their own experiments (CIMMYT, 2000).

6.2.2. The Alternative Technologies Project

In the south and southeast of Brazil, a group of local associations and farmers organisations supported by NGOs of the Alternative Technologies Project and EMBRAPA have worked to safeguard and encourage farmer production of maize seed, based on the valuation and reintroduction of local varieties instead of commercial hybrids. The first step was to recover local varieties that farmers were still growing for seed multiplication. All recovered varieties were also maintained in community seed banks as back-up reserves. The recovered varieties were then evaluated through comparative trials and farmer observations. Farmers are trained on the basics of stratified mass selection and crossing, and provided with information, which enable them to define, on the basis of their own criteria and needs, the best strategy to pursue. Emphasis is given to the importance of maintaining the widest genetic base possible. In a few cases EMBRAPA plant breeders carry out crosses and the descendants are handed out to the framers to continue the selection process on their own holdings. The experience showed that farmers could get equally good yields from locally controlled maize varieties. It also showed the possibility to innovate in plant breeding, in a collaborative way between farmers, technical support people and plant breeders (Cordeiro &de Melho, 1994).

6.3. Soil Conservation through zero/minimum-tillage agriculture:

Minimum tillage practices were originally stimulated by the oil crisis of the early 70s, as farmers tried to lower farm energy costs. New machinery was developed to drill seeds into untilled soil, herbicides were developed which could control weeds in the seedbed without tillage. Farmer adoption has been rapid and widespread. The system is been used in several countries of Latin America. Initially zero/minimum tillage was perceived as a practice for large farmers. This has now changed as experience has shown that this system is also suitable for small farms, using modified animal-drawn implements.

In Brazil, minimum or no-till techniques have been adopted on about 12 million hectares in three southern states, Santa Catarina, Rio Grande do Sul and Paraná, by 1999. A high level of management skills has been required to achieve successful transition from conventional to conservation tillage systems. An important element of adoption in Brazil has been adaptive, participatory research working with farmers at microwatershed level to ensure technologies are adapted to local conditions. In the case of Santa Catarina State, the state government extension and research service works with farmers, technicians and the private sector. A significant factor in the transfer of this technology has been the unique system of *“Friends of the Soil/Land”* clubs, joined together in regional associations and a national federation the *‘Federação Brasileira de Platio Direto na Palha’* (FEBRAPDP). Farmers swap experiences, hold technical events and promote no-till farming in their local clubs. In Brazil some 200,000 are members of *the “Friends of the Land*” club with 8-10000 groups formed.

These programmes have shown an important conceptual change: the transition from soil conservation based on physical conservation measures (such as terraces and barriers) to soil restoration and improvement based on biological measures such as maintaining soil covers. The technology focuses on soil and water conservation at the microwatersed level using contour grass barrier, contour ploughing, green manure and cover crops. Farmers use animal-drawn tools to knock over and cut up the green manure/cover crop, leaving it on the surface. For planting they open only the planting furrow.

The major on-farm impacts have been on crop yields, soil quality, and water retention. There has been a substantial increase in production of maize (67%), wheat (82%), and soybean (83%) over 8-10 years. Soil erosion has been reduced by about 90%. Zero/minimum tillage agriculture has also resulted in better input use (e.g. fossil fuel use has been reduced by 40-70%). This system also cuts water run-off, reducing water pollution.

Some biodiversity concerns have been raised where herbicides are misused, but the incorporation of green manure, cover crops and rotations with legumes have reduced the requirement for herbicides. In general, there has been a major positive impact on soil biodiversity. Recently interest has focused on the public benefit being produced by these farms through reduced release of carbon gases and reduced air pollution. (FAO, 1998; Aarnik *et al*., 1999; Pretty & Hine, 2000).

7. Results and lessons learned

The efforts of the countries to increase food production in order to meet the needs of a growing population, and economic growth through the promotion of agro-exports have had an adverse effect on the environment and on biodiversity, putting natural resources under stress. This has been due to a large extent to agricultural policies.

The lack of information or understanding of the importance of biodiversity has led policymakers to take decisions, which have a negative impact on biodiversity. Policies with long term effect and wide range effect have been formulated without knowing or assessing their effect on the environment and biodiversity. Environmental issues were not taken into consideration in developing the national policies. Agriculture was seen as a mean of producing cheap food or as an important source of government income.

Protectionist policies had a negative impact, creating incentives to degrade the environment and exacerbate poverty. Subsidies and development strategies overvalued land conversion and under-valued environmental goods and services. Conservation loss has been an economic response to incentives. Thus an understanding of incentive structures and their effects is necessary to achieve judicious use and conservation of biodiversity.

There has been deficient intersectoral participation. The policy of environmental issues has been, in general, structured based on one sector, ignoring that the improvement of the environment benefits all sectors. Reportedly, sectoral participation has been improved in the process of the formulation of the NBSAPs.

There is a lack of understanding or appreciation of the close connection between agriculture and natural resources by many policymakers, environmentalists and the general public. Agriculture is often perceived as a factor in environmental degradation, without understanding that natural resources are part of production systems.

