CHAPTER 1

AGRICULTURE IN LATIN AMERICA AND THE CARIBBEAN: CONTEXT, EVOLUTION, AND CURRENT SITUATION

Coordinating Authors: Elsa Nivia (Colombia), Ivette Perfecto (Puerto Rico)

Authors: Mario Ahumada (Chile), Karen Luz (USA); Rufino Pérez (Dominican Republic); Julio Santamaría (Panama)

Contributing Authors: Edson Gandarillas (Peru), Carlos J. Pérez, Dalva Maria Mota (Brazil), Tirso González (Peru)

Revie Editors: Claudio Bragantini (Brasil), Maria Amanda Galvez (Mexico)

Table of contents

Key Messages

1.2 Conceptual and Analytical Framework

1.3 Latin American Agricultural Production Systems

1.4 Regionalization

1.5 Global Context: Main Trends

1.6 Regional Context

1.6.1 Evolution of development models

1.6.2 Social context

1.6.3 Economic context

1.6.4 Political context

1.6.5 Environmental context

1.6.6 Cultural context

1.7 Recent Evolution and Current Situation of Agriculture in LAC

1.8 Performance of Production Systems

1.9 Impacts of the Production Systems

1.10 Conclusions

Key Messages

Latin American agriculture is characterized by its heterogeneity and diversity of cultures and actors. Its heterogeneity is expressed by reference to agroecological conditions, resource endowment and means of production, and access to information and other services. The diversity of cultures and actors implies differences in the systems for producing, generating, and using knowledge, resource management and stewardship, world views, survival strategies, and forms of social organization.

For purposes of this evaluation, three agricultural systems are considered: the traditional indigenous system, the conventional system, and the agroecological system. The traditional/indigenous system is based on local/ancestral knowledge and is very much tied to the territory. The conventional system has a reductionist and market-based approach, is focused on large-scale monoculture, and uses many external inputs. The agroecological/organic system takes agroecology as its scientific basis and traditional knowledge as its starting point.

The environmental and social vulnerability of Latin American agriculture is one of the results of implementing the industrial-productivist model of development. The industrial-productivist model of development has accorded priority to capital- and technology-intensive production systems that consume large quantities of fossil fuels, are oriented to foreign markets, and are socially exclusionary, having a detrimental impact on the social, political, and environmental viability of agriculture and rural society.

Agricultural productivity has increased in the last 50 years; nonetheless, this has not resulted in a proportional reduction of poverty or hunger. There are 54 million persons suffering malnutrition in the region, while the amount of food produced is three times the amount consumed. Although the agricultural knowledge, science, and technology (AKST) systems have been aimed at the goal of increasing agricultural production, other factors have stood in the way of this translating into less hunger. Hunger and malnutrition in LAC are not the result of the inability to produce enough food; therefore, increasing production will not solve the problem of malnutrition in the region. To the contrary, one of the main problems in the rural sector has the overproduction and import of foods from other countries where production is subsidized. This oversupply of food products drives down the price of local products, and so has a direct negative impact on the standard of living and ability to make a living of the rural population.

Latin America has abundant natural resources but they are not used efficiently and are highly degraded. Latin America and the Caribbean represent the most extensive reserve of arable land in proportion to the population. The region has 576 million hectares, which is equivalent to 30% of the world's arable land, and 28.5% of the region's land (2.018 billion hectares). In addition, the region contains five of the 10 richest countries in terms of biodiversity, with 40% of the world's genetic reserves (plant and animal). Nonetheless, natural resource use and management has been characterized by the underutilization of the arable lands, with a high

proportion of latifundia with absentee owners, resulting in the use of only 25% of available lands. Moreover, there is a steady loss of soil and diversity due to problems of erosion, urbanization, pollution, and expansion of agriculture.

Most of the Region's rural population has lost or experienced a diminution in their right of access, use, conservation, and control of the natural resources (land, water, genetic resources) in the last 50 years. This situation is an effect of the implementation of the agricultural policies of exploitation, privatization, and patenting of natural resources stemming from the use of the neoliberal agroexport model that has been adopted by most countries in Latin America and the Caribbean. There has been a great concentration of wealth, natural resources, and entrepreneurial resources, among others, with growing marginalization, exclusion, poverty, and migration from rural to urban areas. Special mention should be made of the mounting conflicts in the region brought about by the concentration of land tenure and the loss of the right to land of thousands of peasant and indigenous families.

The free trade agreements have increased the vulnerability of small and medium producers in the region, benefiting almost exclusively the large producers. Neoliberal globalization and the economic programs imposed by the IMF have created an unlevel playing field in which local producers have to compete with imported products subsidized in their countries of origin. This has resulted in the displacement of many small producers, creating a rural exodus in many countries. In some cases, small producers have reacted by forming cooperatives and developing alternative markets, in particular the fair trade market and the organic market. Many large producers in the region have successfully inserted themselves in the international market.

Poverty, marginalization, and inequality, especially rural, have been on the rise in LAC despite the technological advances in agriculture. Agricultural development programs have resulted in an increase in production, exports, and incomes, benefiting the rich more than the poor, excluding thousands of small producers, leading them into debt and resulting in the loss and degradation of their resources.

In Latin America and the Caribbean, approximately 25% of the inhabitants live on less than US$ 2 a day. These levels of poverty, in contrast to other regions of the world, are not proportionally impacted by economic growth in the region. While China experienced annual per capita growth of approximately 8.5% from 1981 to 2000, which reduced poverty 42 percentage points, in Latin America per capita GDP declined 0.7% in the 1980s and increased 1.5% in the 1990s, without poverty levels changing significantly.

The problem of malnutrition and hunger has a detrimental impact on the potential for development of the countries of the region and increases susceptibility to disease. For sustainable development in LAC to translate into well-being and prosperity for its peoples, the

countries of the region must have the capacity to produce sufficient food, in quantity and quality, in time and space, and for people to have enough purchasing power to acquire these foods as they need them. Approximately 11% of the people in the region suffer from malnutrition, which results in vulnerability and diminished productivity. Having this proportion of the population vulnerable to disease, unable to have a normal educational performance, and therefore limited in their ability to participate effectively and productively in development processes seriously compromises the attainment of the most fundamental principles and values associated with the right to life and human dignity, without which there cannot be sustainable development in LAC.

The performance of the agricultural systems is mixed, depending on the particular agricultural system. The indigenous/traditional system stands out for its sustainability, but has moderate or marginal levels of production. These systems are being displaced to marginal lands and much of the knowledge that sustains them is being lost. The conventional system stands out for high levels of production and competitiveness in external markets, yet under current conditions is not sustainable or efficient in terms of energy use. This system has enjoyed the support of development models and has benefited from support systems such as credit and technological capital. The agroecological system stands out for its high productivity, profitability, competitiveness, and sustainability, but its exploitation has been limited by the lack of governmental-institutional support, and there is a debate as to whether it can satisfy the world demand for food. The performance of the different agricultural production systems considered only on the basis of their productivity, competitiveness, and profitability accords little weight to indicators such as sustainability, equity, safety, and quality of their products and services.

The development of agriculture over the last 50 years in LAC has caused critical environmental impacts. Among the impacts, mention should be made first of the deforestation of vast areas high in biodiversity, especially in the tropical forests of Central America and the Amazon. In addition, the use of agrochemicals and soil erosion caused by farming have had a major negative impact on terrestrial, aquatic, and marine biodiversity. More diversified agricultural systems can mitigate these impacts up to a point, providing habitats and connectivity between fragments of natural habitats.

Food sovereignty is being lost in LAC. This sustained loss of the food sovereignty of the most vulnerable sectors is due to the increase in food insecurity, the lack of access to food of sufficient quantity and quality, the lack of a healthy and culturally appropriate food supply, and the deterioration of people's right to conserve, use, and control their genetic resources. The region has been losing its food independence, in part as a direct result of globalization. The importation of subsidized food products has dismantled local production systems, creating undersupply and dependence on food produced in other countries. The situation is aggravated as the poorest, especially rural inhabitants whose main source of income is agriculture, have to face the

progressive difficulty of the decreasing purchasing power for acquiring food, whether locally-produced or imported.

In LAC, emigration is on the increase and the sustainability of the rural population is declining. This is due to the substitution of a large part of the agricultural labor force by machinery and technologies, the consequent reduction in the number of farms, and the loss of land tenure by peasants and indigenous communities. This phenomenon is the result of the impossibility of incorporating the rural population into the prevailing types of agriculture. Given the difficulties competing, small producers find themselves forced to sell their lands and seek employment as wage earners, or emigrate to the cities, giving rise to more inequality and greater economic and social insecurity. The rural exodus also results from free trade agreements, which allow for the dumping of goods produced with subsidies in the developed countries, driving down the prices of unsubsidized local products, and forcing local and small-scale producers into unfair competition that eventually results in their being squeezed out of the agricultural sector.

In LAC, cultural diversity is being lost with little if any cultural integration. Specifically, local or traditional customs and knowledge are hardly taken into account in the vertical model of technological development prevailing in the region. The technologies that have been predominating and displacing local or traditional knowledge and wisdom are generally imposed, with scant participation in their choice, on the peasants. This process of cultural and technological aggression has been casting aside an ancestral rural cultural heritage, with local content and managed by local people, yielding to external knowledge and cultures that are relatively uniform, and systematically disseminated by the education systems and communications media, independent of their consequences in terms of eroding already-existing cultures.

The health of rural communities across Latin America has been detrimentally impacted by problems of acute and chronic intoxications in the countryside due to agrotoxics. The WHO estimates that there are 3 million intoxications per year, with more than 200,000 dead, due to intoxications. In Central America, the Plagsalud program of PAHO/WHO estimated 400,000 acute intoxications per year; underregistration is estimated at 98%. There are also abortions, malformations, and chronic diseases. Children, the elderly, the infirm, and the malnourished are the most susceptible.

The population of women who are poor, wage earners, and heads of household is growing as a proportion of the total population living in poverty in rural areas. Although there are particularities in different subregions of Latin America, in general, as the participation of men in agriculture diminishes, the role of women in agricultural production increases. Male migration is one of the main reasons for the increase of the female population in the rural economy. The

expansion of non-traditional export crops, wars, violence, and forced displacement are other causes of the so-called "feminization of agriculture."

Despite the controversy over transgenic crops, they have been progressively adopted in LAC, with impacts perceived by some as negative, and by others as positive, in relation to the goals of sustainability, poverty reduction, and equity. The Southern Cone is the region with the largest production of transgenics, followed by Mexico and Central America. Transgenic crops have been an economic success in some countries, nonetheless, until now these benefits have gone almost exclusively to large producers and agroindustries. This technology has caused major transformations in the environment and society in some Latin American countries. The economic benefits have been accompanied by social changes such as migration, concentration of agrobusinesses, and the loss of food sovereignty. In addition, the environmental benefits (zero field work, reduction of insecticides) are overshadowed by the dramatic increase in the use of herbicides, loss of habitat and biodiversity, and the impact on beneficial organisms, among others. On balance, despite the economic success of some transgenic crops, and their rapid adoption by large and small producers in some regions, they have not contributed satisfactorily to the goals of sustainability, poverty reduction, and equity. Nonetheless, there does appear to be consensus in the region on the pressing need to put in place precautionary regulations on the process of generating and adopting this technology.

Agricultural production energy sources that are alternatives to fossil fuels has increased quickly in recent years in LAC, benefiting some economic sectors and providing market alternatives for the agroindustrial sector, but with negative social and environmental consequences. Although the development of these crops could constitute an opportunity for rural revitalization, recent experiences evidence negative impacts, both environmental and social. Soy appears to be emerging as one of the main sources of biodiesel. In LAC the expansion of soy has resulted in the deforestation of dry forests and tropical jungles, as well as the displacement of food crops, impacting food security in some regions. Sugarcane and oil palm plantations expand at the expense of jungles and the territories of indigenous populations and other traditional communities.

The structures of agricultural regulation in Latin America are not institutionally adequate, resulting in regional weaknesses such as low competitiveness and the vulnerability of the endemic natural patrimonies. There are a number of international agreements on biosafety, animal and plant quarantine, food safety, intellectual property, and access to and management of genetic resources that have been important in other regions of the world as part of a sustainable agriculture development agenda. Some of these regulatory instruments include the Cartagena Protocol on Biosafety, the International Plant Protection Convention (IPPC), Codex Alimentarius, the World Intellectual Property Organization (WIPO), the International Union for the Protection of

New Varieties of Plants (UPOV), and the Treaty on Phytogenetic Resources for Food and Agriculture. The understandings countries reach on these agreements has not always meant that they adhere to them, but it has encouraged them to develop particular and appropriate regulatory strategies, for example, on the protection, access to, and use and management of autochthonous natural patrimonies, independent of whether they adopt international regulatory frameworks.

1.1. Introduction

In Latin America and the Caribbean there are 221 million poor, and 54 million persons who suffer hunger and malnutrition, most of whom live in rural areas (United Nations, 2005; FAO, 2004b). Although Latin America and the Caribbean has vast natural resources, they are degrading quickly (GEO, 2005). The situation is all the more complicated taking into account that the region is one of those most affected by economic inequality in the world (ECLAC, 2004). The region is facing the important task of improving the capacity to make a living in rural areas, and ensuring the nutritional security of its population, at the same time as it must turn back environmental degradation, address social and gender inequality, and guarantee health and human welfare. Evaluating how agricultural knowledge, science, and technology can contribute to improving the living conditions of the rural population, as well as the food sovereignty of the population in general, is a multisectoral task that requires paying attention to a wide variety of economic, environmental, ethical, social, and cultural factors. Getting the populations of Latin America and the Caribbean to successfully cover their nutritional needs, and at the same time maintain an appropriate natural, social, and cultural environment in the 21st century, presupposes a series of important changes and a series of challenges to the systems of knowledge, science, and technology in the region.

The document on Millennium Development Goals – Latin America and the Caribbean (2005) concludes that the region produces sufficient food to meet the nutritional needs of all its inhabitants. Though this is not uniform across the region, most of the countries have a food energy supply of more than 2,500 kilocalories per person per day, which exceeds the minimum recommended for an adult (1,815 kilocalories). In all, the region produces three times the quantity of food it consumes (UN, 2005). These data suggest that hunger and malnutrition in LAC today are not due exclusively to the failure to produce sufficient food, and that the problem is more complex, hence its solution must go beyond technical aspects related to production. The divergence of opinions with respect to the causes and possible solutions underscores the need to undertake a critical international evaluation that makes it possible to analyze, using a comprehensive and multidisciplinary approach, aspects crucial for policy-making.

It was with this purpose in mind that the International Assessment of Agricultural Science and Technology for Development (IAASTD) was undertaken. This evaluation is an initiative sponsored

by different United Nations agencies, the World Bank, and multilateral funds[1], which seeks to analyze the complexities of the systems of knowledge, science, and technology (KST) in Latin America and the Caribbean to understand how these systems can contribute to improving the living conditions of the poor in the region in the new era. The objectives of this chapter are: (1) to develop the conceptual framework for the evaluation, (2) to present the context (social, political, economic, environmental, cultural) that impacts on or is affected by agriculture in the region, and (3) to undertake a critical assessment of the recent evolution and current situation of production systems. The conceptual framework, context, and current situation, as well as the historical analysis of the role of knowledge, science, and technology in agriculture (Chapter 2), will provide the elements needed for analyzing future scenarios (Chapter 3) and options for the future (Chapters 4 and 5). In particular, an effort is to be made to evaluate how agricultural knowledge, science, and technology systems can contribute to the goals of sustainable development, and in particular to reducing hunger and poverty, improving nutrition and human health, strengthening ways of life and equity, and achieving environmental sustainability.

1.2. Conceptual and Analytical Framework

Reducing hunger and poverty, improving human nutrition, strengthening ways of life, and achieving environmentally and socially sustainable economic development remain on the social and economic agenda of all local, national, regional, and global strategies and interventions. Similarly, generating, accessing, and using knowledge, science, and technology are considered driving factors of and therefore fundamental components in such strategies and interventions, especially those geared to rural development. Poverty – understood as the permanent condition of economic, social, political, health, and environmental vulnerability stemming from asymmetric relations of property, exchange, and power, in reference to specific historical contexts and conditions that are determined, ultimately, by economic relations of production and the development of the forces of production – is expressed in the absence or shortage of goods and services (food, housing, education, health assistance, drinking water, etc.), resources (productive resources, employment, income, etc.), and sociopolitical conditions (human, economic, social, cultural, and political rights, among others) essential for meeting the basic needs that impact on the loss or deterioration of the standard of living and quality of life, as a result of the difficulty accessing, controlling, and managing productive and natural resources.

1 World Bank (WB), Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO), United Nations Environment Program (UNEP), United Nations Development Program (UNDP), United Nations Educational, Scientific and Cultural Organization (UNESCO), International Fund for Agricultural Development (IFAD), and the Global Environment Facility (GEF).

According to the IFAD (2002), there are two types of poverty in the region, structural and transitory. Structural poverty (or 'hard poverty') affects mainly indigenous communities, rural women, and ethnic minorities. The persons affected by this type of poverty generally have little if any education, scant productive resources if any, limited productive knowledge, and few technical skills, and lack access to basic services. Transitory poverty affects peasant families and rural households that have limited or no access to land and which are especially vulnerable to the changes ushered in by the structural reforms, fluctuations in the economic cycle, and social and political instability. Crises or sudden changes in economic policies have a detrimental impact on both agricultural and non-agricultural incomes, causing periodic declines in such incomes and deterioration in living conditions.

According to the conceptual framework used (Figure 1.1), agricultural knowledge, science, and technology systems (AKST systems) can be understood as the set of actors (individuals and organizations), networks, configurations and interfaces among them that interact in generating, reconfiguring, and disseminating information and technologies for innovation (institutional and technological) of agricultural production systems through processes of social learning regulated and guided by negotiated standards and rules for the purpose of improving the relationships among knowledge, technology, the environment, and human development.

(Insert Figure 1.1: Conceptual Framework)

In processes of innovation, science and technology are important but not sufficient components for attaining the objectives of development and sustainability, as they are conditioned by variables and factors from the regional and global context in their different dimensions, including social, economic, institutional, cultural, political, and environmental, as indicated in Figure 2. The critical external factors are capable of bringing to bear strong influences on AKST systems, determining internal obsolescences, shortcomings of capacities and resources, and flaws in their degree of correspondence with the relevant context.

In particular, in LAC over the last 10 years poverty and inequality have increased, and consequently the poor in this region are more vulnerable to natural disasters and other catastrophes than are the poor in other regions, with the exception of sub-Saharan Africa. Notwithstanding the great biodiversity and availability of natural resources, the rate of degradation of those resources and biodiversity in LAC is the highest in the world, largely because of the type of agricultural development (productivist model) pursued over the last 50 years. From 1970 to 2000, on average six hectares were deforested daily, only 60% of which was incorporated to agricultural production; the remaining 40% were abandoned due to problems of degradation and

speculation. (Ref.) Increases in production and more intense use of the land, particularly in tropical areas, have led to problems of compaction, salinization, desertification, soil erosion, water pollution, and negative effects on biodiversity and human health. The environmental, economic, and social vulnerability of the planet, lifestyles, productive systems, and ecosystems is the most visible result of a form of industrial development that accorded priority to the mechanical and instrumental dimension over human, social, and ethical considerations in human relations with other forms of life and with nature.

If this vulnerability reflects anthropogenic problems – i.e. those brought about by human action – sustainability can only emerge from learning by discovery, through human interaction (Röling, 2003), negotiated to create consensus-based actions that transcend particular private interests, i.e. through social learning (Bhouraskar 2005). Nonetheless, the proposals and solutions of the majority of development "experts" reveal that they themselves are held hostage to the mode of innovation (mode of interpretation + mode of intervention) that has prevailed in creating the problem that we need to grasp if we are to be able to overcome it. Following Albert Einstein, who said that it was not possible to overcome a complex problem using the same method that gave rise to it, we believe that it is not possible to overcome complex situations using the same mode of interpretation and the same mode of intervention that gave rise to them.

In the traditional approaches, the vulnerability of agricultural production systems is conceived of from the dominant world view (generally that of an outside expert) that imposes its universal conception of reality on the local world views and interests of the subaltern groups and creates a division of labor in the process of generating, accessing, and using knowledge that transforms the local actors (producers) into mere receptacles of values, concepts, and paradigms generated far from their context and devoid of any commitment to their needs, demands, and aspirations. To the contrary, the Agricultural Information and Knowledge Systems approach considers the systems as a social construct in which the actors who constitute it perceive their interdependence; come to agreement on the current and future systemic vision; negotiate principles, premises, objectives, strategies, and courses of action; and systematize their experiences and lessons through structured processes of negotiated interpretation. Critical constructivism suggests identifying the world view – the conception of reality – that conditions the modes of interpretation and intervention of those who interact to transform their reality, and therefore is focused on the changing web of relationships and meanings that influence perceptions, decisions, and actions in human initiatives.

With the crisis in the mechanical world view that conditioned the development of modern science, other world views[2] and paradigms are competing with one another to prevail and influence the emerging historical period. The most visible world views in this struggle of shifting paradigms are: cybernetic, market-driven, evolutionist, and contextual (De Souza Silva et al., 2001; Santamaría-Guerra, 2003). Associated with these world views are regimes of truths that condition different perceptions of reality which, in turn, generate different sets of decisions, all of which are considered 'good decisions.' For example, the monopoly enjoyed by the rationalist paradigm of modern science that was born in the 16th and 17th centuries, and consolidated under the exclusive influence of the philosophical tradition of positivism, is facing a legitimacy crisis (Berger and Luckmann, 1966; Astley, 1985; Restivo, 1988; Chia, 1997; Hatch, 1997; Nowotny et al., 2001). This is because of the negative consequences of a type of development (industrial) carried out with the extensive contribution of positivist science. At the current change in era, scientific paradigms (Capra, 1982; Morin, 1984; Bentz and Shapiro, 1998; Nowotny et al., 2001), institutional paradigms (Smircich and Stubbart, 1985; Stacey, 1993; Begun, 1994; Levy, 1994; Chia, 1995; Boje and Thatchenkery, 1996; Gergen and Thatchenkery, 1996; Lissack, 1997; Tasaka, 1999; Watson, 2000; Santamaría-Guerra, 2003) and development paradigms (Sachs, 1992; Escobar, 1998) are being called into question because of their association with the positivist paradigm of industrialism.

Each world view is more consistent with a given scientific paradigm and with a given rationality.[3] The technocentric paradigm that prevailed during the historical epoch of industrialism, consistent with the cybernetic world view and with instrumental rationality, is challenged by the eco-centric (neo-rationalist) paradigm, which transcends reductionism and incorporates systems theory from a positivist perspective and a strategic rationality. With the contextual world view has emerged the holocentric paradigm, focused on the sustainability of humankind and the planet, through the vindication and promotion of the human, social, ecological, political, and institutional dimensions of development, following a communicative rationality.

Accordingly, the application of the conceptual framework proposed implies, first, characterizing the global and regional context in which both the AKST systems and agricultural productive

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[2] World view or *Weltanschauung* (Checkland, 1989; Wilson and Morren, 1990; Bawden, 1998, 2000) is the mental framework that influences who people think, decide, and act. Wilson and Morren (1990) note that world views "*consist of the experiences, feelings, emotions, attitudes, values, morals, beliefs, tastes, and personalities of individuals, as well as their patterns of reasoning (including scientific reasoning) and their store of knowledge.*"

[3] Habermas (1984, 1987) distinguishes among different types of actions: *instrumental*, associated with the material world (physical/biological)*; strategic,* associated with the social world (social relations); and *communicative,* associated with the inner world (self-reflection). Each type of human action is associated with a given sense of "what's right." This sense of what's right or of preferred ways of attaining purposes is what is called *rationality.*

systems find themselves, and analyzing the recent history and current situation of Latin American agriculture, with special emphasis on the performance of production systems.

1.3. Latin American Agricultural Production Systems

Recognizing the structural heterogeneity and diversity of actors, cultures, and knowledge of Latin American agriculture both regionally and subregionally, it was decided to consider three agricultural systems for the purposes of this evaluation:

1. Traditional/indigenous,
2. Conventional/Productivist;
3. Agroecological.

Table 1.1 presents a description of the principal characteristics of these three agricultural systems.

(Insert Table 1.1: Description of agricultural systems)

The traditional/indigenous system is a family agricultural system, involving family consumption, under which one can distinguish the ethnic systems constituted by indigenous and Afro-Caribbean communities linked to the territory and the peasant systems. It is based on local/ancestral knowledge, and is hardly articulated to the market. In general, this system is high in agrobiodiversity, outside inputs are used to a limited extent, if at all, and labor is drawn from the family (Altieri, 1999; Toledo, in press). The cosmovision of indigenous communities assumes a relationship with natural resources that goes beyond an economic-extractive activity: it implies an ecological-cultural-spiritual vision linked to the territory. It stands out for sustainability with respect to the environment and energetic balance, with variable levels of production (Barrera-Bassols and Toledo, 2005). In several regions traditional/indigenous agriculture is displaced to marginal lands, and much of the knowledge that undergirds it is being lost. In these conditions one finds low yields. In most countries of the region, governmental/institutional support has not fostered nor does it foster the strengthening of this system by way of traditional/indigenous affirmation. Frequently, small producers who practice this type of agriculture have multiple survival strategies, combining subsistence agriculture with commercial activities and employment as wage workers (Ewell and Merrill-Sands, 1987; Deere, 2005; Barrera-Bassols and Toledo, in press). Despite the trends towards intensification of agriculture in LAC, traditional/indigenous agriculture is still practiced by millions of producers. By 1980 these production systems were found in 16 million productive units and occupied 160 million hectares, involving some 75 million persons, i.e. about two-thirds of the rural population of LAC (Ortega, 1986). In the 1980s, this

sector produced 41 percent of domestically-consumed foods, and accounted for 51 percent of the maize, 77 percent of the beans, and 61 percent of the potatoes (Posner and McPherson, 1982; Altieri, 1993). Due to neoliberal policies, this sector has been weakening and it is possible that it accounts for a smaller percentage of domestic food production (David et al., 2001).

At the other end of the spectrum one finds the conventional/productivist system, also called "industrial system." This system is characterized by a high degree of mechanization, monocultures, and the use of external inputs, such as synthetic fertilizers and pesticides, as well as contract labor. It is based on technological knowledge, and is highly articulated to the market, and in some regions integrated to productive chains. This system has been supported by the development models and it has benefited from support systems such as credit and technological capital (Chapter 2). Tapping into the results of the AKST system and its insertion in the national and international markets leads the conventional/productivist system to stand out for its high levels of productivity and competitiveness. Nonetheless, it gives rise to significant negative externalities in terms of environmental, social, and cultural costs, leading, in current conditions, to its sustainability and energy efficiency being seriously called into question.

As the environmental and human costs of conventional production have increased, the *agroecological* system is becoming more important. It is based on the knowledge of agroecology stemming from the interaction between scientific and traditional knowledge, and aimed at reducing the negative impacts of the conventional systems through productive diversification and the use of ecologically-friendly technologies. It is characterized by the search for sustainability in social, economic, cultural, and environmental terms; though it has become more important in recent years, its dissemination has been limited by lack of governmental and institutional support.

1.4. Regionalization

Latin America and the Caribbean is a very extensive and varied geographic region. It extends from Baja California (32 1/20 N) to Tierra del Fuego (55o S) and has a total of 2.050 billion ha (including internal bodies of water) in 45 countries with 546 million inhabitants. Given its great range of longitudes and altitudes, as well as its great biodiversity, LAC has a wide diversity of ecosystems including moist tropical jungles, dry forests, conifer forests, temperate forests, tropical savannahs, temperate savannahs, páramos, and desert environments. To facilitate the analysis and characterization of the region in this evaluation we will refer to large geographic zones as follows: Southern Cone, Andean Region, Central America, Mexico, and the Caribbean (Table 1.2; Figure 1.2). Nonetheless, on occasion it will be necessary to refer to the regions based on the natural ecosystems, such as tropical jungles, pampas and cerrados, mangroves, etc.

(Insert Table 1.2: Geographic zones and countries in Latin America and the Caribbean)

(Insert Figure 1.2: Map of the region)

Due to the great diversity of ecosystems and climates in the region, LAC is characterized by a great diversity and complexity of agroecological zones, as well as production systems associated with these zones. The high biological diversity contributes to the production, in this region, of 36% of the world's cultivated foods and industrial species (Dixon et al., 2001).

Following is a brief description of the different agroecological zones and types of production found in the region (based on Dixon et al., 2001) (Table 1.3):

Irrigated farming system – Covers two extensive areas of arid lands, one in northern Mexico, the other in coastal areas and interior valleys of Peru, Chile, and western Argentina. It is characterized by the presence of irrigation infrastructure, which usually implies a high level of agricultural intensification. The main crops produced using this system are rice, cotton, fruits, vegetables, and vineyards.

Forest-based farming system – Located mainly in the Amazon basin and the moist tropical forests of Central America and Mexico. It is the largest agroecological zone of LAC, covering an area of approximately 600 million ha, the equivalent of 30 percent of the region's area. Nonetheless, given the poor conditions of production, including low soil fertility and low population density (less than 0.02 persons/ ha), the planted area covers only one percent of the total. The agriculture includes traditional migratory agriculture practiced by indigenous communities and *colonos*, and is characterized by low levels of inputs and high diversity, and includes agroforestry systems and permanent crops, as well as extensive cattle raising.

Coastal plantation and mixed farming system – This extends along the northeastern and northwestern coast of South America as well as the coastal zones of Mesoamerica and the Caribbean. Approximately 10% of the area is cultivated using two different subsystems: (a) small-scale family farms with mixed agriculture, coastal fishing, and the frequent use of off-farm employment (tourism), and (b) large commercial plantations with production for export, generally owned by foreign entrepreneurs (i.e. enclave agriculture), characterized by intensive production, with a contracted labor force with high levels of poverty.

Intensive mixed farming system – Covers some 81 million ha in eastern and central Brazil, in one of the regions with the highest population density in Brazil and in the region as a whole. Approximately 13 million ha in this zone are cultivated, and it has an agricultural population of approximately 10 million. The leading crops are coffee, horticulture, and floriculture.

Cereal-livestock (Campos) farming system – Consists of more than 100 million ha of lands in southern Brazil and northern Uruguay, some 18 million ha of which are cultivated, and has a rural population of 7 million. The zone is characterized by lower levels of precipitation and soil fertility than the mixed intensive system described above. The leading productive activities are extensive cattle-raising and rice production.

Moist temperate mixed-forest farming system – Covers a limited area of 13 million ha in the coastal zone of central Chile with climatic and topographic conditions similar to New Zealand. With an agricultural population of less than 1 million and a planted area of only 1.6 million ha, it is characterized by large expanses of natural forests and plantations, combined with production of milk, sheep, and crops such as sugar beet, wheat, and barley.

Maize-beans (Mesoamerican) farming system – Characteristic of Mesoamerica and extends from central Mexico to the Panama Canal. It covers some 65 million ha and historically is based on the production of maize and beans for subsistence with a very large indigenous component. Although a large part (40 percent) of the area is irrigated, the zone is characterized by extreme poverty due to the displacement of the indigenous population from the most fertile valley lands by the *colonos* and commercial enterprises.

Intensive highlands mixed (Northern Andes) farming system – This covers the Andean zone of Ecuador, Colombia, and Venezuela, encompassing some 43 million ha, part of which is irrigated. It is divided into two sub-systems: (a) the inter-Andean valleys and lower slopes, where the coffee and horticulture production is predominant, and (b) the highlands and upper valleys, where temperate crops, maize, and pigs predominate and where the Andean indigenous cultures are well-established.

Extensive mixed (Cerrados and Llanos) farming system – This type of production is predominant in a total area of 230 million ha, separated into two main areas by the Amazon jungle. One area is to the southeast of the Amazon in Brazil and part of Bolivia; the other is north of the Amazon in Venezuela and Guyana. Fifteen percent of the area is cultivated, and irrigation is practically nonexistent. This zone has been characterized by extensive cattle production, but more recently there has been an increase in intensive soy production.

Temperate mixed (pampas) farming system – Covers an area of 100 million ha in east central Argentina and part of Uruguay. Historically this zone was given over mainly to stock raising, and has very little irrigation infrastructure, but nowadays approximately 20 percent consists of soy, wheat, and sunflower, as well as horticulture to supply the populations in the capital cities.

Dryland mixed farming system – Covers approximately 130 m ha and is situated in two regions, in the northeastern coast of Brazil, and the Yucatan peninsula in Mexico. The system has limitations in terms of water and soil quality. A small proportion of cultivated lands is irrigated and

the producers face frequent droughts. In these zones small scale producers coexist with large-scale stock raising. The small producers have a high poverty rate; many depend on wage labor.

Extensive dryland mixed (Gran Chaco) farming system – Covers some 70 million ha in central Argentina, northern Paraguay, and eastern Bolivia. The dominant production system is stock-raising, though recently various crops have been developed with incipient irrigation. Agricultural development is limited by soil fertility and low moisture.

High altitude mixed (central Andes) farming system – Covers 120 million ha and extends throughout the Andean zone of Peru, western Bolivia, and northern Chile and Argentina. The system is divided into two sub-systems: (a) the rugged valleys of the high sierra in Peru, and (b) the Andean altiplano. In the highest areas (> 3200 m) the principal products are native grains, potato, sheep, and llamas. In these zones, the indigenous cultures predominate, and there is a high level of poverty. In the lower areas the same crops are produced as in temperate zones in the northern Andes.

Pastoral farming system (southern pampas) – The southern pampas in Argentina become drier and cooler in the higher latitudes, limiting agricultural production. In these zones, the only agricultural activity is stock-raising (cattle and sheep). This system extends from central Argentina to Patagonia, covering some 67 million ha without irrigation, and has a population of less than one million.

Temperate forest farming system – This is found in a zone in which the crops are limited by the low temperatures and in which temperate forests dominate. Agriculture is submarginal and the population depends on stock-raising, forest resources, and tourism.

(Insert Table 1.3: Agroecological zones and types of agriculture)

1.5. Global Context: Main Trends

Since the 1950s, the combined effects of three revolutions—technological, economic, and cultural— have been giving rise to new realities (Castells, 1996), shaped by old and new contradictions, which transform (in a differentiated manner) the many "worlds" that coexist on earth, through, for example (Capra, 1982; Restivo, 1988; Dicken, 1992; Sachs, 1992; Barbour, 1993; Najmanovich, 1995; Castells, 1996, 1997, 1998; Chisholm, 1996; Escobar, 1998; Wallerstein, 1999; Busch, 2000, 2001; Rifkin, 2000; Mooney, 2002; Santamaría, 2003; de Souza Silva et al., 2005):

- The emergence of an immaterial economy dependent mainly on an intangible factor — *information* — and on the communications infrastructure;

- The emerging scientific and technological possibilities (*robotics, new materials, nanotechnology, cellular and molecular genetics, information technology, etc.*) that point simultaneously to new advances important for humankind and to new inequalities within and among social groups and societies;
- The end of the social contract between capital and labor under the notion of "labor flexibility";
- The emergence of a digital hemisphere whose dynamics depend on virtual networks of power through which capital, decisions, and information flow;
- The construction of a world economic and political order whose corporate and transnational nature is becoming consolidated under the dominant influence of actors with global interests and expansionist ambitions;
- The technological convergence and productive decentralization that construct transnational productive chains outside the control of nation-states and local actors;
- The rise of the network concept, supported by new possibilities of digital technology and communications infrastructure, and their implications for managing interdisciplinary, inter-institutional, and international projects;
- The decline of the sovereignty and autonomy of the nation-state, so as to give rise to the prevalence of transnational rules over national ones, giving rise to a crisis of representative democracy, with the emergence of a supranational state-network;
- The mounting "social" and "natural" catastrophes caused by human action, which have created multiple types of vulnerability for humankind and the planet;
- The formation of regional and subregional economic blocs for internal integration (economic, technological, and political) and external competition;
- The struggle to establish a *global civil society* dependent on *participatory democracy* networks;
- The struggle for sustainable development dependent on the creation of a global civil society to monitor the excesses of transnational corporate capitalism;
- The dramatic erosion of biodiversity and cultural diversity;
- The emergence and proliferation of social movements to vindicate and uphold the importance of the interdependence among human, social, and ecological considerations;
- The rise of initiatives and dynamics that accord priority to local development as the starting point for transformations committed to human, social, and ecological needs;

- The rise of social movements for the purpose of controlling (and in general contesting) the products of science and even the process of doing science (anti-GMO groups, anti-human cloning groups, groups to stop animal suffering, etc.)

As a result of the global changes under way, the swift restructuring of agriculture and the global food system is striking. Reflecting the nature, direction, priorities, and contradictions of current global changes, both agriculture and the food system are being transformed by several changes, such as (Friedland et al., 1991; Goodman and Redclift, 1991; Friedmann, 1993; Bonnano et al., 1994; McMichael, 1994, 1995; Goodman and Wats, 1998; Busch, 2001; Mooney, 2002):

- The prevalence of the importance of services and the speculative economy over primary production in the productive economy.
- The construction of transnational productive chains transforming the nature of productive and power relations, in which emerging global actors decide on the nature, direction, and priorities of the new transnational agriculture.
- Agriculture and the food system are and will be profoundly restructured with the application of techniques associated with the revolutions in modern biotechnology (genetic engineering), nanotechnology, robotics, and information technology. The genetic code of certain plants and animals may now be known and modified in keeping with the interests of those who can finance and control the nature, direction, and priorities of the new scientific and technological developments.
- The Green Revolution of the 20th century was led by public international agricultural research centers, while the genetic revolution of the 21st century is unfolding under the leadership or control of transnational corporations.
- While the Green Revolution tried to increase the production and productivity of some food crops, the emerging revolutions in agriculture and the food industry have the potential to destroy the tropical agriculture-temperate agriculture dichotomy and even to change the nature of foods.
- In agriculture, genetic research is under way to “teach” some plants of tropical origin to behave in the temperate world as if it were their natural environment, while in the food industry research aims to replicate the structure, texture, color, and taste of certain foods derived from tropical products, and to create *natural foods* manufactured based on a biochemical mass derived from certain perennial plants, with the aim of freeing up the industrialized countries of the North from having to import certain strategic tropical products from the countries of the South.

- With the emergence of new scientific and technological revolutions, agribusiness, currently aimed at food production, is coming to take in non-food products, such as energy products (biofuels such as biodiesel and ethanol), and new fibers resulting from biotechnology, and drugs such as vaccines resulting from the combined activity of biotechnology and nanotechnology.

Because of these and other changes, agriculture as we used to know it is facing a profound transformation, with implications for its protagonists whose impacts are not yet clear, much less understood. To understand the current situation of agriculture in LAC, one must historically deconstruct the path taken so as to unveil the models, visions, and development paradigms that shaped the strategies of intervention that gave rise to the consequences we are trying to overcome.

1.6. Regional Context

1.6.1. Evolution of development models

Development strategies in LAC were not designed in a political vacuum, but rather were decisively influenced by political events inside and outside the region. These development strategies impacted directly on the agrarian policies of the region, and on the systems of agricultural knowledge, science, and technology.

With the economic expansion of the United States after the Second World War came the need to expand external markets for its products, find new investment opportunities, have access to cheap raw materials to support growing industry, and establish a global network of military power to ensure access for consumers, markets, and raw materials. Taking advantage of its dominant economic and military position, the United States imposed an open door and free access policy on the countries of LAC, as well as incentives for private companies and privileged treatment for U.S. capital. The region's development was subordinated to U.S. interests and growth needs. To foster development and maintain economic stability internationally, the industrialized countries, led by the United States, assigned a new role to the World Bank and the International Monetary Fund, institutions originally created to rebuild Europe (Stiglitz, 2002). Yet the type of development promoted through the new international institutions is highly conditioned on the economic, political, and military needs of the industrialized countries, especially the United States.