Environmental concerns regarding agricultural activities have emphasised physical aspects such as soil and water, and little attention has been paid to the biotic environment and biodiversity conservation. Biological resources are undervalued. The understanding of agrobiodiversity seems to be restricted to crop and livestock species and their wild relatives rather than to the broader ecosystem. There is no much consideration of biodiversity that provide services to agriculture.

Conservation of biodiversity efforts tends to focus on protected areas and natural resource degradation, without or with little consideration of agrobiodiversity in particular.

The NBSAPs mention the importance of biodiversity for agriculture, but they tend to overlook the value of biodiversity in cultivated or grazed areas, which account for much of the landscape. Some consideration has been given to how biodiversity can be enhanced in agricultural systems. Crop diversification is recommended in some cases as well as the use of low-input technologies. The importance of a broad genetic diversity of crop species is recognised. Recommendations focus on genetic improvement and biotechnology, which is some cases, tends to narrow crop diversity.

Traditional knowledge systems are essential to the sustainability of farming and natural resource management. The knowledge of rural people and their ability to conserve enhance and use biodiversity has rarely been taken into account when designing management interventions and devising policy for agricultural development and natural resources management. However, there is an emerging interest for tapping indigenous knowledge.

Despite the major challenges countries are facing they have made a positive response to the CBD and to biodiversity conservation, though, agrobiodiversity has been, in the rule, neglected. In recent years, policy and institutional changes have taken into account environmental protection. Progress in technology development has been limited to areas of high economic returns. Often, the problem is not the lack of legislation for the protection of biodiversity, but the enforcement of the regulations.

The trend towards biodiversity friendly practices in agricultural development is increasing, although biodiversity conservation was not always a primary concern as was the case in Cuba. There has been progress in policies, legislation, institutional capacity and technical aspects. However, the progress is not yet sufficient and the developments are not generalised. The Cuban experience shows potential for other countries confronted with environmental degradation due to use of conventional technologies.

Environmental perspectives are being incorporated into agricultural strategies at a number of the region's national centres, international research centres, and non-governmental organisations. NGOs and International Research Centres are playing an important role in exploring ways to improve the management of agrobiodiversity through greater involvement of farmers as shown in the examples of best practices.

8. Guidelines or policies that have resulted from this experience.

Restructuring of agricultural, land and economic policies should include awareness of implications of strategies adopted and their potential effects on agrobiodiversity and sustainability. Policy makers and stakeholders must understand that conserving and managing biodiversity for agricultural development are linked**.**

Indicators to measure how productivity, biodiversity and sustainability are interrelated and to give an indication of how they are evolving in the different regions would help understanding the relationship between agriculture and biodiversity.

Efforts for mainstreaming biodiversity in agricultural development and increasing agricultural production should be concentrated on alternatives to the expansion of agricultural land and should address on-farm and off-site effects of land-use systems such as reduction or elimination of pollutants in groundwater and in run-off and greater emphasis on IPM.

Alternatives to the expansion of agricultural lands should be researched to by find ways to manage farming methods that avoid negative consequences on the environment including biodiversity. For instance, by supporting environmentally sound farming systems, and by rehabilitation of degraded agricultural land. The valuable knowledge of traditional agriculture in the use and preservation of agrobiodiversity should be taken into account. Policies should take into account the need to develop or use these alternatives. Smallholders and traditional farmers need to be supported. Their access to land and agricultural credits needs to be improved, agricultural research and development need to be directed towards the small farmers need and investment in rural social services need to be given higher priority. Similarly, farmers in degraded lands need help to intensify their agriculture, through improved sound technologies and access to credits and infrastructure.

There is a need to evaluate financial instruments, such as subsidises and incentives schemes, in terms of their effect on the sustainable use of agrobiodiversity, in the long term and to ensure that they are applied in a manner that would ensure sustainable agricultural development.

Sectoral participation should be improved by co-operation and agreements between institutions in charge of agricultural policies and reforms and environmental protection.

Financial support should be made available to implement actions suggested in the strategies and action plans such as studies to improve the limited knowledge of plant and animal species, *in situ* conservation of agricultural biodiversity, development and implementation of sound agricultural technologies. This would imply additions to existing budgets rather than reallocations since resources currently available to technical and policy research and development are a not enough to make a significant impact on biodiversity conservation. The impacts of the expenditures could be maximised by promoting collaboration and partnership among state and local level of governments and with NGOs the private sector.

It is important to appreciate the value of agrobiodiversity**.** Mechanisms to compensate farmers using and conserving biodiversity should be established. Farmers' rights have been suggested to compensate local farmers for preserving and selecting traditional varieties subsequently used in plant breeding. Laws and regulations governing property rights should be revised so they provide incentives for environmental protection and sustainability.

More emphasis should be given to promote biodiversity in agricultural ecosystems.
Development projects should promote a mix of land use systems in a given area whenever appropriate, in order to increase agrobiodiversity.

It is important to build farmer capacity to understand and manage diversity; this would facilitate the compliance of regulations.