In the 1950s, President Harry Truman of the United States held great influence over the path of development in LAC. In his *New Deal*, Truman proposed the "technification" (intensification) of agriculture as one of the instruments for emerging from underdevelopment (a term he introduced in the international discourse). During his administration, the first two agencies were created dedicated to international development, and a period marked by the proliferation of development

projects began. In the 1960s, the program that most influenced the type of development in the region was the *Alliance for Progress*, a hemispheric initiative led by President John F. Kennedy to counter the potential influence of communist Cuba in the rest of LAC and to promote the U.S. economy (Smith, 1999); its development strategy entailed articulating the peasant sector to the market (Escobar, 1995). World Bank documents (World Bank, 1975) make clear that under this development strategy, the peasants of LAC had two options: (1) to become small entrepreneurs, or, (2) to disappear from the market (or from the agricultural sector). This strategy was focused on modernizing and monetizing the rural sector, and making the transition from isolation to integration with the national economy. The technological vehicle for this strategy was the Green Revolution, yet its results in terms improving the living conditions of the rural population have been much debated (Glaeser, 1987; Rosset et al., 2000; Evenson and Gollin, 2003). With the Green Revolution food production in LAC increased 8%, yet during the same period hunger in the region increased 19% (and this was not due to population increase, as the total amount of food per person also increased).

During the 1960s and 1970s, this conception of development held sway. To a certain point one can say that these development policies were successful since during these two decades Latin America and the Caribbean experienced unprecedented economic growth. Most of the countries attained per capita growth of 2.4 percent annually during the 1960s and some countries were able to maintain this rate in the 1970s (Inter-American Development Bank, 1989). This growth was based largely on the import substitution model developed and promulgated by the United Nations Economic Commission for Latin America (ECLA) (Bulmer-Thomas, 1987). This was a period of fast-paced industrialization and economic integration at the regional level. Yet once again the benefits of this growth were not distributed equitably and in many cases they did not even reach the most impoverished sectors of the region (ICCARD, 1989; Conroy et al., 1996). This period also saw the resurgence of military dictatorships in Latin America. The increase in oil prices and the energy crisis of 1973 led to high levels of borrowing that in turn resulted in an economic crisis in the 1980s. The collapse of the Latin American economies in the 1980s led the Inter-American Development Bank to baptize this period *The Lost Decade in Latin America* (IDB, 1989).

Given the threats of default by Mexico, Brazil, and Peru, the international financial institutions, chiefly the World Bank and the International Monetary Fund, mobilized to impose structural adjustment programs on the economies of LAC. They also pressured the governments to impose austerity programs. The response to the crisis of the 1980s was the return to the liberal policies of the early years of the century, but now stronger than before and reinforced by a neoliberal program globally.

Guided by the international financial institutions' structural adjustment programs, the wave of liberalization and deregulation implemented in Latin America in the 1990s also extends to the rural world. In addition to policies such as freeing up the economy and open markets geared to exports, the adjustment programs fostered a reduction in national industrial protection, lowering tariffs and cutting back on social spending and social development, including investment in agriculture.

In the last 15 years government economic policies have been geared to applying the rules of the so-called "Washington Consensus" (Stiglitz, 2002), in particular, policies to (1) ensure fiscal discipline (putting finances in order, fiscal responsibility, cutting public spending, voluntary retirement plans, etc.); (2) implement tax reform (providing for universal incentives, tax reform); (3) free up imports (unilateral lowering of tariffs, free trade agreements); (4) privatize productive state enterprises and services (electricity, communications, and ports); (5) deregulate the domestic market (freeing up the price system and eliminating subsidies); and (6) reform the state and introduce labor flexibility (reforms to the labor code and creating special regimes for foreign investment).

From an economic and commercial perspective, the United States, Canada, and some Latin American governments gave impetus to the creation of the Free Trade Area of the Americas (FTAA) and subregional or bilateral variations of it. The FTAA is the regional expression of neoliberal globalization that is trying to become established through a process of asymmetric integration and under the leadership of the transnational companies. This asymmetric integration seeks to reorganize the economic factors and natural resources of Latin America in keeping with the interests of U.S. corporate capital. The promoters of these free trade agreements argue that foreign investment will lead to economic development benefiting all, but these treaties, thus far, have provided total and indiscriminate protection for the investments of transnational companies to the detriment of the sovereignty of the nation-state (Gratius, 2002). As in the case of the NAFTA, the treaty among the United States, Canada, and Mexico, the states would lose their capacity to protect the environment and human rights, and their citizens would lose the right to participate democratically in determining the course and priorities of their development.

Following these guidelines, the IICA and other multilateral regional organizations in the Latin American countries are implementing the *New Rurality* approach, with three main components: competitiveness of agriculture and rural production, equity in the rural sector, and the creation of a new institutional framework (IICA, 2000). The objectives of the "new rurality" in respect of sectoral competitiveness are geared to (1) improving and deepening the insertion of the countries into the international markets; (2) improving technically and professionalizing crop, livestock, and forestry production and agribusiness development; (3) improving the capacity of the public sector

to support sectoral development; (4) inducing gradually and with supervision the transfer of public services to the private sector.

The approach appears to take up anew some of the same guidelines of the previous models, with similar results. The recent data on economic growth and inequality in LAC in the first years of the millennium confirm this. Indeed, real per capita growth rates in the first four years of the millennium (2000-2004) were 2.1 percent, -1.1 percent, -2.1 percent, and 0.5 percent, far below the averages attained in the 1960s and 1970s (ECLAC, 2004), and economic inequality in the region continues to be the highest in the world (UNDP, 2005).

In summary, the development models that have guided the economic policies in LAC after the Second World War have answered mainly to the needs of the principal world power, the United States. With respect to agriculture and the development models, the role of the state is changing from producer and supervisor to organizer and facilitator of the development processes in the agricultural sector. Second, the multinational companies are already leading the process of technological development, especially in the area of biotechnology, and consulting firms and NGOs are quickly filling the spaces being abandoned by the state in different technical, environmental, and social areas. Finally, the privatization of utilities and resources associated with ecological services (such as water) distributes conservation costs locally among many, while the benefits are reaped by just a few, who generally are not part of the rural communities. If this development paradigm doesn't change, the combination of all those factors could be devastating for the rural sector in Latin America and the Caribbean.

1.6.2. Social context

1.6.2.1. General situation of poverty in Latin America

As of mid-2005, Latin America and the Caribbean had a total population of 563 million, 77.8% of which is urban and 22.2% rural (ECLAC, 2004). Nonetheless, it is estimated that the region has 221 million poor and 54 million persons who are malnourished; of the 220 million, 140 million are urban and 80 million rural. At the same time, children and youths are the hardest hit, as they account for almost 60% of the poor as of 2002 (Dirven, 2005; ECLAC, 2003).

For the purposes of this evaluation, poverty is defined as a permanent condition of economic, social, political, health, and environmental vulnerability stemming from asymmetrical property, trade, and power relations, with reference to specific historical contexts and conditions that are ultimately determined by the economic relations of production and the development of the productive forces. Poverty is expressed in the lack or scarcity of goods and services (food, housing, education, health care, drinking water, etc.), resources (productive resources, employment, income, etc.), and sociopolitical conditions (human rights, economic, social and cultural rights, political rights, etc.) essential for meeting the basic needs that contribute to the

loss or deterioration of the standard of living and quality of life of persons, resulting from the difficulty accessing, controlling, and managing productive and natural resources.

At the Millennium Summit, organized by the United Nations in 2000, the governments undertook to cut poverty in half in the following 15 years; even so, poverty reached the levels mentioned above. According to ECLAC (2004), the number of poor and indigent (those living in extreme poverty) diminished in relative terms only 1.8% from 1997 to 2004, from 43.5% to 41.7% of the total population; nonetheless, in absolute terms, the number of poor increased in the same period, from 204 million to 216 million persons.

According to almost all indicators, Latin America and the Caribbean is the most unequal region in the world (Cardoso and Helwege, 1992; Rosenthal, 1996; Berry, 1998; O'Donnell and Tockman, 1998, Portes and Hoffman, 2003; Hoffman and Centene, 2003; ECLAC, 2004). The Gini coefficient in the region is 0.52, whereas in the industrialized countries of the OECD is it 0.332; in the Asian countries it is 0.40, and the Gini coefficient for Africa is 0.48. Note that the index of inequality is different from the poverty level: Africa is poorer than Latin America, but less unequal. The worst cases are Brazil, Chile, Colombia, Guatemala, Honduras, Mexico, Panama, and Paraguay (Table 1.4), where the indices of extreme poverty appear to be on the rise due to the combined effect of falling incomes among the most underprivileged strata and a widening of the inequality gap.

(Insert Table 1.4: Gini coefficient for income distribution in some countries of Latin America and the Caribbean)

In the late 1990s, six of every 10 poor lived in urban zones, making Latin America and the Caribbean the developing region that best exemplifies the worldwide process of the "urbanization of poverty" (in contrast with Asia and Africa, where most of the poor population is in the rural areas). The poverty rate continues to be higher among rural residents, especially among women, since economic globalization and neoliberal policies are clearly expressed in the characteristics of the contemporary rural labor market, where government protection for workers is reduced to a minimum or eliminated, unemployment and underemployment are on the rise, and men and women are marginalized from the market (Valdés, 2005).

Most of the poor in the countries of the region were in the rural areas until the early 1980s. As a result of the negative social impact of the "crisis of the lost decade" and of the advance of the process of urbanization, poverty came to be located mostly in urban areas by the mid-1980s. During the subsequent period of economic and social improvement, the urbanization of poverty

continued, until it stabilized at about 62 percent from 1994 to 1997 (as a result of a new increase in the number of rural poor) (Table 1.5).

(Insert Table 1.5: Trends in urban and rural poverty in Latin America and the Caribbean)

The statement that poverty in LAC is mainly an urban phenomenon (Dirven, 2004) reflects that 70% of the population is urban, and poor neighborhoods are very extensive. This perspective is due in part to the fact that four large and relatively urbanized countries – Brazil, Mexico, Colombia, and Argentina – dominate regional statistics. In addition, surprisingly little is known of the degree of rural poverty in the region, since the estimates of poverty in LAC are incomplete, or little attention is paid in the analyses of poverty to rural poverty, especially as it affects the indigenous peoples of the region; they have higher poverty levels and have never been very well-represented in the statistics. Urban poverty in LAC has been better studied and documented through surveys. Nonetheless, there are two notable data:

- In three countries, the rural population is over half the national population (Guatemala, Haiti, and Honduras).
- Since a much higher proportion of the rural population is poor, in at least 12 countries most of the poor live in rural areas.
- In Colombia, where less than 42% of the population is rural, 74% of the poor live in rural areas. In Brazil, where 26% of the population is rural, approximately 40% of poverty is rural. In Venezuela, where 16% of the population is rural, 30% of the poor live in rural areas. In Mexico, where 41% of the population is rural, 57% of the poor live in rural areas. In Panama in the year 2000, 40.5% of the population was classified as poor, and 26.5% as living in extreme poverty, with 64% of the poor in rural areas.
- In all the countries of Latin America, the lowest income deciles, i.e. the extremely poor, are mostly made up of rural population.

If one compares the average standard of living of the urban poor with that of the rural poor, it is clear that poverty is much more severe in rural areas.

According to ECLAC (2004), in absolute terms, the number of poor in urban areas has also increased, since in 1980 it came to 73 million, and the number of peasants in extreme poverty has climbed, over the last two decades, from 39.9 million to 46.4 million. In that context, the gains of the 1990s in terms of poverty alleviation have not sufficed to offset the increase in poverty during the previous decade.

It is estimated that eight to ten million rural households are headed by women; some two or three million women perform seasonal work in agriculture or agroindustry; and 30 to 40 million women with spouses or partners are partly or entirely responsible for agricultural production and small-scale rural industry. Rural women have become part of the poorest population groups as a result of internal conflicts, the increase in the migration of men within and outside the country, natural disasters, and the consequences of structural adjustment.

In terms of the levels of education, the illiterate population 15 years and over accounts for 9.5% of the total population in this age group in LAC (ECLAC, 2004). Illiteracy is 10.3% among women and 8.8% among men. The drop-out rate is 37% for Latin American adolescents. Almost half drop out early, without finishing primary education, but in several countries most of those who drop out do so in the first year of secondary education; and most are in the lowest-income strata, reinforcing the chain of inequality from childhood. Economic difficulties, work, or looking for employment are the main reasons young people adduce for dropping out of school. Among women, other reasons are household tasks, pregnancy, and maternity.

In rural areas in particular, a very small percentage of the poor complete their secondary studies. In addition to the supply factors (availability of schools and quality of teaching), this may also reflect demand factors: with adolescents who work on the farm, or as wage-earning employees, the opportunity cost of sending them to school – without considering the costs of schooling, and of room and board for those who must live in the town – is considerably greater than in urban areas.

On average, illiteracy in rural areas is two to six times greater than in urban areas. A comparison indicates that on average rural dwellers have three fewer years of schooling than urban dwellers. If one divides schooling into primary and secondary, it is clear that the difference is not so great at the primary level; nonetheless, the situation is completely different for the secondary level, and the percentages are even lower in poor rural areas (Psacharopoulos, 1993; World Bank, 1992).

The poor in rural areas, compared to those who are not poor, generally have worse health, since the families are more numerous and more dependent, and access to health services is more limited. The availability of information on the delivery of health services and other services is very scarce. Nonetheless, from 2000 to 2005 infant mortality – one key indicator of health – was 35.4 per 1,000 live births in LAC; for males it was 38.8 per 1,000 live births, and for females 31.8 per 1,000 live births. In addition, not only are the rates extremely high in the middle-income developing countries, but also, for most countries, those rates are considerably greater in rural than in urban areas (ECLAC, 2004). Infant mortality has declined gradually since 1990 in most of the countries, although it is still alarming in Haiti, at 54.1 per 1,000 live births; and Bolivia has the highest infant mortality in South America, at 45.6 per 1,000 live births.

ECLAC (2004) also recalls that chronic malnutrition in the region affects 15 percent of children under five years, as a symptom of severe poverty. In most of the countries of the region, children in rural areas, where food is produced, have the highest levels of malnutrition (Dirven, 2004).

Another factor of social deterioration in the region is the lack of employment and its low quality (Dirven, 2004). The degradation of working conditions in the countryside in LAC is reflected in the low incomes of rural families and, therefore, in a persistent increase of accelerated migration from rural areas to the cities, creating mega-cities with areas of extreme poverty, and greater demand, in many cases impossible to meet, for services in the main cities of LAC (Davis, 2005). The structural adjustment programs promoted and imposed by the International Monetary Fund, combined with economic liberalization, have provoked a massive exodus from the countryside to the cities (Bryceson et al., 2000). In addition, there is migration to industrialized countries, either in the region, or to Europe or the United States. Examples of this phenomenon include Mexico, Ecuador, El Salvador, Peru, and Nicaragua; remittances become a very important source of income for rural and urban poor families in these countries (Andean Community, 2006).

According to the IFAD (2002), there are two types of poverty in the region, structural and transitory. Structural poverty (or 'hard poverty') affects mainly indigenous communities, rural women, and ethnic minorities. The persons affected by this type of poverty generally have little if any education, scant productive resources if any, limited productive knowledge and few technical skills, and lack access to basic services. Transitory poverty affects peasant families and rural households that have limited or no access to the land, and that are especially vulnerable to the changes brought about by the structural reforms, fluctuations in the economic cycle, and social and political instability. Crises or sudden changes in economic policies affect both agricultural incomes and non-agricultural incomes, causing periodic diminutions in those incomes and deteriorating living conditions.

1.6.2.2. Inequality in land tenure

Latin America and the Caribbean represent the most extensive reserve of arable land, in proportion to population. The region has 576 million ha (UNEP, 2002), equivalent to 30% of the arable land in the world, and 28.5% of the total land in the region (2.018 billion ha). Nonetheless, the region has the greatest inequality in land distribution in the world (Ferranti et al., 2004). Historically, the land tenure systems in Latin America were based on private property, the concentration of agricultural lands in the hands of a few families, and the existence of a large number of peasant families or landless workers, in what was called the latifundia-minifundia complex, and the plantation economy (Lastarria-Cornhiel and Melmed-Sanjal, 1998). The latifundistas had vast expanses of land, and those best suited for agriculture, while the small farms, or minifundia, survived in the marginal areas.

The agrarian reforms of the 1950s, 1960s, and 1970s attempted to modify this situation of inequity by expropriating and purchasing large properties and redistributing them to peasants with little or no land, in general in the context of political and social mobilizations. Nonetheless, from the economic perspective, the agrarian reforms of this period did not succeed in reducing the levels of poverty of the rural population (Groppo, 1996). The reforms were limited in terms of the redistribution of land, and allocation of land was not accompanied by supplemental measures (technical assistance, loans, market access, etc.) that might enable the small producers to emerge from poverty.

Several decades later, the effects of the agrarian reforms on relations of production in agriculture, the development of a modern capitalist economy, and the problems of poverty and equity continue to be part of the debate (Chris van Dam, 1999). In several countries large haciendas have given rise to commercial agriculture or agroindustry that controls the lion's share of the productive process, for both the domestic market and increasingly geared to external markets. At present, the modernization of Latin American agriculture has dramatic effects in terms of tenure, since there is a high concentration of property and agricultural production, whose main effects have been to displace and expel small producers and peasants, with the consequent processes of impoverishment, migration, and social exclusion (Chris van Dam, 1999).

Nowadays, the forms of land tenure in the region are highly varied and complex. Nonetheless, within this heterogeneous reality, the bipolarity persists in which the latifundium has been replaced by the capitalist enterprise that gears its production almost exclusively to the export market, which no longer maintains economic relations with the minifundista peasants, who produce for their own subsistence and for the local and regional markets (Mertins, 1996). At the same time, the impoverished small landowners are exposed to the constant threat of being forced to sell their land and other assets to buy foods. For the landless, access to land is generally difficult, insufficient, and insecure. The systems of tenancy (*arriendo*) or sharecropping (*aparcería*) increasingly appear as a solution to the problems of inequity.

Most authors coincide in noting that the new land policy model being applied in Latin America uses market mechanisms instead of policy reforms. Nonetheless, Thiesenhusen (1996) considers that having made the market the main land policy instrument has not resolved the problem of land redistribution, nor allowed peasants to have access to land; rather, it has deepened the existing inequality. Indeed, it is possible that as the number of small producers in countries such as Brazil, Chile, Uruguay, Argentina, Bolivia, Colombia, and Mexico has continued to decline, inequality in land distribution has increased (David et al., 2001).

Another indicator of inequity is access to landed property for rural women, resulting from the specific and disadvantageous conditions in which they must face poverty (ECLAC, 1999). The liberalization of the market in land is marked by a paradox, as it favors direct access for women to

landed property, yet its purchase is limited by lack of income and by factors that make it increasingly difficult to develop rural and agricultural areas. As a result, Latin America is the region with the most unequal land distribution in the world, on average. More than 30 percent of the rural poor in Latin America and the Caribbean are landless. According to studies, more than half of the households with little or no land live in extreme poverty. By way of contrast, only 10 percent of farmers with more than three ha of land are in a similar situation of poverty. Many other studies have confirmed that the reduction in or loss of access to the land leads directly to a loss of income and access to food (CLADEHLT, 2002).

1.6.2.3. Food security and food sovereignty

Food security is associated with a problem of social vulnerability, which lies in the difficulty of accessing food, the origin of which is to be found in the asymmetries of development. A situation of food insecurity is reached when one does not have the means to obtain sufficient food, thus it is associated with levels of poverty (Torres, 2003).

Many different meanings are associated with the concept of food security. In 1996 Maxwell drew up a list of 32 possible definitions (Runge, 2003). Nonetheless, two main considerations should be taken into account: (a) the internal capacity to increase production in the different categories of demand, and (b) the country's financial possibilities for completing its food supplies (Torres, 2003). In effect, in the first, emphasis is placed on what could be called food self-sufficiency, and in the second, priority is accorded to food purchases based on comparative advantages. Following are the various perspectives in the debate.

The United Nations Development Program (UNDP) mentions that four criteria should be adopted: (1) acknowledging; (2) economic efficiency; (3) social equity; and (4) ecological integrity. It emphasizes that the policy changes are not always those needed, and that capacity-building is essential at the local level (Hall, 1998). In 2000, at the UN Millennium Summit, eight millennium development goals were established, the first being to eradicate extreme poverty and hunger.

For the FAO food security exists when all persons have material and economic access at all times to sufficient safe and nutritious foods to satisfy their food needs and food preferences so as to lead an active and healthy life. In 1994, the Special Program for Food Security (SPFS)[4] was begun (FAO, 2006). In 1996, more than 180 nations participated in *World Food Summit* and

[4] In 1994, two years before the 1996 World Food Summit, FAO implemented the SPFS as the main program for helping its developing member states reduce hunger and malnutrition. The premise on which the design of the SPFS is based is that the productivity of small farmers in developing countries could increase considerably by introducing relatively simple, economic, and sustainable technological changes (FAO, 2003). As a result of the 1996 summit, the Rome Declaration on World Food Security was issued, with seven commitments that the participating governments would implement to enhance food security.

undertook to reduce by half the number of undernourished persons by the year 2015, and thereby contribute to the UN Millennium Development Goals.

The World Bank defines food security as persons' access at all times to sufficient food to lead an active and healthy life (Hall, 1998). The World Bank posed the need to increase the productivity and profits of small producers, and seeing to it that they become involved at all stages, relying on biotechnology so as to be able to see what science can do for the poor and the environment (Hall, 1998). The person in charge of the rural development division argues that it's hard to make policymakers seek that agriculture is crucial and that there should be investment in research and development, especially geared to marginal producers (Hall, 1998).

The United States Department of Agriculture (USDA) argues that food security for a family means access for all its members to sufficient food to be able to lead an active and healthy life. Food security includes, at a minimum: (1) the availability of adequate and safe foods, and (2) the assured capacity to acquire goods by socially acceptable means.

The concept of food sovereignty was developed by Vía Campesina and brought into the public debate at the World Foot Summit in 1996; it offers an alternative to neoliberal policies. Since then, that concept has become a major topic of the international agrarian debate, including in the United Nations bodies. It was the main topic of the NGO forum held parallel to the FAO's World Food Summit in June 2002 (Vía Campesina, 2003).

Food sovereignty is the right of the peoples, their countries, or unions of states to define their own agrarian and food policy, without dumping, vis-à-vis third countries.
Food sovereignty includes: Prioritizing local agricultural production to feed the population, access for peasants and the landless to land, water, seed, and credit. Hence the need for agrarian reform, and the struggle against GMOs (genetically modified organisms), for free access to seeds, and to preserve water as a public good that is distributed sustainably (Vía Campesina, 2003).

The concept of food sovereignty has come about as a reaction to the definition of food security, which preaches that everyone should have food, but doesn't say where it will come from. As a result, this concept provides a place for the companies and helps create more poverty, marginalization, and hunger. For this reason, food sovereignty places emphasis on local autonomy, local markets, and community action. It is a process of popular resistance in the context of social movements (Grain, 2005).

The local space is accorded priority first of all because it is there that sovereignty takes on its essential meaning. It is in the spaces where the local communities create autonomy based on their own needs, beliefs, and time frames. They are the custodians of thousands of years of research and creation, as a result of which theirs is an agriculture based on biodiversity, in

contrast to the industrial agriculture that fosters monoculture and only develops certain species, which are not those grown and consumed by the local populations (Grain, 2005).

Food sovereignty has a broader dimension, incorporates issues such as agrarian reform, territorial control, local markets, biodiversity, autonomy, cooperation, debt, and health, all of which have to do with local food production. Advocates of food sovereignty argue that to attain a world without hunger one must place the communities center stage once again (Grain, 2005).

Oxfam is an NGO that works against world hunger. Based on its experience it concludes that the steps to be taken are: (a) seek ways of increasing agricultural productivity sustainably, (b) foster partnerships between NGOs and the government, (c) promote capacity building, (d) include women's participation, (e) have participatory extension systems, (f) have alternative sources of income, (g) respect land rights, (h) foster nutrition practices, and (i) gain familiarity with regional food markets (Hall, 1998).

With the free-market paradigm of the WTO food security has a different definition, and went from meaning the ever greater capacity in the developing countries to produce food for their own consumption, to meaning merely access to cheap food, supplied by the developed countries (Glipo, 2003).

For civil society, food sovereignty, as a different paradigm, is needed to ensure that the developing countries can attain food security, rural employment, and the development goals. For the developing countries, food sovereignty encompasses the demand that the WTO put an end to its control over food and agriculture. Food sovereignty basically recognizes that small farmers and landless peasants can never compete in the entrepreneurial agricultural paradigm (Glipo, 2003).

Among NGOs, defending food sovereignty is based on an across-the-board opposition to structural adjustment programs and to the model of export-oriented agriculture that they imposed on the developing countries in the 1980s. With the implementation of the Agreement establishing the WTO in the mid-1990s, this position was focused on the devastating impact of the WTO on the ways of supporting and assuring the food security of small farmers (Glipo, 2003).

To the extent that food sovereignty incorporates fundamental aspects of economic sovereignty, agrarian reform, women's rights, and the rights of small farmers, it has become a broader platform for those seeking fundamental changes in the national and world order. Some groups putting forth proposals for food security speak of the "right to food" (Glipo, 2003).

1.6.3. Economic context

It is generally accepted that economic growth is of fundamental importance in fighting poverty (Adelman, 1973; Dollar and Kraay, 2000). World Bank reports (2006) indicate that for every one percent of economic growth, poverty diminishes 1.25 percent. Nonetheless, in Latin America and

the Caribbean, economic growth has not been accompanied by a significant and lasting reduction in poverty and inequality (Fajnzylber, 1990; Korzeniewicz and Smith, 2000). At the same time, poverty has a negative and very significant effect on growth, and is also a significant factor in economic performance. On average, a 10 percent increase in poverty reduces annual growth 1 percentage point (World Bank, 2006). It is likely that an increase of the same magnitude is associated with a diminution in investment of six to eight percent.

As mentioned above, Latin America and the Caribbean is the region with the highest levels of inequality in the world (ECLAC, 2004). The wealthiest 10 percent of the population receives 48 percent of total income, while the poorest 10 percent receives only 1.6 percent. In the industrialized countries, the highest 10 percent receives 29.1 percent of the income, while the lowest 10 percent receives 2.5 percent.

A comparison among regions within countries reveals stark differences in levels of prosperity. In 2000, the per capita income of the poorest district in Brazil was only ten percent that of the wealthiest district; in the case of Mexico, per capita income in Chiapas was only 18 percent of per capita income in Mexico City. Regional differences account for more than 20 percent of inequality in Paraguay and Peru and more than 10 percent in the Dominican Republic and the Bolivarian Republic of Venezuela. In Bolivia, Honduras, Mexico, Paraguay, and Peru, the differences in the levels of poverty between different regions is more than 40 percent.

The impact of neoliberal globalization on the economy of Latin America and the Caribbean is a very controversial issue. On the one hand, the proponents of neoliberal restructuring argue that market-oriented reforms will eventually lead to economically sustainable growth, greater equity, and a better standard of living for the population. On the other hand, others argue that globalization is worsening the lives of millions of Latin Americans. More than an economic model, neoliberalism has been described as a mode of domination on a national and worldwide scale that stems from the restructuring of capitalist relations (Gilly, 2005). In the rural sector, the effects have been favorable for those who were already economically well off, but devastating for the most dispossessed; it has resulted in greater inequality and the continuation of poverty. These inequalities are expressed both among countries and among sectors within each country (Conroy et al., 1996; UNDP, 1999; Stiglitz, 2003). For example, the economic situation that the countries of the Caribbean are facing today, especially in the Lesser Antilles, is critical. The loss of the preferential treatment that had been accorded certain products of the Antilles by the European Union, and which was designed to provide economic support to the former colonies, will have a devastating impact on these Caribbean countries. The European Union, pressured by the World Trade Organization, will reduce the preferential price it pays for Caribbean sugar (Theodore, 2005).

In contrast with the neoliberal policies covering the region, centrist and center-left governments are drawing up proposals that point to an alternative path of inter-American economic cooperation. For example, the foreign ministers of the Caribbean countries have begun to draw up trade agreements with Mercosur and support the trade initiatives proposed by Brazil, which include technical assistance and cooperation programs in agriculture. Brazil has also offered the Caribbean countries generic drugs to fight AIDS. This is an important step, as the Caribbean is the region with the highest incidence of AIDS after sub-Saharan Africa. Recently, the Petro-Caribe agreement was signed between 13 Caribbean nations and Venezuela for obtaining Venezuelan oil. In addition, regional integration initiatives have taken place such as the "Caribbean Single Market" and the second CARICOM-Cuba meeting (Theodore, 2005).

Some countries of LAC are also putting up resistance to the negotiations of the World Trade Organization (WTO). At the WTO meeting in Cancún, Mexico, in 2003, the resistance of a coalition of Third World countries, including Brazil, Argentina, and Jamaica, brought about the collapse of the negotiations. The main demands of this coalition had to do with the exclusion of agriculture from free trade agreements (Narlikar and Tussie, 2004).

1.6.4. Political context

In LAC (with the exception of Cuba), neoliberal reforms have generated a mix of dispossessed, displaced, informal workers, and migrant workers forced to survive and adapt to a new reality of unemployment or underemployment, vulnerability, precarious conditions, and hunger. The masses of dispossessed, in both the countryside and cities of LAC, are organizing new social movements that are challenging the neoliberal regime. This new form of populism is expressed in the form of broad social movements that are beginning to have a major political impact in the region (Gilly, 2005; Dussel, 2007). For example, there is no doubt but that the Movement of Landless Rural Workers (MST: Movimento dos Sem Terra) had a major influence in the victory of the Partido dos Trabalhadores (Workers' Party) in Brazil. Nor is it questioned that the rise of the Zapatista movement in Mexico played a part in the defeat of the Partido Revolucionario Institucional (PRI), which had been in power for 79 years. In Bolivia, the indigenous movements brought an indigenous candidate to the presidency. These social-political movements without political party affiliations are changing the political landscape of the region, and turning Latin America to the left.

These movements are fostering internal changes that are important in the context of this evaluation. Among the most important issues are: (1) recognition of the rights of indigenous nations and the growing role that indigenous organizations are playing in national politics; (2) the importance of agrarian reform, and especially land redistribution; (3) access, control, and sustainable management of natural resources, including mining and energy resources and water; (4) food sovereignty; (5) access to education and health services; and (6) gender equality.

In Latin America, the indigenous peoples live inside and outside protected areas, in tropical forests and in intertropical rural areas. Most live in marginal rural areas (Toledo, 2001). Their communities, territories/lands, and natural resources continue to be subject to several pressures as well as a growing demand on the part of forces internal and external to their local communities (Smith, 2002; Kearney, 1996). Internal ones include the growing demand for coverage of basic needs (health, food, employment). External forces include national and international capital, *colonos*, illegal hunters, government policies and laws, and conservation organizations. This situation suggests, significantly, that the contemporary neoliberal policies of the nation-states of the region, and the respective democratic regimes, among other things, (a) have not put in place or facilitated clear and coherent policies, institutions, and spaces for the participation of the indigenous peoples in rural/agrarian development, and in the economy and society; and (b) have not supported, in a sustained and significant fashion, the strengthening of indigenous institutions, leaders, and sages. All of this has continued perpetuating the marginalization and oppression of the region's indigenous peoples.

1.6.5. Environmental context

1.6.5.1. General aspects of the environmental context

Latin America and the Caribbean is well-known for its extraordinary biodiversity, containing five of the ten countries in the world with the highest biodiversity (Dixon and Gulliver, 2001); it has 40% of the world's plant and animal species (UNEP, 1999). It is considered the world's leader in floristic diversity (Heywood and Watson, 1995) and in avian diversity (UNEP, 2006). While 11 per cent of the terrestrial area of Latin America is officially under protected status (World Bank, 2006), many protected areas exist on paper only, and consequently much of the area's biodiversity is highly threatened. Almost half of the ecoregions of Latin America and the Caribbean (82 of 178) are considered critical or endangered in conservation status (Dinerstein et al., 1995). Some 873 vertebrate species in Latin America are currently estimated to be threatened with extinction, and six of the 12 countries with the highest number of globally threatened bird species are found in the region (UNEP, 2002).

The Latin American region possesses 28 percent of the world's forest area, almost a billion hectares in total (World Bank, 2005b); it contains the vast majority (68 percent) of the world's tropical rain forests (UNEP, 1995). Deforestation has accelerated precipitously since 1950. It has been primarily caused by agriculture (Millennium Ecosystem Assessment, 2005a), and cattle production has been the major driver for the region as a whole (Angelsen and Kaimowitz, 2001; Ledec, 1992). The overall annual deforestation rate from 2000 to 2005 in the region is estimated at 0.51 percent (World Bank, 2005b), but there is considerable variation across the region (Table 1.6). Historically the highest absolute amount of deforestation has occurred in South America, driven by deforestation in the Amazon; from 1981 to 1990, 6.2 million hectares were stripped of

forest annually in South America. Nevertheless, the highest rates of deforestation have consistently been found in Central America and Mexico, where deforestation in the same period reached 1.5 percent annually, compared to 0.7 percent in South America. In the Caribbean, most deforestation occurred in the 1800s, and with a few exceptions (particularly the Dominican Republic), most primary moist forest suitable for agriculture had already been converted prior to the middle of the last century (Toledo, 1992; Myers, 1980). In the last decade of the 20th century, the rate of deforestation slowed throughout the region, but this slowdown was marked in South America (to 0.44 percent annually), and barely registered in Central America and Mexico, which still racked up 1.47 percent annual deforestation in that period. During this decade, forest area actually grew in the Caribbean (at 0.1 percent annually), driven by a rise in forested area in Cuba. It is notable that both the absolute and relative rates of deforestation in Latin America and the Caribbean during the 1980s are much higher than any other region of the world, but by the 1990s Africa had surpassed Latin America in both hectares cleared and annual deforestation rates (Barbier, 2004).

(Insert Table 1.6: Extent and exchange of forest area in Latin America, 1990-2005)

Latin America and the Caribbean are considered to have the most diverse freshwater ecosystems in the world. The region is home to one-quarter of the world's species of fish, with areas of high endemism. The Amazon in particular is noted for high freshwater fish biodiversity, and tropical South America in general is a hotspot for amphibian diversity. The Caribbean and Central America are noted for their outstanding coral reefs. The Mesoamerican Reef, off the Caribbean coasts of Mexico, Belize, Guatemala, and Honduras, is the second longest barrier reef in the world and is one of the most diverse coral reefs in the western Atlantic. Home to over 500 fish species, 66 stony coral species, and the largest population of endangered manatees in Central America, the reef is also the basis of much of the region's economy (Kramer and Kramer, 2002).

In terms of natural resources of importance to agriculture, the region has relatively favorable endowments compared to other areas in the developing world. It has almost half of the world's total renewable water resources, and some 90% of the land area falls in the humid or sub-humid zones. While overall the region is relatively wet, there are several areas where drylands predominate, principally in northern and central Mexico and the coastal and inland valleys of Peru, Chile, and Western Argentina, Northeast Brazil and the Yucatan Peninsula, and the Gran Chaco area of Paraguay, Bolivia, and Argentina. In total, drylands comprise some 15 percent of the region (FAO, 1998). Natural grasslands or savannahs, many of which are relatively dry, are found in much of Argentina, as well as central-western and southern Brazil, Uruguay and parts of Colombia, Venezuela, and Guyana. Crops occupy around 160 million hectares of the region,

while another 600 million hectares are dedicated to pasture and grazing land (Dixon and Gulliver 2001).

Latin America and the Caribbean is the region with the greatest reserve of arable lands in the world. It is estimated that in LAC, 576 million hectares, or the equivalent of 30% of the territory, has agricultural potential (Gómez and Gallopin, 1995). Nonetheless, due to poor soil management and the use of marginal areas for agriculture, the region has approximately 300 million ha of degraded agricultural areas (FAO, 1998), while another 80 million ha of dry lands are threatened with desertification due to overgrazing, overexploitation of the vegetation for domestic uses, deforestation, and the use of inappropriate irrigation methods. This means that more than 50% of the total agricultural area (including pasturelands) is impacted by degradation. Erosion, acidification, loss of organic matter, compaction, impoverishment of nutrients, salinization, and soil contamination are consequences of the intensification of agriculture through the intensive use of agrochemicals, fertilizers, and pesticides, as well as the use of inappropriate irrigation technologies and agricultural machinery. Deforestation has contributed to soil degradation, especially in the moist tropical zones, such as the Amazon and the Atlantic coast of Central America (GEO, 2005).

Erosion is the main cause of degradation of the land in Latin America, and affects 14% of the territory of South America and 26% of Mesoamerica (Oldeman, 1994). This problem is especially serious in areas with steep slopes such as the Andean region (central and north), as well as the maize and bean zone of Mesoamerica. In these zones, erosion is causing low levels of production and helping spur the migration of small producers to the cities or the agricultural frontier in forested zones, contributing to soil degradation in these zones (FAO, 1998). This process is occurring in other steep sloped zones such as the Chiapas highlands in Mexico (Richter, 2000).

Nutrient attrition is another very serious problem that results from the intensification of agriculture and especially the use of synthetic fertilizers. In South America, nutrient attrition affects at least 68 million ha (Scherr and Yadav, 1997). Nutrient attrition may also be a consequence of deforestation in moist tropical zones. The conversion of forest to crops in these areas has brought about a loss of organic matter and has accelerated erosion while also increasing the sediment load in rivers and lakes (FAO, 1998).

Chemical contamination of the soil and water also stems from the technologies used in intensive agriculture, which have increased in the last 30 years. Nitrification of the soil and water is directly related to the use of chemical fertilizers (GEO-Global Environment Outlook, 2005), and in LAC the use of fertilizers increased from less than one million tons in 1961 to more than 13 million tons in 2003 (FAOSTAT, 2005).

1.6.5.2. Climate change and agriculture in Latin America and the Caribbean

Latin America and the Caribbean is a very heterogeneous region in terms of climate, ecosystems, and population distribution. Nonetheless, most productive activities are based on natural ecosystems, and this land use interacts in a complex way with climate. Due to this complexity and the heterogeneity that characterizes the region, it is difficult to identify the effects of and vulnerability to climate change in the region. The Third Report of the Intergovernmental Panel on Climate Change (IPCC, 2001) concludes that the main patterns of climate change in the region are an increase in average temperatures, mainly in medium and high latitudes, and changes in the rate of precipitation and intensity of rainfall in several countries of the region. Also predicted, with a certain degree of uncertainty, is an average rise in sea level of 5 mm per year. The IPCC (2001) also identifies the following sectors as those that will be most impacted by climate change in LAC: natural ecosystems (e.g., forests, wetlands, savannahs), water resources, coastal zones, agriculture, and human health. Although Latin America accounts for only 4 percent of global emissions of greenhouse gasses, the potential impacts of climate change in the region may be considerable and very costly, in both economic and social terms. In addition, the carbon emissions that result from massive deforestation in Latin America have the potential to change the carbon balance globally.

Most productive activities in LAC depend on the availability of water, such that any climate change that results in a shortening of the rainy season, greater variability of precipitation, and/or greater frequency of years without rain will have extremely negative consequences for the region (IPCC, 2001). Mexico, in particular, will be very significantly affected by drier and hotter climatic conditions as it is already suffering from very little and highly variable precipitation (Liverman and O'Brian, 1991). The Brazilian Northeast is another region highly vulnerable to drought caused by climate change. Under different climate change scenarios, global models project reductions of up to 53 percent in the yields in this region (Rosenzweig et al., 1993), in which it will be common for there to be years in which it doesn't rain and the population suffers hunger and is forced to migrate (Magalhães and Glantz, 1992).