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Table 1: Plan of actions related to genetic resource management and conservation in the National Biodiversity Strategy and Action Plan from Cuba.

Short-term Actions:	**Medium-term Actions:**
- Guarantee conservation of natural germplasm of species of economic and scientific importance.	- Guarantee conservation of genetic resources with appropriate characterisation, record and documentation including *ex situ* as well as natural resources in protected areas.
- Establish mechanisms to allow validation, use and dissemination of the genetic material included in the *ex situ* collection of plants of economic importance.	- Establish measures and control mechanisms to facilitate farmers' access to the *ex situ* collection of cultivate species and publish the correspondent technical instructions
- Strengthen the production and conservation of seeds of crops of economic importance	- Strengthen the national infrastructure to guarantee the quarantine of biological material to be imported or exported for economic or scientific interest.
- Complete the elaboration of a national proposal for the access to natural resources.	
- Establish a system for protection of intellectual rights on natural resources to guarantee community and social benefits.	
- Guarantee the implementation of the international regulations on the security of biotechnology.	
- Elaborate programmes to educate the population on uses, risks, and benefits of biotechnology.	
- Include the management of wild and domesticated populations in the priority research of programmes of science and technological innovation.	
- Value the diversification in the use of natural resources that generate the development of alternative production	

Figure 1: Cacao field planted under native trees in Mexico. Source: "Mexico País Agricola" 1994. *Secretaria de Agricultura y Recursos Hidraulicos* (now *Secretaria de Agricultura, Ganaderia y Desarrollo Rural*, SAGAR).

Figure 2: Keeping hedgerows and trees helps in maintaining biodiversity and in the reforestation of land around Tapachula, Chiapas, Mexico. Source: "Mexico País Ganadero" 1994. *Secretaria de Agricultura y Recursos Hidraulicos* (now *Secretaria de Agricultura, Ganaderia y Desarrollo Rural,* SAGAR).

Acronyms

ANAP: Asociación Nacional de Agricultores Pequeños

BCI: Bats Conservation International

BIOVIDA: Programa Biodiversidad e Recursos Genéticos.

CBD: Convention on Biological Diversity

CENARGEN: Centro Nacional de Pesquisa de Recursos Genéticos e Biotecnologia

CENBIO: The National Centre of Biodiversity

CIAT: Centro Internacional de Agricultura Tropical

CIP: Centro International de la Papa

CIDEA: Centro de Informacion, Documentación y Educación Ambiental.

CIMMYT: Centro International de Mejoramiento de Maiz y Trigo

CITMA: Ministerio de Ciencia, Tecnología y Medio Ambiente.

CNOC: Coordinadora National de Organizaciones Cafetaleras

CNPF: Centro Nacional de Pesquisa de Florestas.

COBIO: Coordenaçao Geral de Diversidade Biológica

CONABIO: Comision Nacional para el Conocimiento y uso de la Biodiversidad

CONACYT: Concejo Nacional de Ciencia y Tecnología.

CONDENSAN: Consortium for the sustainable development of the Andean Region.

CP: Colegio de Postgraduados.

CPATU: Centro Nacional de Pesquisa Agroforestral da Amazônia Oriental.

CTNBio: Comissão Técnica Nacional de Biossegurança.

DEPAM: Departamento de Formulação de Politicas e Progammas Ambientais.

EMBRAPA: Empresa Brasileira de Pesquisa Agropecuária.

FEBRAPDP: Federação Brasileira de Platio Direto na Palha.

FHEP: Food and Health Education Programme.

GNP: the Gross National Product

IDRC: International Development Research Centre.

IMECBIO*:* Instituto Mananatlan de Ecologia y Conservación de la Biodiversidad.

INE: Instituto Nacional de Ecologia

INIFAP: Instituto National de Investigaciones Forestales y Agropecuarias

IPGRI: International Plant Genetic Resources Institute

IREGEP Instituto de Recursos Genéticos y Productividad

LGEEPA: Ley General del Equilibrio Ecologico y la Proteccion al Ambiente

MINAGRI: Ministerio de Agricultura.

MINAZ : Ministerio del Azúcar

MMA : Ministerio do Meio Ambiente

NAPPC: the North American Pollinator Campaign

PLANAFLORO: Plano Agropecuário e Forestal de Rondonia .

PND: Plan Nacional de Desarrollo

PRODEAGRO: Programa Desenvolvimiento Agroambiental do Estado de Mato Grosso.

PRODECER: Programa Desenvolvimento dos Cerrados.

PROFEPA: Procuraduría Federal de Protección al Ambiente

PRONABIO: Programa Nacional de Diversidade Biológica

PRONAF: Programa Agricultura Familiar.

PROSOLO: Programa Conservação de Solos na Agricultura.

SAGAR: Secretaria de Agricultura, Ganaderia y Desarrollo Rural.

SEMARNAP: Secretaria de Medio Ambiente, Recursos Naturales y Pesca.

SEMAM: Secretaria do Meio Ambiente

SMA: Secretaria de Coordenação de Assuntos do Meio Ambiente.