Another effect of climate change on the productive activities of the region has to do with the effects of the Southern Oscillations, El Niño. Although there is no consensus on the effect of climate change on the El Niño phenomenon in the long term, in the short term an increase is reported in its frequency and intensity (IPCC, 2001). In Central and South America, the relationship between El Niño and changes in precipitation is well-documented. El Niño is associated with massive fluctuations in the marine ecosystems of the western coast of South America (Ecuador, Peru, and Chile), adversely affecting fishing, and taking a devastating socioeconomic toll on the communities that depend on this activity (Pauly and Tsukayama, 1987; Sharp and McLain, 1993). In 2001, El Niño caused severe droughts in Central America and northern South America, with damages estimated at US$ 189 million, 66 percent of these in

agriculture, and affecting 600,000 people in Central America, mostly small producers, who suffered due to the lack of food and were forced to migrate (ECLAC, 2002).

Hurricanes and tropical storms also have a devastating effect in the region. Central America and the Caribbean are the regions hardest hit by these climatic events. In this region, 18 hurricanes and tropical storms were detected from 1960 to 2001 (CEPREDENAC, 2007). Hurricane Mitch, in 1998, is considered the most devastating hurricane to hit the Central American region (Pielke et al., 2003), causing total damages amounting to US$ 6 billion, half resulting from losses in agriculture (CEPRENEDAC, 2007).

It has been said that carbon dioxide has a fertilizing effect that could benefit agriculture, increasing crop yields. Nonetheless, studies in Brazil, Chile, Argentina, and Uruguay, based on climate change models and crop models, predict reductions in the yields of several crops (e.g. maize, potato, soy, and wheat), even taking into consideration fertilization with carbon dioxide and moderate adaptations by producers (IPCC, 2001).

The projected climate changes may also have a negative impact on productive activities through their effect on human health. For example, an increase in temperature and precipitation is predicted that could expand the range of vector-transmitted diseases (e.g. malaria, dengue, leishmaniasis, Chagas' disease) and infectious diseases (e.g. cholera), making it possible for them to become established to the south of their current range, and at higher elevations (WHO, 1996).

The effects of the increase in the sea level include a greater risk of flooding in the coastal zones of Central America, South America, and the Caribbean, and the possible loss of land area. Although the loss in land area could represent a small proportion of the national territory (except in the Caribbean), it may have a major impact in areas where large populations, tourist centers, and infrastructure are located (e.g. ports) (IPCC, 2001).

The Report by the IPCC (2001) concludes that the alterations resulting from climate change have a high potential to impact negatively on the way of life of subsistence farmers and pastoralists who live in the high Andean planes and tropical and subtropical forests. Despite the grave socioeconomic impacts associated with climate change in the region, the governments have done very little to implement risk management strategies or adaptive systems to cushion the negative effects on productive activities in the region. In Brazil, drought forecast systems have been implemented that have succeeded in reducing the negative impacts of droughts. There are also experiences in Central America involving the resistance of agroecological systems to the impacts of tropical storms (Holt-Giménez, 2002; Box 1.1).

(Insert Box 1.1: Resistance of agroecological systems to the impacts of Hurricane Mitch)

1.6.6. Cultural context

Latin America and the Caribbean are characterized by having three major cultural influences, the indigenous, the African, and the European (mainly Spanish and Portuguese). The word "agriculture" emphasizes the overarching role of culture in this type of production. All the cultures, both those existing and those already lost, have impacted the region's production systems to a greater or lesser extent. Nonetheless, the agriculture practiced by most small producers in the region is highly influenced by the indigenous cultures.

The indigenous population of LAC accounts for about 10% of the total (IDB, 2004; Hall and Patrinos, 2006). The ethnic and cultural diversity of indigenous groups in Latin America is estimated at more than 400 ethnic groups (Deruyttere, 1997) or 800 cultural groups (Toledo, in press), the largest percentages being in Bolivia (70 percent), Guatemala (47 percent), Ecuador (38 percent), and Mexico (12 percent). One important aspect of the relationship between agriculture and the cultures is the relationship between biodiversity and cultural diversity. In LAC, cultural diversity is highly correlated with agrobiodiversity in general. The region has two centers of the origin of genetic diversity – in the territories that are today Mexico and Guatemala, and Peru and Bolivia (Possey, 1999; Diversity 1992). The lands/territories of the indigenous peoples intersect/overlap to a large extent with the areas recognized as biologically megadiverse. The indigenous peoples live in 80% of the region's protected areas (Colchester and Gray, 1998). In Central America the percentage increases to 85% (Oviedo, 1999). Toledo (2003), for his part, notes that nearly 60% of the areas in central and southern Mexico recommended for protection are inhabited by indigenous peoples.

Biodiversity constitutes an irreplaceable common patrimony of humankind, the result of prolonged and ceaseless evolutionary processes, that is fundamental for socioeconomic development and for the very survival of humankind. The ethnic groups, Afrodescendant communities, and peasant communities in LAC hold a large part of the cultural patrimony represented in the systems of knowledge, innovations, and millenary practices of integral and sustainable management in their territories associated with biodiversity (Barrera-Bassols and Toledo, 2005; Toledo, in press). Just as the biodiversity is threatened, the cultural integrity of ethnic groups is seriously threatened. Cultural erosion, the loss of land and the loss of control over their territories by these communities occur with ever greater frequency and intensity, which no doubt has a detrimental impact on the cultural patterns and appropriation of their traditional habitat.

The Green Revolution transformed the traditional agricultural culture. For thousands of years farmers, mainly women, have taken it upon themselves to select and save seeds to create, literally, thousands of 'local varieties' of food crops adapted to the conditions and preferences of each place. When the Green Revolution swept across the countries of the south, the diversity that

these farmers had been caring for began to weaken. The local varieties can only survive in interaction with persons, and disappear if not preserved and planted. In the words of the Ecuadorian indigenous woman Marcela Machaca Mendieta, of the Asociación Bartolomé Aripaylla in her paper "Planning and the Andean Experience," presented at the Fourth Academic Unit of the Master's program in Biodiversity and Andean Amazonian Peasant Agriculture (Universidad Nacional Agraria De La Selva, Graduate School, Andean Peasant Technology Project) in Quito: "The key point of this intervention is rural development, which was designed to force Andean peasant communities to convert their agriculture from self-sufficiency into homogeneous, market-dependent agriculture, so as to convert the culture of reciprocity into a monetized economy. Of course, instead it succeeded in increasing the vulnerability of the Andean ecosystems." She then refers to the following assertion by the UNDP in 1997: "The second Green Revolution– for the poor peasants on marginal lands – should not be a copy of the first. It should seek environmental sustainability, low-cost inputs and greater yields for the smallholdings, and reduce to a minimum the risks…. It should be focused less on crops and more on systems, on finding the way to diversify production and use the various resources available."

The cultures of the indigenous peoples and Euro-American societies, and of the westernized/modernized societies, are immersed in two profoundly different ways of knowing (epistemologies), of being (ontologies), and of relating to the world (cosmovision/world view). In the words of Jorge Ishizawa, coordinator of the Andean Peasant Technologies Project (PRATEC) in Peru "... an epistemology for cultural affirmation should be geared to supporting the elaboration of an interpretation of a cosmovision radically different from the modern western cosmology, in this case, the cosmovision of the peasant breeders of biocultural diversity."

After more than three decades of political struggles – local, regional, national, and international – the indigenous peoples have become actors known in their own terms, without mediation, or mediators, in the political arena. Their rights, albeit very slowly, and still more on paper than in practice, are recognized by the United Nations (Farmers' Rights, Convention on Biological Diversity, ILO Convention 169), by financial and development organizations (World Bank, Inter-American Development Bank, USAID, European Union), and by international conservation organizations (World Wildlife Fund (WWF), World Conservation Union (IUCN), The Nature Conservancy (TNC)). A number of countries of the region have adopted and ratified ILO Convention 169 on Indigenous and Tribal Peoples (http://www.ilo.org/public/spanish/standards/norm/whatare/stndards/indig.htm

or http://www.ilo.org/public/english/standards/norm/whatare/stndards/indig.htm), which could significantly benefit the communities of indigenous peoples. Nonetheless, the states of the region, which are members of the United Nations, do not display a coherent, significant, and clear

will to implement, in practice, this Convention in their respective countries.

1.7. Recent Evolution and Current Situation of Agriculture in LAC

1.7.1. Importance of agriculture to Latin America and the Caribbean

In the last 50 years agriculture has contributed only 10 to 12 percent of GDP; it has been secondary to other productive activities. Nonetheless, agriculture still represents a key sector of the Latin American economy, as it accounts for a large part (30 to 40 percent) of the economically active population. In those countries that lack minerals and oil, agriculture represents the main source of exports and foreign exchange. Agriculture is a relatively more important part of the economy in the Central American countries than it is for Latin America generally. While agriculture only contributed 8% of GDP in 1998 in Latin America overall (Dixon and Gulliver 2001), in Central America in 2000 agriculture contributed from a low of 7% of GDP (in Panama) to a high of 36% (in Nicaragua). The importance of agriculture as a generator of foreign exchange is even more significant. In 2000, agricultural exports ranged from a low of 30.8% of total exports of goods in Costa Rica, to a high in Belize of 69.4% of total exports (Harvey et al., 2005). Finally, in most Latin American countries, agriculture represents a subsistence way of life for millions of persons, and for indigenous communities (Baethgen, 1994; IPCC, 1996).

The current status of agriculture in Latin America and the Caribbean, in terms of production and productivity of goods and services in relation to expectations for attaining the millennium goals, is not uniform across the region. This heterogeneity in levels of productivity and productive capacity of the agriculture, forestry, and fisheries sectors in the region is explained in part by the prevalence of undernourishment in a large number of countries of the region. There is an inversely proportional relationship between the levels of food production and levels of undernourishment. Group I countries (with undernourishment of 0%-10%), have 400% greater per capita food production than the group II countries (undernourishment of 10%-20%), and 320% greater per capita food production than the group III countries (undernourishment 20%-65%).

The heterogeneity in levels of agricultural knowledge has also been an effect of the structural reforms carried out in the region. In the last 25 years most of the countries of the region began or intensified their processes of adjustment and structural reforms, as a result of which they experienced major changes in their structure of production, productivity, competitiveness, and in the profitability of various activities, including agriculture, at the same time as the structural heterogeneity of agriculture has deepened (Beatriz et al., 2005).

It should be noted that it is practically impossible to establish typologies of development models by country, as one finds the coexistence of very different and more complex situations than in the rest of the economy, given the major differences between and within the countries. The

differentiation of the growth model has occurred within the countries, with repercussions both on the specially located dynamic poles and on the type of activities and actors.

1.7.2. Characteristics and changes in production in Latin America and the Caribbean

1.7.2.1. Available resources

1.7.2.1.1. Natural resources

Agriculture produces unprocessed agro-food products using natural resources (land, rivers/lakes/oceans, air) as one of the factors of production, and the process may involve "cultivation" (planting, aquaculture, stock-raising, forestry) or "gathering" (hunting, fishing, forestry) (Dirven, 2004). The peoples of LAC live in a territory in which 25% of the world's forests and 40% of the world's biodiversity are to be found, and its auriferous basins contain 35% of the world's hydroenergy potential (OSAL, 2005). The water and soil, key elements in agricultural production, may or may not be considered renewable resources, depending on their degrees of cultural management. In any event, they constitute the main limitations on or potential for agriculture at this level (León, 2007).

Land – Latin America and the Caribbean has approximately 30 percent of the world's arable land; in contrast to other regions of the world, it has kept a large percentage of these in natural systems (UNEP, 2002).

Water – (NOT DONE)

Biodiversity - Biodiversity is an irreplaceable common patrimony, the result of prolonged and unceasing biological and cultural processes of evolution, that is fundamental for socioeconomic development and the very survival of humankind.

Large ecoregions stand out in LAC that are home to a diversity of soils, major water sources, and perhaps the greatest diversity of plant species on the planet, such as the Andean Cordillera, the Amazon basin, and the Biogeographic Chocó.

Central America and the Amazon are the most extensive areas of the planet in terms of biodiversity, not only because of the tropical area they occupy, but also because of the presence of the arch of the Andean cordillera, which determines the upper courses of the rivers that form the Amazon basin, and the whole sierra that joins South America and North America, the Sierra Madre that runs through Central America, such that these regions host different altimetric gradients making possible a great diversity of cultivated species (Porto, 2006). The greatest agricultural development in LAC has taken place in the Andes. Conventional/industrialized agriculture has been developed mainly in lowlands, inter-Andean valleys, and altiplanos, where one finds the most fertile lands, sources of water, and flat to undulated topographies. The small

and medium producers have been displaced little by little to the slopes of the mountains, where the soils are poor, subject to erosion, and hard to work.

The Amazon jungle, which extends through the Guianas, Venezuela, Colombia, Ecuador, Peru, Bolivia, and mainly Brazil in an area encompassing eight million km^2, is considered an immense "green ocean " responsible for the evapotranspiration that produces a dynamic equilibrium for the hydrology of the whole planet, an environmental service from which all humankind benefits (Porto, 2006). In general terms, it is recognized that it is not suited for agriculture, due especially to the fact that its soil characteristics are truly unfavorable for the growth of many crops, yet on the whole is it a highly efficient system for recycling organic matter, hence its biodiversity is so high (León, 2007).

The ecoregional complex known as the Biogeographic Chocó, one of the regions with the greatest biodiversity in the world, extends form northwestern Ecuador to southwestern Panama, and along the entire Pacific coast of Colombia, covering approximately 145,000 km^2. It has forest cover in 85% of its territory, and is not especially suited for agriculture. Its value lies in the high biological diversity it hosts and its large number of endemic species: up to 400 trees and 800 vertebrates per ha; and 7,000 to 8,000 plant species and 100 bird species not found anywhere else on earth. In addition, it is one of the most diverse regions of Latin America from the cultural point of view (León, 2007; WWF Colombia, 2007). Despite its limited suitability for agriculture, it has about 18,000 ha with large and medium African palm plantations along the Mira, Guanapi, and Mataje rivers (León, 2007), in collective territories of Afrodescendant communities that have been forcibly displaced by paramilitary violence.

Hydrobiological resources represent another component of South America's biodiversity, with approximately 3,000 fish species. Nonetheless, very little is known of the biological cycle of the fish species dependent on the water cycle, and even less of the zooplankton and phytoplankton of the continental and marine waters (Bernal and Agudelo, 2006).

Agrobiodiversity - The biodiversity of plants in fields under cultivation also corresponds to the different cultural diversities and economic conceptions of agriculture. Albeit with some degrees of disappearance of symbolic links, it is still possible to find indigenous peoples and groups of peasants in LAC who are descendants of native inhabitants who maintain in their agricultural work important vestiges of the original heterogeneity of plant life (León, 2007).

Mesoamerica and the Andes are two major centers of origin of domesticated plants, many of which are now of global importance. Maize and beans are the most prominent of these, but the list also includes potatoes, sweet potatoes, tomatoes, cassava, chili peppers, gourds, squashes, avocado, cotton, and peanuts. Wild ancestors have been discovered for some of these crops, such as maize. There is also significant genetic diversity across the region that has been

developed since the introduction of non-native crops such as banana and sugar cane. With a few exceptions, the region's agro-biodiversity is not well studied.

Maize (*zea mays*) is one of the most significant crops that originated in the Americas; it is now the most widely grown crop in the world. Due to its ability to grow under highly varied climatic conditions, it is grown in at least 164 countries worldwide (Global Crop Diversity Trust, 2007). Mexico is the center of origin and the center of diversity for maize, with more than 60 landraces and numerous local varieties, as well as the wild relatives of maize, the teosintes. Mexico provides one of the earliest examples of deliberate conservation of wild crop relatives *in situ*; the existence of teosinte was the primary reason for the creation of the Sierra de Manantlán Man and the Biosphere Reserve there in 1988 (Iltis, 1994; Meilleur and Hodgkin, 2004).

The common bean (*phaseolus vulgaris*) appears to have been domesticated separately in Mesoamerica and in the Andean region. Wild gene pools are also concentrated in these areas. Mesoamerican cultivars dominate global production; some 60% of beans produced throughout the world are of Mesoamerican origin. Common beans are the world's most important legume food crop and are particularly important for human nutrition because of the high protein content, which is roughly double that of most cereals (Beebe et al., 2000).

Relatively few animals were domesticated in the new world; only one, the turkey, has spread significantly beyond its native habitats in Mesoamerica and the present-day United States. The llama and alpaca, domesticated in the Andes, still play an important role in Andean society, as does the guinea pig, domesticated for food. The Muscovy duck was also domesticated in South America. Wild relatives of some of these animals, particularly the wild turkey and the vicuña, which is related to llamas and alpacas, are still to be found in the areas where they were domesticated (Hieser, 1990).

The agricultural genetic resources of the Latin American region are enormous. As one of only a few places where agriculture was independently invented, and the center of origin of many of the world's major food crops, the area retains numerous landraces, local varieties, and wild relatives of great importance to the future development of agriculture worldwide.

1.7.2.1.2. Economic resources

As a result of the structural adjustment processes in the context of globalization, changes have taken place in the agricultural sector in LAC that have had a differential impact on the population in three ways: changes in incomes as there have been changes in wages, employment levels, and the prices of goods, especially essential goods, such as food items; changes in the levels and composition of public spending, especially social spending; and changes in working conditions, such as type of contracting, hours, and social security. The changes have included greater differentiation in the conditions of production between small and large producers, and

there are fewer agricultural jobs, with adverse results for many sectors due to the increase in poverty and inequality in the rural world.

Among the causes of the reduction in employment, Da Silva (2004) cites increases in labor productivity, relative stability of the agricultural frontier, and the expansion of stock-raising and forestry, which do not require much labor. Other categories that have been expanding (such as fruit crops, vegetable crops, and poultry) are using ever more contract agriculture, which is based on more capital and also reduces employment (Da Silva, 2004).

According to several sources compiled by David et al. (2001), cited by Da Silva (2004), approximately 66 percent of the poor who live in the rural sectors – 47 million people – are small producers, 30 percent are landless rural dwellers, and the remaining 4 percent are indigenous groups and others. Of the small producers, at least 40 percent are small-scale farmers with little if any access to loans, technical assistance, or agricultural support services, and little capacity to purchase land.

Recently what various observers have called the multifunctional nature of agriculture and the rural space has emerged, in which the rural space performs not only an economic function of producing food, but also a social function related to the well-being of rural communities, and an ecological function described as the possibility of providing environmental services to society as a whole, including the other sectors of production (Chaparro, 2000).

Recent research has shown exhaustively that agricultural activities are being reduced in the rural areas, in terms of the number of persons involved and the income generated, while non-agricultural activities are increasing, in particular those tied to the provision of services. For these reasons, the families that live in areas defined as rural increasingly abandon exclusively agricultural activities to seek other opportunities (Da Silva, 2004; Dirven, 2004). These phenomena are responsible in part for rural-urban migration, but they are not the only factors contributing to it. The expansion of large transgenic monocultures in the Southern Cone countries is transforming the agrarian structure, increasing the concentration of land and the migration of peasants. In addition, violence reflecting territorial interests is causing massive forced displacement, as in Colombia and Ecuador.

The financial sector plays a role in activities related to rural employment, favoring non-agricultural activities, which vary from country to country, and depend on the ties between non-agricultural rural employment and other sectors of economic activity. In an IDB document on rural financing strategies cited by da Silva (2004), it was recognized that the non-agricultural rural sector is an increasingly important part of the rural economy and accounts for a growing part of rural income and rural employment. Most of the document posed the need to develop financial services other than short-term loans so as to specifically increase productivity and the possibilities of expanding non-agricultural services and manufacturing and processing plants. The main conclusion of the

document was that rural financial markets do not operate properly in Latin America and the Caribbean, and that the underdevelopment of these financial markets has a negative impact on those investments that aim to bolster productivity, expand incomes, and spur sectoral growth (Da Silva, 2004).

Fishing is also an important economic activity in LAC generating employment and incomes, in which the Southern Cone countries account for most of the catch offloaded. Inland fishing, developed on an artisanal basis by those who live along the rivers of fresh water ecosystems, is considered to have attained its maximum sustainable yields with some resources that are undervalued and subject to the threat of alterations to the habitat, its degradation, and unsustainable fishing activities, based on just a few species, generally migratory ones, that are sold in the domestic market of each country (Coates, 2002; Bernal and Agudelo, 2006). Urban, industrial, and agrochemical expansion diminish fishing yields by impacting the life cycles, well-being, and aquatic diversity, increasing the instability of the ecosystem, and reducing the quality and safety of the foods extracted or produced (Bernal and Agudelo, 2006).

1.7.2.1.3. Technological resources

Agriculture is experiencing major changes, leading to the rise of new scientific and technological paradigms that are transforming the dynamics of agricultural production, which can be grouped in three major areas: the new biotechnologies, sustainable development models, and the new information and communication technologies. The new biotechnologies are constituted by a set of techniques that operate at the subcellular level and make it possible to directly manipulate the genetic characteristics and process of reproduction of living beings. The main ones are: in vitro tissue cultures; molecular markers; genetic engineering, by which transgenic crops are produced (mixing genetic matter of different species in a way that would never be done by nature); monoclonal antibodies; and bioprocesses.

These recent technological developments, especially in the field of the new biotechnologies, have created conditions that favor the private appropriation of knowledge, given their complexity, requirements for multiplication, and high relative cost. This new situation has led to massive private investments in activities associated with the conservation, improvement, and industrial production of biological resources and agricultural technologies, especially by transnational companies involved in the production of agricultural inputs. This is leading to a radical change in the balance of these two sectors. For example, 85% of current global investment in agricultural biotechnology comes from private interests. Two key controversial issues have arisen in this new context, involving intellectual property and access to genetic resources (Chaparro, 2000).

The second scientific and technological area includes the proposals for alternative forms of agriculture, with proposals for ecological agriculture as an approach that integrates principles, has

to do with the sustainable management of the natural resource base (water, soil, biodiversity), and is distinguished from the agriculture of the Green Revolution by its scientific, socioeconomic, political, and cultural approach (León, 2007).

Information and communication technologies constitute the third scientific and technological area that is profoundly transforming agriculture and giving rise to multiple applications with a direct impact on agricultural production and the management of natural resources. These are a set of technologies related to the processing and dissemination of information and knowledge, using Internet tools, which are important in education and for the broad and swift dissemination of the processes of globalization and its effects (Chaparro, 2000; Farah, 2004a).

1.7.2.1.4. Labor

Worldwide, it is estimated that the urban population is on the way to increasing from one-third of the world population in 1975 to two-thirds in 2020. These high rates of urbanization are changing the structure of demand for food towards the consumption of processed foods with some type of value added, which fosters greater demand for non-agricultural labor (Chaparro, 2000).

As a result, agricultural employment dropped in almost half of the Latin American countries, while non-agricultural rural employment continued to increase in all of them. According to data taken by ECLAC from Latin American censuses, non-agricultural rural employment climbed during the 1970s and 1980s at an average of 4.3 percent annually, while the economically active population in agriculture rose only 0.03% per year. In the 1990s, non-agricultural rural employment once again increased appreciably (Dirven, 2004).

The main type of non-agricultural rural employment varies across the different income strata. Middle income households work mainly in non-agricultural endeavors, high-income households are mainly self-employed in non-agricultural rural activities or have small and medium enterprises that perform the same type of work, while most poor families perform agricultural wage labor that does not enable them to emerge from poverty, and obtain some additional non-agricultural income from crafts or small-scale commerce (Dirven, 2004).

Working conditions (whether formal or informal; reproductive, productive, or community; remunerated or non-remunerated) have changed visibly with globalization, and clearly reflect the inequalities and widening gap between rich and poor. In the processes of internationalization, work is valued on a purely mercantile basis, using the criterion that value is to be found in those things that can be bought and sold, which can be assigned a monetary value. For women, especially rural women, a considerable part of their work is not seen as economically productive, as it does not fit within the logic of the market, i.e. it takes place in the context of an economy without wages or prices, and its objective is to generate products and services for household consumption (Farah, 2004a).

In the greenhouses for flowers and vegetables in Ecuador, Guatemala, Mexico, and Colombia, for example, labor is mostly female, and the contracts are short-term but renewed time and again. In Colombia, 80% of the flower workers are women, and they generally earn the minimum wage, which covers only 45% of a family's basic needs. In Chile, Argentina, and Brazil, women are contracted for seasonal positions in the production of fruit for export. Thus, for example, the employment of women in the fruit sector in Chile quadrupled from 1982 to 1992, and was concentrated in temporary jobs, such that 75% of women in the agricultural sector in Chile work under temporary contracts, harvesting fruit more than 60 hours a week during the harvest season. Of these women, one in three earns less than the minimum wage.

Alongside this difficult context, fishing is also being developed; it continues to be one of the central components of certain local economies in many parts of Latin America, especially in the Amazon, in terms of both the value of output and employment. Bernal and Agudelo (2006) cite FAO figures according to which there are, at present, more than 38 million persons directly employed in fishing and fish farming working full days or part days; the developing countries currently supply 70% of the fish for human consumption.

1.7.2.2. Regional trends

The region has a total of 2.018 billion ha, of which approximately 726 million ha (i.e. 36%) are under agricultural production, including seasonal crops (7.1%), permanent crops (about 1%), and pastureland (about 30%). In the last 15 years, the total agricultural area increased 4.5 percent, while the total covered by forest (including forest plantations) diminished 1.3 percent. The area under permanent crops such as cacao and coffee experienced the greatest increase in area, 10.5 percent.

The change in land use varied by region (Table 1.7). Figure 1.3 shows the increase in the total area under agricultural production by region from 1961 to 2003. The Southern Cone, the largest region in area, also saw the greatest increase in area planted. In the three decades from 1961 to 1990, the area under production increased by 27%. Although the rate of increase has diminished, since 1990 there was a 6% increase in the region; Brazil, French Guiana, and Paraguay are the countries that saw the largest percentage increases. Suriname, Argentina, Uruguay, and Guyana have experienced almost no change since the 1990s, while Chile suffered a decline of almost 6% in the total area in agriculture.

(Insert Table 1.7: Land use by region)

(Insert Figure 1.3 Change in land use in the 4 geographic regions)

The main change in land use in the Southern Cone has been due to the increased production of soy (Figure 1.4), especially in Brazil and Argentina; the total area planted in soy was almost 47 million ha in these two countries alone, which represents 8 percent of the total agricultural area of the Southern Cone (including pastureland) (FAOSTAT, 2005). In Brazil, the expansion of soy has occurred at the expense of natural vegetation and more recently of the tropical forest in the Amazon (Fearnside, 2001), while in Argentina the increase in soy has been at the expense of the production of milk, maize, wheat, and fruit crops (Jordan, 2001; Pengue, 2005). The expansion of this crop has also accelerated deforestation indirectly by means of the construction of railways, and an extensive network of highways that attract cattle growers, mining companies, and logging interests to the Amazon jungle, and by displacing small producers (Fearnside, 2001).

(Insert Figure 1.4: Area planted in soy)

Another major change in this area has been the expansion of stock-raising in Brazil. Brazil has increased its cattle herd by 122 million animals in the last 15 years (an 83% increase) and today has 269 million animals (Figure 1.5). This expansion has also taken place at the cost of the Amazon forests. According to Giglo (2000), the expansion of cattle in Brazil (and Bolivia) was facilitated by tax incentives put in place by the governments (for example, the “Amazonas Legal” program in Brazil) and the availability of cheap labor.

(Insert Figure 1.5: Cattle, Southern Cone)

The total agricultural area in Mesoamerica increased almost 9 percent from 1961 to 1990, but only 4 percent since 1990 (Table 1.7). Though initially Belize, Costa Rica, and Guatemala contributed considerably to the increase in agricultural lands in the region, since the 1990s Belize, El Salvador, and Nicaragua have experienced the greatest increases (27 percent, 19 percent, and 11 percent, respectively). Surprisingly, Honduras has been experiencing a decline in agricultural lands since the 1990s; its agricultural area has diminished almost 13 percent. This is mainly due to the decline in banana production, which was Honduras’s main export during the first half of the 20th century, but which began to fall as the result of a combination of diseases, labor organizing, and globalization (Soluri, 2005).

The Andean region shows a similar pattern of change as Mesoamerica (Figure 1.3), with an increase in the total agricultural area of 16 percent from 1961 to 1990, and 4 percent since 1990.

Ecuador is the country with the greatest change in the first three decades (65%), but it increased only 4 percent since 1990, whereas Peru saw an 11 percent increase in the same period. The other Andean countries, with the exception of Venezuela (which has seen almost no change in its total agricultural area since 1990), have seen increases of 2 to 5 percent.

The Caribbean is the region with the smallest area in LAC. This region experienced a 35 percent increase in the area planted; Cuba is the country that contributed most to this increase. In the first three decades of the Cuban Revolution, it expanded its agricultural area 91 percent, while other Caribbean countries saw decreases. Since 1990 there has been a decline in total agricultural lands of 1.3 percent in the Caribbean. Although most of the Caribbean countries experienced a diminution in agricultural area (including Cuba, but especially Puerto Rico, with a decline of 51 percent), other countries, such as Dominica, Bahamas, and Saint Vincent, had relatively significant increases (from 15% to 28%).

The four subregions of LAC also differ in terms of the percentage of land that is under different uses (for example, permanent crops, pasturelands, etc.). As reflected in Table 1.6, Mesoamerica and the Caribbean are the two regions with the highest proportion of their territory in seasonal crops. This is related to greater population density, and the predominance of the maize and bean system in Mesoamerica and sugarcane in the Caribbean. Nonetheless, in terms of the total area in seasonal crops, the Southern Cone has 34 times more area under such production than the Caribbean. Compared to the other regions, the Caribbean also has a higher proportion of land in permanent crops. The proportion of land in pastures in the Caribbean, the Andean region, and the Southern Cone fluctuates from 25 to 27 percent, but Mesoamerica has a higher proportion of its land in pastures (almost 40%). Finally, both the Southern Cone and the Andean region have more than 50 percent of their territory under forest cover, while the Caribbean and Mesoamerica have a smaller percentage (20% and 30% respectively).

In terms of products or specific groups of categories of products, it has become clear that there is a shift of interest from one to another due to changes in the markets' demands. In some products, growth has been very minimal, and there has even been stagnation, such as root crops and tubers, coffee, bananas, cotton, and cereal grains. In contrast, there has been a jump in the production of oil-bearing crops, fruits, and sugarcane.[5]

Sugarcane is a very important crop in clean energy systems. For example, the ethanol industry alone, in the next 10 years, may overtake the entire sugarcane industry. Sugarcane has the advantage that it is extremely efficient in the production of biomass, and is a crop that can

[5] Rural Development Unit of ECLAC, based on the FAO production yearbook, Rome. Food and Agriculture Organization of the United Nations (FAO).

produce year-round. In the region, only Brazil has begun to reap the comparative advantages of the cane crop as the raw material par excellence for the ethanol industry (Licht, 2005). Brazil has the potential to produce enough ethanol to respond to the domestic demand for fuel if the area given over to this crop is doubled (in other words, if the area increases to 5.6 million ha), or alternatively if all of its sugarcane production is earmarked for ethanol production (Berg, 2004). Unfortunately, expanding the area of this crop has negative implications for the environment. It is estimated that sugarcane monoculture accounts for 13 percent of all herbicide use in all Brazil. Studies done by EMBRAPA in 2002 (cited by Altieri and Bravo, 2007) confirm the contamination of the Guaraní aquifer in the state of Sao Paulo, which is attributable mainly to the cane crop (Altieri and Bravo, 2007). The area planted in sugarcane is quickly expanding to the Cerrado region, one of the biodiversity hotspots (Myers et al., 2000), and is contributing to the destruction of this unique ecosystem, which maintains only 20 percent of its original vegetation (Mittermejer et al., 2000).

The production of cereal grains (beans, lentils, pigeon peas, and others) and root crops and tubers has remained stable in recent years. In some cases there have been drops in production. Latin America exported a total of 18.8 million metric tons[6] of cereal grains (18% of world exports), but almost all of this was supplied by Brazil and Argentina (4 million metric tons and 14.5 million metric tons respectively). In the particular case of maize, world exports come to 74.5 million metric tons, of which only 14 million are exports from Latin America, specifically Argentina, Brazil, and Mexico.

The maize crop and its consumption in Mexico and Central America has been affected by imports of subsidized maize from the United States, and more recently by the increased use of maize to produce ethanol in the United States (see Box 1.2).

(Insert Box 1.2: Subsidies, maize, and food sovereignty in Mexico)

Latin America holds a leading position in the world market in stock-raising. Nonetheless, this leadership is represented by just two countries, Argentina and Brazil. Of total world beef exports, estimated at 5.72 million tons[7], Argentina and Brazil together account for 37%, with 2.14 million

[6] Foreign Agricultural Service of the United States Department of Agriculture. Circular of July 5, 2005. http://www.fas.usda.gov/grain/circular/2005/07-

[7] Foreign Agricultural Service of the United States Department of Agriculture. Circular of July 5, 2006. http://www.fas.usda.gov/grain/circular/2005/07-

metric tons of beef exported between them. It is forecast that the economic take-off of Asia, mainly China and South Korea, will result in a 22% increase in demand for beef with respect to 2005 imports.

The experience of Brazil and Argentina represents an extraordinary resource for the region. It is to be expected that efforts to improve the region's beef production systems will take into account the know-how from their experiences. Mexico should also be seen as potential markets on the horizon, as it will almost double its imports of beef from 2005 to 2015.

A similar analogy can be drawn in hog production. Of a total of 4.2 million tons sold in the international market, only 11% is supplied by Latin America. Once again, two countries alone account for the lion's share of these figures: Argentina (48 MT) and Mexico (440 MT). As with beef, there is a high ceiling of growth for pork exports.

Milk production in Latin America is far below expectations, taking into account the proportion of arable land and pastureland in the region. The region produces only 8.96% of the milk produced in the world (FAPRI, 2006). The production of milk in the region is concentrated in South America (Argentina, Brazil, Peru, Venezuela, and Colombia). In terms of exports, the region's performs at levels below what one would expect given the world dynamic in relation to processed products. Only Argentina and Uruguay export butter, cheese, and powdered milk. Considering the importance of milk in human nutrition, and its socioeconomic impact in rural areas, the dairy industry must necessarily be an anchor in any effort to improve the standard of living of the rural population in the region.

The wealth of Latin America's marine biomass has not been properly taken into account, as evidenced by the region's poor performance tapping this resource. The fish supply internationally is 100.2 million MT, only 3.1 million tons of which is produced in Latin America[8] (FAO 2003). Clearly aquaculture and fishing are important elements in any strategy to combat hunger and improve the standard of living of the rural populations.

Forestry and timber production constitute another category with extraordinary potential. The region is one of the more forested in the world, with one-fourth of the total forests worldwide (UNEP, 2002). The forested area comes to 834 million ha of tropical forest and some 130 million ha of other types of forest, accounting for 48% of the total. This forest cover is not evenly distributed, for Argentina, Brazil, Bolivia, Colombia, Mexico, Peru, and Venezuela account for 56% of the total. There are other countries, however, with serious forest problems, such as Haiti, less than 3% of whose territory has forest cover. The forests of LAC contain 160 billion m^3 of timber, accounting for one-third of all timber in the world. In terms of exports, Brazil and Chile are

[8] This figure does not include Mexico.

the leading exporters of timber and timber products. It should be emphasized that any type of use of forest resources should take into consideration the possible environmental impacts and impacts on climate change, and be done in the context of sustainable management plans. Today there are three programs for tropical timber certification that attest to the origin of the timber and whether it comes from a forest managed using certain criteria of environmental sustainability (Baharuddin, 1995). Forest resources may also be tapped by rural communities and provide an important source of income to the communities that live in forest areas. Mexico is one of the world leaders in community forest management for commercial timber production (Bray et al., 2005). The Mexican communities are attaining a balance between income-generation for the community and forest conservation.

1.7.2.2.1. Transgenic crops

(Insert Box 1.3: Transgenic soy in Argentina)

1.7.2.2.2. Bioenergetic crops

(Insert Box 1.4: Biofuels in Brazil)

1.7.2.3. End use of production and productive chains (NOT DONE)

In LAC, changes have taken place over the last three decades in the production platform based on variables such as the elasticity of demand domestically and internationally and market access, the rise of new market niches, and the breakdown in the government support structure for the peasant sector as the result of neoliberal policies. Depending on the magnitude of the stimulating effect of demand on growth in agriculture, one finds three different situations in the region when considering the rate of growth and the importance of the agricultural products that are expanding: (a) production geared to meeting domestic demand, such as those countries with large tourist operations (Caribbean, Mexico), as well as other countries that have experienced large domestic demand, such as Brazil; (b) production geared to meeting jumps in demand and market niches, such as Argentina, Chile, and Costa Rica, in which external demand has been the stimulus for the growth in agricultural production; and (c) production stimulated by a combination of domestic and external demand.

1.7.2.4. Sociocultural characteristics

The agricultural sector in Latin America and the Caribbean is made up of different systems of production (subsistence family, commercial family, and commercial) that differ markedly from one another, depending, among other things, on working capital, quantity of assets, type of land tenure, source of income, use of labor, destination of production, and especially their sociocultural characteristics.

Indeed, each system is highly varied given the plurality of agricultural structures in the region. This is why, in general, family farming is marked by a wide social heterogeneity; nonetheless, it also has some characteristic sociocultural elements that distinguish it from commercial agriculture (Ahumada, 1996):

- The family is at the core of all the activity of the productive system.
- The family lives on its property.
- The family produces and consumes its output.
- In addition, it is a source of labor for itself and for third persons.
- Its production is geared to meeting the needs of the family and the market.
- The household is an important decision-making unit.

There are other sociocultural aspects that determine differences within this productive system and set it further apart from commercial agriculture.

- The family develops socially and economically in a milieu marked by geographic isolation distinct from the urban-industrial sector.
- Many of its members have a common socio-historical development.
- The families share traditions and customs that are determinant in their lives in terms of relationships and production.
- Tradition is the dominant institution in the family's relationships and exchanges.
- There is a close relationship between the degree of isolation and its traditional patterns.

These aspects define more family farming of the peasant and indigenous type, where the peasants constitute a subculture, but this peasant pattern in countries such as Chile, Brazil, Argentina, and Uruguay differs from that of other regions of Latin America (Peru, Guatemala, Mexico, Bolivia, etc.), in which the indigenous cultural characteristic is even more determinant, in some cases to the point of having their own cultural traits (Rojas, 1986).

Another fundamental element that identifies this system socioculturally is belonging to a local community in which the networks of interpersonal relationships are essential not only for the

economic strategies of the households and their members, but also for other crucial aspects of human life, such as friendship, religion, leisure, and sense of belonging. The members of a peasant or indigenous community share their own sociocultural system in which beliefs and norms complement institutional and social relationships, and vice versa (Durston, 2002).

In addition, in the micro, regional, and national social system, the peasant occupies one of the bottom rungs on the social scale, and therefore is subject to economic exploitation and social and political exclusion by the more powerful groups (Wolf, 1966), phenomena that are generally more intense when the peasants belong to ethnic groups with a history of domination by others (Durston, 2002).

When subsistence family-based agriculture directs its production basically to the market, uses wage labor, has some degree of productive specialization, and has assets and capacities that give it some potential for accumulation, it assumes a position of transition to commercial forms. In this transition, externally strong pressures are brought to bear that alter its traditional economic and sociocultural foundations. In this transition, some changes take place in family life, some members of the family no longer participate in the productive activity, but instead dedicate themselves to studying or working in other independent activities, there is a greater link to the urban culture, and gradually the traditional rural way of life is lost (Acosta and Rodríguez Fazzone, 2005).

In contrast, the commercial agricultural system considers only the landowner as the agricultural entrepreneur and his function is primarily to organize the productive process and connect the property to the markets for inputs, financing, goods, and labor. In addition, the producer and his family do not necessarily live on the property; most of their social and cultural activities are tied to the urban milieu; the enterprise uses, as the main labor force, temporary and/or permanent labor; the size of the property is an important factor behind large productive surpluses; it uses a large amount of technology; and production is for market. The further it is from the characteristics of the family agricultural system, such a system is considered more modern and commercial, and less traditional (Gómez S., 2000).

1.7.2.5. Knowledge

Although a retrospective evaluation and an analysis of the current situation of the role of agricultural science and technology in the sustainable development of Latin America requires an epistemological approach, so that prospective assessments may be made, one must recognize that there is a wealth of scientific knowledge, as such, in the region. If the same evaluation is made from a gnoseological perspective that includes, in the analogical process, more intrinsic elements that are equally important and very particular to LAC, such as wisdom and metaphysical analysis, one can devise conceptual structures that are very useful for designing development

strategies in which the protagonist is the *Latin American and Caribbean Human Being (woman and man)*. This last school of thought integrates, in its contents, the elements of culture, customs, and intrinsic particularities of the Latin American and Caribbean human being, characteristics that are fundamental in the evolution of societies in every realm, including science and technology.

One must, therefore, reconstruct the historical-cultural diversity and diversity of knowledge in the region, and their influences in the evolution of science, as a preamble to an approach to the role, for example, of colonialism, ethnicity and the ignored racial and cultural complications of the region, vis-à-vis the new and imposing paradigms such as globalization or global interdependence (Gotta, 2003). In this context, it is evident that the region is broken into complexities, different bodies, memories, languages, histories, and diversities (Chamber, 1995). This fragmentation, conceived of from a less uniform perspective, is considered in contrast to the assumption of a region seen from a reductionist perspective as a homogeneous mass, and that advances on a symmetric front towards one or another scenario.

Recognizing the validity of the gnoseological approach for the purposes of gauging the role of knowledge, science, and technology in the development policies of the region will enable us to vindicate and value aspects such as the experience of colonialism as a present and preponderant reality in Latin America (Gotta, 2003). Colonialism in its diversity of nature and time intrinsically exists in the region, not as a territorial phenomenon, imposed and invasive, but voluntary, reflected in a colonialist attitude that predominates in many Latin American countries. Today's voluntary and self-imposed colonialism is one of the reasons why Latin America invests less than the world average today in research and development.

The colonialism that resulted in the suppression of local knowledge and wisdom for almost half a century restricts the creative and proactive use of – and even ignores – local knowledge, still believing that scientific and technological spillover is the only instrument that is going to best position the region and offer comparative advantages in today's interdependent world. Yet on the other hand, Amartya Sen (2001, 2002) suggests the contrary effect of that voluntary colonialism, rejecting western and capitalist ideas. Sen argues that rejecting the globalization of ideas and practices because of the supposed threat of westernization is a mistaken approach that has played a regressive role in the colonial and post-colonial world. This rejection fosters parochial trends and sabotages the objectivity of science and knowledge. Given global interactions, not only is it counterproductive, but it can cause non-western societies to place limits on themselves, and may even torpedo the valuable resources that their own cultures and wisdom represent. For example, the region has not capitalized on the extraordinary and phenomenally diverse indigenous, Afro-American, Hispanic, and Anglo-Saxon customs.

Less in the realm of philosophy, and more in that of epistemology, one can argue that LAC, even though it is a region with extraordinary resources in terms of knowledge and wisdom, culture and

natural resources, is lagging in terms of optimizing those resources with a view to producing new knowledge. Latin America and the Caribbean is the region that invests the least in research and development in relation to the rest of the world. In the agricultural sector, the region invests only 0.3% of gross domestic product, whereas the rest of the world invests 0.5%. The countries that invest most in research and development in the region (Argentina, Mexico, Costa Rica, Brazil, and Chile) do so at levels very far below the developing countries that are prototypes in terms of returns on research and development, such as China, India, Korea, South Africa, Singapore, and Israel, among others.

1.7.2.6. Gender aspects

The main trends associated with the neoliberal restructuring and the increase in rural poverty in LAC include greater participation of women in agriculture, as both producers and as wage workers in the agricultural sector (Deere, 2005; Cornfield, 2006). As the participation of men in agriculture diminishes, the role of women in agricultural production increases. Male migration is one of the main motives for the increase in women's participation in the rural economy. The expansion of non-traditional export crops, wars, violence, and forced displacements are other causes of the so-called "feminization of agriculture," and with it, the feminization of poverty.

The increase in women's participation in wage work in the agricultural sector is closely bound up with the expansion of non-traditional export crops that benefit from the neoliberal programs (Robles, 2000; Chant, 2003; Deere, 2005). In particular, women play a predominant role in labor activities such as packing flowers (e.g. in Mexico, Ecuador, and Colombia), fruits (e.g. in Mexico, Argentina, Brazil, and Chile), and vegetables (e.g. in Mexico, Guatemala, and Brazil), and strawberries for export to North America (Deere, 2005). In addition, a large proportion of women and their children (50%) provide labor in the fields where these crops are produced (Deere, 2005). The flower sector has the largest percentage of female workers of the non-traditional crops. In Mexico and Colombia it is estimated that 60 to 80 percent of the labor force in this sector is made up of women (Lara Flores, 1992; Becerril, 1995; Meier, 1999). This work is mostly seasonal, lacks security, and is marked by precarious working conditions and discrimination (Lara Flores, 1995; 1998; Barndt, 2002; Díaz and Ruiz, 2006). There is also persistent income inequality as between male and female workers, as well as between white workers and those belonging to other ethnic minorities (Hirata, 2002). The increase in the use of women as wage workers in agriculture is not a uniform trend throughout the region, and is very much associated with non-traditional export crops. Several studies on the participation of women in wage work show that in many countries of the region a much higher proportion of women work in the non-agricultural sector, such as in the maquilas, as domestic servants, and in the industrial sector (Reardon, 2001; Katz, 2003). For example, in the Dominican Republic and Panama, 92 percent of economically active rural women work in the non-agricultural sector (Katz, 2003).

The literature includes a debate over whether this type of work represents greater exploitation of female labor or, to the contrary, is potentially liberating for women. In relation to this debate, Safa (1995) emphasizes the complexity and at times contradiction in the relationship between wage labor (and the discrimination, exploitation, and precarious working conditions this often represents), and greater access to and control of the salary, greater purchasing power, changes in gender relations (which tend to favor women), and greater awareness of women's subordination to men.

The other important trend in Latin America, especially in the indigenous/traditional sector of agriculture, is the incorporation of women as the main producer (Preibisch et al., 2002). This so-called "feminization of agriculture" is occurring in some countries more than in others and is directly tied to the increase in the migration of men, the search for jobs off the farm, and the diminishing viability of traditional/indigenous agriculture under neoliberalism (Chiriboga, 1996; Preibisch et al., 2002). For example, Mexico, the country with the largest migration of men to the United States, is also one of those in which the feminization of agriculture is most evident (Robles, 2000).

The incorporation of the traditional/indigenous sector in the production of non-traditional export crops has also resulted from an intensification of the role of women in agriculture (Deere, 2005). Guatemala and Chile are the two countries where this incorporation was most successful, even if it was ephemeral (Murray, 2003). Here too there is a debate on the impact of that greater participation on women. On the one hand, studies by Dary (1991) and Blumberg (1994) conclude that the incorporation of peasant women into the production of agroexport crops had a negative impact on women because it reduced the time available for their own independent activities, reduced their power to bargain within the family, and increased their dependence on men. On the other hand, the studies by Katz (1995), Hamilton et al. (2001), and Hamilton and Fischer (2003) conclude that women (in Guatemala) gained more decision-making power over productive activities.

Whether as wage workers in the agricultural sector or as producers directly, there is no doubt but that the role of women in agriculture has been expanding. This feminization of agriculture is linked to the decline of agriculture as the main economic activity of peasant families, and to the greater absence of men due to migration or wage work away from the farm. As traditional agriculture becomes ever less viable, production is turning more to food security for the family, and women are taking on a more important role (Deere, 2005).

1.8. Performance of Production Systems

1.8.1. Productivity

Productivity is defined as an average quantity of output divided by a measure of the quantity of input. The economic concept of agricultural productivity is an evaluation of the production of a crop (i.e., yield) and its market value, so that one can estimate its profitability (i.e., profit). Agricultural economists often use a partial measure of productivity based on an area of land and/or labor. Nonetheless, for many farmers in Latin America, especially those who produce for family consumption, or those who have systems using low levels of external inputs, the concept of productivity is much broader. For these producers, a productive farm is that which provides the largest amount of resources needed for the survival of the producer and his or her family. This may include foods, fuel, fiber, medicinal plants, etc. Unfortunately, there are very few studies that consider these factors; most existing statistics report only productivity per unit of land and per unit of labor.

Traditional/indigenous system – What is frequently known as *agricultura campesina* or peasant agricultural, and which in this evaluation we call the traditional/indigenous system, is still a predominant system in the rural areas of Latin America (Ortega 1986), though they are being threatened by neoliberal policies (Davis et al., 2001; Deere, 2005). These systems, in their traditional form, have been refined over many generations and much accumulated knowledge. The marginalization and displacement of producers from their ancestral lands contributes to their being characterized as having low or moderate productivity. Nonetheless, there are traditional systems that have high productivity, in some cases higher than the conventional system (Altieri, 1999). For example, in the 1950s Sanders estimated that maize production in the *chinampas*, a traditional system in Mexico, yielded 3.5 to 6.3 tons per ha. That same year, the yield of maize in the United States was 2.6 tons per ha, and it was not until 1965 that it reached 4 tons per ha (USDA, 1972). In the 1990s the average yield of maize in LAC was only 2.56 tons per ha, and the countries with the highest yields were Argentina and Chile, with 4.35 and 8.49 tons per ha respectively (Morris and López-Pereira, 1999; FAO, 1998). In the Amazon, traditional systems such as that of the Kayapó have yields that surpass *colonos*' yields by 200 percent, and the yields of livestock production by 175 percent (Hecht, 1984).

The traditional/indigenous system is also characterized by favorable rates of output per unit of energy input. For example in slash-and-burn systems (swidden agriculture), which depend on manual labor in the mountains of Mexico, estimated yields were 1,940 kg per ha, with a rate of energy efficiency (unit output per unit input) of 10:1 (Pimentel and Pimentel, 1979; Altieri, 1999) (Figure 1.6). In Guatemala a similar system generated a rate of energy efficiency of 4.8:1, and when one adds fertilizer and pesticides, the yields increase (to anywhere from 5 to 7 tons per ha), but energy efficiency drops to less than 2.5:1 (Altieri, 1999).

(Insert Figure 1.6: Comparison of energy balance)

One characteristic of the traditional systems is their high agrobiodiversity (Toledo, in press). Multicrop systems and agroforestry systems are common in this type of agriculture (Clauson, 1985; Thrupp, 1998). In LAC, most of the subsistence crops are produced in multicrop situations. For example, it is estimated that 40 percent of the cassava, 60 percent of the maize, and 80 percent of the beans are produced in combination with other crops (Francis, 1986). This is an important factor when comparing yields because these comparisons are normally by crop, which means that often the yield of other crops grown on the same plot is not taken into account. The multicrop systems development by traditional and/or indigenous producers are 20 to 60 percent more productive (in terms of harvestable product) than monoculture systems (Beets, 1982). For example, in Mexico, 1.7 ha planted in maize in monoculture is needed to produce the same amount of food as can be produced on one hectare planted in maize, squash, and bean (Gliessman, 1998). In Brazil, the multicrops of maize and bean have a 28 percent advantage over monocultures; under more arid conditions the multicrops of sorghum and cowpea produce 25 to 58 percent more than the monocultures (Altieri, 1999). The literature that shows the advantages in the yields of multicrops is substantial and dates back to the 1970s (Trenbath, 1976; Beets, 1982; Francis, 1986; Vandermeer, 1989). Among the facts that have been identified as responsible for these advantages are the more efficient use of resources (nutrients and water), and the reduction in the incidence of pests and weeds (Vandermeer, 1989; Gliessman, 1998). The greatest advantages of multicropping are obtained when gramineous and leguminous species are combined, as these two plant groups tend to complement one another very well (Vandermeer 1989). Other combinations may not be as advantageous from the standpoint of yields (Vandermeer, 1989).

Conventional/productivist agriculture – The emphasis of the conventional/productivist system has been on maximizing productivity and profit. In this regard, there is no doubt but that the conventional/productivist system has been a success for those producers who have enough capital to implement it (Figure 1.7). This system has been extending throughout the region, as the AKST system has assigned it high priority. For example, the hybrid varieties of maize development by CIMMYT in Mexico were planted on 10.6 million ha, accounting for more than 36 percent of the total area planted in maize throughout the region, and more than 74 percent was planted with some hybrid variety (Morris and López-Pereira, 1999). It's hard to know how much of this was produced under the conventional/productivist system, since many small producers, who produce using the traditional system, also incorporate improved varieties in their systems.

(Insert Figure 1.7: Increase in yield of select crops)

The main objective of the Green Revolution was to increase the yields of the main food crops per unit of area. Contrary to the perception that the Green Revolution brought about a sharp increase in yields in the late 1960s, Evenson and Gollin (2003) argue that the Green Revolution has taken place in the long run, through the successive development of improved varieties. These authors divide the Green Revolution into two stages, early (1961-1980) and late (1981-2000), and argue that in the developing countries, including LAC, improved varieties contribute to a 17 percent increase in yields, while in a later period these varieties contributed to 50 percent of the increase in yields. Notwithstanding these figures, the rate of increase in yield has been diminishing in the last 10 years (Evenson and Gollin, 2003). The advocates of biotechnology argue that the only way to continue the increase in yields, which, according to them, will be necessary given population increase and changing consumption patterns, is by the use of transgenic crops, which they have called "the new Green Revolution" (Smil, 2000; Trewavas, 2002). By way of contrast, the critics of conventional/productivist agriculture argue that it is possible to attain levels of production equal to those of conventional agriculture, and in some cases higher, using agroecological practices and without transgenics (Pretty, 2002; Halberg et al., 2006; Badgley et al., in press).

This system's high demand for fossil energy has been a research topic for several decades, and is well-established (Pimentel, 1980). The greater demand for fossil energy in this system stems from the use of machinery and agrochemicals (Pimentel, 1980). It is well-established that the conventional/productivist system is less energy efficient than the traditional/indigenous system (Figure 1.6).

Agroecological system – This type of agriculture encompasses a wide array of systems, practices, and methods that use agroecological principles to design and manage production systems. In the last 20 years the agroecology movement has grown enormously in LAC (Altieri and Masera, 1993). In order to research whether sustainable agriculture could produce enough food to feed the world, a study by the University of Essex in England carried out a census of 200 projects in 52 countries, including 45 projects in Latin America. The authors estimated that 9 million producers are using agroecological methods on approximately 29 million hectares (worldwide) (Pretty et al., 2003). When the yields on farmland using agroecological or organic methods are compared, the authors found that the farms with agroecological agriculture produce the same and in most cases significantly more than those lands in conventional production (Figure 1.8). This type of agriculture is benefiting, in particular, peasants and small producers. Approximately half of the producers interviewed had less than one hectare, and 90% had farms with less than two ha. The result is an increase in food consumption of the family unit and greater

production, allowing the peasant/producer to consume and market a variety of products. Pretty et al. (2003) estimated an increase in food production of 93% per hectare.

Yet in addition to the benefits in terms of production increases, agroecological practices can also bolster the system's resistance to catastrophes. Recently, a participatory study by the Movimiento Campesino a Campesino showed that farms managed with agroecological practices had greater resistance to the impacts of Hurricane Mitch in Nicaragua (Holt-Giménez, 2001) (Box 1.1).

Recent studies leave not the slightest doubt that agriculture based on agroecological principles is not only feasible for a niche market (such as products certified to be organic) but also offers a real alternative to meet food needs globally, without having to convert natural habitats to agriculture, using 30% less energy, less water, and no agrochemicals (Pretty, 2002; Halberg et al., 2005; Pimentel, 2005; Badgley, in press). Yet even more important for the purpose of this evaluation, agroecological and "knowledge-intensive" agriculture offers the peasants and small producers of LAC an alternative for the production not only of food, but of culture, human capital, and social capital (Zinin et al., 2000; Pretty et al., 2003). Agroecological experiences in the region provide testimony to the potential of sustainable agriculture to pull peasants out of poverty, strengthen social relations, eliminate dependency on outside inputs and knowledge, and strengthen the connection with their environment.

Since the early 1990s, organic agriculture has experienced a leap in demand, which has induced a spectacular increase over the last 15 years, representing one the areas of agriculture with great potential.

1.8.2. Sustainability

Some of the ecosystem services that are degraded by the conversion of natural vegetative cover to farmlands or pasture are essential to the viability and sustainability of the agricultural systems themselves (McNeely and Scherr, 2002). Soil fertility is a prime example. There is increasing evidence that the rich and complex below-ground ecosystems of bacteria, fungi, protozoa, nematodes, arthropods, earthworms, and other organisms play a critical role in creating and maintaining the soil conditions that are optimal for agricultural production (Buck et al., 2004). A study in eastern Amazonia in Brazil, for example, found that recently cleared fields had less than half the macrofauna (invertebrate) species of forest plots. Species frequencies were also halved for many groups (Mathieu et al., 2005). Invertebrates, particularly earthworms, play an important role in nutrient cycling and decomposition and hence soil fertility. "Modern" production practices like those promoted by the Green Revolution, which are dependent on packages of chemical inputs and mechanical manipulation of soils, can also have devastating effects on these important but little-understood ecosystems.

Agriculture has been responsible for impacts on key ecosystem services essential to human societies. For example, in 1990, net emissions of greenhouse gases due to deforestation in Brazil were estimated to be 5% of the global total (Fearnside, 2005). Loss of natural vegetation, especially conversion of forested land, can also affect climate, hydrological cycles, freshwater quality, soil fertility and retention, pollination, vulnerability to pests, and resistance to invasive species (Millennium Ecosystem Assessment, 2005).

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Pollination is a key ecosystem service that can be seriously degraded in agricultural landscapes. Studies in Costa Rica and Argentina have shown that more pollinators are found in agricultural fields adjacent to forest fragments or remnants of native vegetation, and that more pollen deposition actually occurs in those sites (Chacoff et al., 2006; Ricketts et al., 2004). It is also clear that use of agrochemicals can reduce the number of beneficial organisms available both for pollination and for control of crop pests (Buck et al., 2004).

The use of chemical inputs (pesticides and fertilizers) in agriculture and the introduction of transgenic varieties have translated into accelerated destruction of beneficial fauna, the development of resistance in pests, the resurgence of primary pests, outbreaks of secondary pests, and the destruction of bees and other pollinators. The high and proven toxicity of these chemical products destroys microscopic and macroscopic organisms necessary for maintaining natural soil fertility, degrading the resource, altering the natural equilibrium of plants, making them more attractive to attacks of pests and disease, and contaminating the water, air, and food. In addition to all these negative consequences, the producer faces the high costs of this model of production, negatively impacting the cost-benefit ratio, with the resulting detrimental impact on incomes and quality of life in rural communities.

The use of chemical inputs (pesticides and fertilizers) in agriculture, and the introduction of transgenic varieties, has been reflected in the accelerated destruction of the beneficial fauna, development of resistance to pests, outbreak of secondary pests, and destruction of bees and other pollinators. The high and proven toxicity of these chemical products destroys microscopic

and macroscopic organisms necessary to maintain natural soil fertility, degrading the resource, altering the natural equilibrium of the plants, making them more subject to attacks by pests and disease, contaminating the water, air, and food. In addition to all these negative consequences, the producer faces the high costs of this model of production, with the consequent negative impact on the cost-benefit ratio, and a detrimental impact on incomes and quality of life in rural communities.

Additionally, the FAO has recognized that crop losses due to pests and disease have increased notably even though more and more pesticides are used.

1.8.3. Profitability (NOT DONE)

1.8.4. Competitiveness (This section should be modified to cover aspects of competitiveness at the system level, not at the country or regional level)

According to the OECD, regional competitiveness is defined as the degree to which a given region can, under free and fair market conditions, produce goods and services that meet the markets' requirements over time, while simultaneously maintaining and expanding its people's incomes. In recent decades, most Latin American countries have pursued policies geared to the formula: (a) improve domestic economic conditions, (b) increase international trade, and (c) increase real incomes so as to effect a proportional reduction of poverty and inequality.

Evaluating the competitiveness index for 21 countries of Latin America and the Caribbean, with respect to 117 countries of the world, only Chile is among the 50 most competitive countries, in 27th place, following by Argentina in 54th place (Schwab, 2006). All the other countries of Latin America follow, with the most competitive, after Chile, being Costa Rica, Brazil, Colombia, and Mexico, in that order. Haiti, Bolivia, Paraguay, and Guyana are the least competitive Latin American countries.

To evaluate the levels of competitiveness in the region, particularly in the agricultural sector, one must take into account a series of variables such as the macroeconomy, institutional strength, infrastructure, primary education and health, higher education and training programs, market efficiency, installed technological capacity, sophistication of businesses, and finally, installed capacity for innovation. Accordingly, the region's agricultural production system and the system of agricultural knowledge, science, and technology as a tool for sustainable development will have to incorporate these elements in regional strategies for reducing poverty by generating wealth.

1.8.5. Quality and safety

In the search for greater yields in the varieties of the Green Revolution, the "improvers" selected varieties mindful more of production volumes than nutritional value; this has had negative impacts on the quality of food and on the physical and mental human health of the communities, all of

which is aggravated by contamination with residues of agrotoxics. Deficiencies of micronutrients and essential vitamins in food crops also resulted from the loss of traditional varieties, soil degradation and contamination, and the elimination of their organic management. Chemical fertilizers are not a substitute for organic matter, and cannot replace vital interrelationships or essential micronutrients, either in the soil or the plant; these will not be attained by the use of transgenic varieties that produce a given vitamin or nutrient.

The Regional Conference of Consumers of Healthy Food, held in Bogotá, Colombia, in August 2004, organized by Consumers International, Office for Latin America and the Caribbean, recognized that the use of pesticides as well as the presence of pesticide residues in foods present in the market are a major concern for the consumers' movement, since quality and safety include the primary stage of production and the processing of such products. Accordingly, emphasis was placed on the need for a comprehensive approach to ensuring safety, from production to final consumption, through sustainable agricultural production. It was emphasized that the cooperation and joint action of Consumers International with Latin American networks such as RAP-AL (Red de Acción en Plaguicidas y sus Alternativas en América Latina, Pesticide Action Network in Latin America) and MAELA (Latin American Agroecology Movement) play an essential role here. It is also crucial that strategic partnerships be strengthened with the women's movement to work on issues of food security and food sovereignty, health promotion, promoting breastfeeding, and safe foods.

1.9. Impacts of the Production Systems

1.9.1. Environmental (This section needs to be shortened and the environmental impacts of the production systems need to be emphasized)

Biodiversity - As an ever-increasing proportion of Latin America's land is cleared for agriculture, agricultural plots themselves and the semi-natural areas that often surround them have become more important habitats for species that are able to adapt to disturbed environments. Several specific aspects of traditional and indigenous agricultural systems tend to make them more conducive to conserving biodiversity on and around farms. Traditional farmers have generally relied on a mosaic of fields, pasture, and forests to provide the full range of their subsistence needs, which produces a variety of habitat for wild biodiversity (McNeely and Scherr, 2003). Agricultural diversity is greater, thus providing different habitat options to biodiversity: more types of crops tend to be grown, and several crops may be grown together, or intercropped. Trees are often left standing in some agricultural fields or pastures. Cultivation is usually less intensive and, in the case of the swidden agricultural systems typical of indigenous cultivation in the humid tropics in Latin America, fields are allowed to return to secondary vegetation for a considerable period after a few years of cultivation. The patchwork of land uses and in some cases use of

intercropping reduces erosion and thus sedimentation of streams and rivers. And because these farming systems use fewer or no agricultural chemicals, they cause less pollution.

There is evidence that use of some traditional practices leads to enhanced on-farm biodiversity, as compared to more intensive farming methods. Harvey et al. (2004) review the literature for Latin America and conclude that practices that increase the variability of habitats available on farm, such as live fences, windbreaks, and isolated trees, have had a demonstrable impact on taxa such as birds and mammals. Other studies have demonstrated linkages between increased biodiversity and both organic agriculture and shaded tropical agriculture, such as shade coffee (Buck et al., 2004). As farming systems have evolved to more technology-intensive over the last half century, many of these more sustainable practices have been abandoned (McNeely and Scherr, 2003). Consequently, the amount of wild biodiversity supported on farms has decreased over time.

There is widespread agreement that habitat destruction and fragmentation is the major driver of biodiversity loss worldwide**.** While habitat destruction and fragmentation have many causes, foremost among them in terms of the area impacted is agriculture (Millennium Ecosystem Assessment, 2005; McNeely and Scherr, 2003; Heywood and Watson, 1995; Goudie, 1990). Agriculture also impacts biodiversity beyond the conversion of natural habitat. Agrochemicals can harm species that utilize agricultural landscapes or nearby areas, and they have a major impact on aquatic and marine biodiversity. Siltation of water bodies caused by the removal of natural vegetative cover can have similarly negative effects on aquatic and marine organisms. Agriculture directly impacts aquatic biodiversity when excessive water is removed for irrigation. Production practices, such as burning cleared vegetation, can cause additional loss of biodiversity. Livestock contributes enormous amounts of methane to the world's atmosphere, which in turn contributes to climate change and impacts biodiversity (Clay, 2004). Some species introduced for agricultural purposes have become invasive and directly or indirectly caused the loss of native biodiversity as well. In short, agriculture is the human activity that has most affected the earth's environment and that has caused the most direct and indirect biodiversity loss.

Freshwater ecosystems - Freshwater ecosystems are very poorly understood, but it is clear that they are highly threatened worldwide (Millennium Ecosystem Assessment, 2005; Abell, 2001; Olson et al., 1998). Conventional/productivist agriculture is a major source of threat to these systems. A recent assessment of Latin America's freshwater biodiversity concluded that more than 85% of freshwater biodiversity in the region is seriously threatened (Olson et al., 1998).

Threats related to agriculture include direct habitat conversion, for example in the case of wetlands drained for agricultural use; sedimentation from the loss of riparian and catchment basin forests; and pollution and eutrophication from agrochemicals, fertilizers, and fish farming. The

introduction of non-native species, often as part of fish farming initiatives, is a particular problem for lakes; unintentional escapes from fish ponds into streams and rivers is also problematic (ILEC, 2005). Dams and channelizations constructed for flood control or irrigation, and excessive water withdrawal, are another source of impact related to agriculture. An emerging issue with dams is the importance of environmental flows, that is, the timing and size of flows necessary for maintaining downstream ecosystems. Pollution from waste produced by processing agricultural crops also impacts freshwater biodiversity (Olson et al., 1998; Clay, 2004; ILEC, 2005). Finally, direct exploitation of freshwater fish for food is also an important threat.

While these problems have not been well-studied in Latin America, there is some evidence of their impact in particular places. Agostinho et al. (2005) review studies of impacts from various threats to freshwater systems in Brazil. There is evidence of reduced species diversity and alteration in community structure in freshwater bodies subject to pollution or eutrophication. Siltation caused by intensive agriculture has been documented as impacting freshwater biodiversity in the Pantanal, the Cerrado, and in streams in the highly threatened Atlantic Forest, as well as the Amazon. In Chile, native lake fishes appear to have declined with the establishment of populations of rainbow trout, an exotic species, in the 1900s. With explosive growth in the Chilean aquaculture industry, and Chile poised to become the worldwide leader in salmon production, there is concern about the impact of runaway salmon on native fish populations as well (Gajardo, 2003).

Coastal and marine ecosystems - The greatest impacts on marine ecosystems worldwide are caused by overfishing. Nevertheless, nutrient loading, largely due to agricultural use of fertilizers, is a major cause of degradation for coastal ecosystems (Millennium Ecosystem Assessment, 2005a). Sedimentation caused by erosion on agricultural fields and pollution caused by agrochemicals also represent significant threats to marine ecosystems (Clay, 2004). Coral reefs, which are generally close to shore and are important repositories of the world's biodiversity, are particularly affected by these threats. Almost two-thirds of the reefs of Central America and the Caribbean are considered at risk, and one-third are considered at high risk (Barker, 2002).

Aquaculture represents a relatively new but growing source of impacts on coastal ecosystems. Shrimp farming often displaces mangroves, among the most valuable and highly threatened of coastal habitats, as well as wetlands and estuaries. Shrimp production is prevalent in coastal areas throughout Mexico, Central America and the Caribbean, and northern South America, especially Ecuador. In addition to outright destruction of fragile and economically valuable coastal ecosystems, shrimp farming causes considerable water pollution in coastal areas. Aquaculture was virtually nonexistent at mid-century and now represents an important economic sector in many countries, and with the growth in world demand for fish, its impact on coastal ecosystems can only accelerate (Clay, 2004).

Deforestation and Fragmentation - The annual expansion in cultivated area in Latin America from 1961 to 1997 was 1.26% per year, far greater than any other region (Dixon and Gulliver, 2001). The region had 160 million hectares of land under annual and perennial crops in 1999, and another 600 million hectares dedicated to grazing and pasture (Dixon and Gulliver, 2001). Since 1961, cultivated land has expanded by 47%, while cropping intensity has only increased by 1% (Dixon and Gulliver 2001), meaning that most of the increase in agricultural production has been due to the expansion in cultivated area.

Expansion of the agricultural frontier in Latin America has commonly been ascribed to a set of key drivers: tax and credit policies and agricultural subsidies; agricultural colonization schemes; international and national markets; clearing for establishing land ownership; and technological factors (White et al., 2001). Frontier expansion in Latin America often starts with the cutting of logging roads into primary forest. Logging by itself deforests relatively minor areas of land. But logging roads allow colonists, usually small farmers, to enter into hitherto impenetrable areas and slash and burn the forest, cultivating primarily subsistence crops for one to three years, until the soil begins to lose its fertility. Then they sell the land they have cleared to others, often large landowners, for conversion to pasture (Nations, 1992). Cattle production is usually extensive, with low levels of inputs. Because of the characteristics of soils in tropical rain forests and grazing practices on the recently cleared land, pastures often quickly become degraded. When this happens, it can be very expensive to recuperate them, and since land at the frontier is cheap, pastures are simply abandoned for newly cleared areas. In the Amazon, pastures are often abandoned within ten years, and more than 50% of the area cleared is estimated to have been abandoned by the early 1990s (Hecht, 1992). Some research, however, indicates that soil fertility does not decline as markedly as widely believed, and that agriculture in the Amazon may continue to be profitable over time if appropriate cultivation techniques are used (Schneider, 1995; Vosti et al., 2002).

The relative contribution of small-scale, traditional agriculture to deforestation is a matter of some dispute (Sanchez et al., 2005; Vosti, 2002). While small farmers using traditional cultivation methods are certainly part of the phenomenon of the expanding frontier, large-scale clearing may ultimately be responsible for a larger absolute area of deforestation (Partridge, 1989). Nevertheless, spontaneous or state-sponsored agricultural colonization, which uses the frontier as a safety valve to address the problems of smallholders from the agricultural core areas of a country, has certainly played an important role in deforestation throughout the region. In some cases, such as immigration from traditional farming areas in Guatemala to the Petén (Barraclough and Ghimire, 2000), small farmers are displaced by the modernization of agriculture in the sending areas. In other cases, farmers from marginal agricultural areas move away in hope of better opportunities. This has been one reason for internal migration in Brazil and elsewhere, where farmers from the poor, drought-prone northeast of the country were among the

most likely to migrate to the Amazonian agricultural frontier (Mahar, 1989; Lisansky, 1990). Typically the farming techniques that migrant farmers learned in their areas of origin are inappropriate for the fragile soils and vastly different climatic conditions of the frontier they have colonized, leading to even quicker degradation of the areas they have cleared and greater need to continually clear new areas.

The two most active agricultural frontiers in Latin America over the last few decades of the 20th century have been in the rainforests of Central America and Brazil, both areas of high biodiversity. Central America, for example, has only around 0.5% of the world's land area, but represents around 7% of the world's biodiversity. It is considered a biological hotspot and has many endemic and threatened species. Much of the original forest has already been cleared, with only 20% of the isthmus still covered in dense forest. Nevertheless, a significant swath of tropical moist broadleaf forest remains along the Atlantic Coast, stretching from southern Mexico to Panama (Dinerstein et al., 1995).

The expansion of the agricultural frontier has been linked to export cycles of commodity crops in Central America, but the ultimate use of cleared lands has been predominantly for pasture. The total area in pasture has almost quadrupled from approximately 3.5 million hectares in 1950 to over 13 million hectares in 2001 (Harvey et al., 2005). Much of the cattle production was export-oriented. The decline in forest cover across the peninsula since the mid-20th century has been precipitous. Nicaragua, for example, lost 50% of its forest cover from 1963 to 1992 (Barraclough and Ghimire, 2000). The agricultural frontier has disappeared in El Salvador and Costa Rica, where most forest has already been cleared or, in the case of Costa Rica, designated as protected, but there is still an active agricultural frontier along the Atlantic Coast of the remaining countries of Central America (Harvey et al., 2005).

Important "push" factors for spontaneous colonization on the agricultural frontier include population growth, poverty, and insecure land tenure. Very skewed land distribution and the tendency for large, modernized agricultural operations to gradually absorb the best agricultural lands has led to land-poor or landless farmers seeking their fortune at the frontier, as for example in Honduras, where mechanization of export crops in southern Honduras led to migration to the rain forest margins in the departments of Olancho and El Paraíso (Jones, 1989). At the same time, unclear tenure at the frontier has sometimes led to rent-seeking behaviors at the expense of sustainable land use, as well as out-and-out speculation (Harvey et al., 2005).

Government policies also provided incentives for colonization of the agricultural frontier. In both Brazil and Central America, those seeking titled land were required to show "productive" use of the land by clearing it. This has been documented as a major factor in agricultural conversion at the frontier in Costa Rica, Honduras, and Panama in Central America (Barbier, 2004). Government policies that subsidized credit for certain activities have also had a big impact. In the

1960s and 1970s, Costa Rica embarked on a program of diversification of agro-exports, supported by government credits, which pushed cattle exports up to become the third largest agro-export earner (Lehnmann, 1992). By 1973, 1/3 of the land area of Costa Rica was in pasture. State-sponsored colonization schemes, in the Guatemalan Petén, for instance, also directly added to deforestation (Barraclough and Ghimire, 2000).

While traditional agriculture practiced by small farmers is sometimes the proximate cause of deforestation in the moist tropical forests of Brazil and Central America, export-oriented production of commodities has led to extensive clearing of native vegetation by larger, market-oriented producers. This is exemplified by the recent expansion of soy cultivation throughout the Brazilian cerrado. This phenomenon has a long history in Latin America, and its effects have been exacerbated by the typical boom-bust cycle of commodity prices for crops such as bananas, coffee, and cotton.

The cerrado is a mosaic of savannah and woodlands on Brazil's vast central plateau. It is one of the world's biodiversity hotspots, and is home to the most diverse savannah flora in the world (UNEP, 1999), an astonishing 44% of which is endemic (Klink, 2005). Government policies played a major role in stimulating agricultural conversion in the cerrado, as they did in the Amazon. Starting in the 1960s, government policies aimed at generating foreign exchange through the production of export crops, principally soy, combined with a desire to populate what was perceived as a vast "empty space" in the country's interior, led to subsidized loans, the development of infrastructure, and other incentives to open up the cerrado (Wood, 2000; Klink, 2005). As a result, by 2002 more than half the original vegetation of the cerrado had been cleared for human use (Klink, 2005), with more than 70% of the farmed area dedicated to cattle production, generally of low intensity (Wood, 2000). Most of the rest is dedicated to large-scale, mechanized soy production, oriented towards the export market.

Environmental impacts of this conversion do not stop with outright habitat destruction. Habitat fragmentation, invasive species, water pollution, changed fire regimes, and other impacts of agricultural production in the cerrado have also had a big impact on the area's unique biodiversity (Klink, 2005). Increasing land values in the cerrado have also pushed poor farmers into the Amazon, where they have a secondary impact on that region's biodiversity (Kaimowitz and Smith, 2001).

Contamination and degradation of aquatic and terrestrial ecosystems – Pesticides are applied by aerial spraying or using equipment on the ground. A large part of the toxics applied have the capacity to pollute the air by drift or losses during application, evaporation, or wind erosion. Drift or transportation by the wind is greater when applied by aerial spraying; it is estimated that using this method, 5% to 15% of the pesticide applied reaches its target, with most of it dispersing over

other ecosystems, contaminating them and having a detrimental impact on the health of the populations living nearby.

One of the most serious long-term impacts is suffered by two resources, the soil and the water. The methods of the Green Revolution do not maintain natural soil fertility, thus farmers need to use more and more fertilizer to maintain crop yields. On treating the soil as a passive resource, where only external inputs are important, one ignores the complexity of the life of the soil, and it is weakened for future use. Herbicides and other pesticides alter the balance of the soil ecosystems, often to the detriment of organisms beneficial to the soil such as earthworms, antagonists of pathogens, micorrhizae, and bacteria. The loss of soil organisms causes deficiencies of nutrients and diseased plants.

The impact of fertilizers and pesticides on the soil has been the subject of little research in Latin America, yet food production ultimately depends on soil quality. This may be one of the main causes of declining crop yields and the diminution in levels of micronutrients in foods that the Green Revolution has suffered.

Another source of high levels of agricultural soil contamination is to be found in the toxic waste of pesticides, such as the packages, bottles, and leftover pesticide not used. In addition, illegal and clandestine burying of obsolete or expired products has been discovered in recent years in many Latin American countries, such as the northern coast of Colombia.

Chemical pesticides that reach the soil, in addition to their multiple effects on populations, will have a detrimental impact on the viability of the seeds and on the physiological processes of crops. Their contamination is also especially important due to the transfer of those contaminants to foods through the roots of the plants that humans and animals consume. In the case of livestock production, the residues can pass through the soil to the forage so as to ultimately be absorbed by the animals, causing acute and chronic intoxications and/or becoming concentrated in the fat and increasing the rate of residues in meat and milk.

The Green Revolution also demands a large increase in water use, including an enormous expansion of irrigation facilities. This has reduced groundwater reserves and led to a drop in the water table in vast agricultural regions, as in Valle del Cauca in Colombia, where one finds sugarcane monoculture, and the savannah of Bogotá, the main zone for the cultivation of flowers for export; wells for drawing water from the subsoil have to be dug deeper and deeper.

In addition, water resources have been highly contaminated by fertilizer and pesticide residues. The surface waters and groundwater are contaminated in the processes of manufacture, transportation, storage, and application of pesticides. The pesticides have a negative impact on aquatic life, both plant and animal, by direct toxic action, or indirectly by contaminating the species they feed on, or by producing physical-chemical changes in the aquatic environment.

The transport of pesticides through riverways from agricultural zones to the coastal zones, estuaries, and mouths of rivers affects the marine environments where a large number of aquatic species important to the economy and the environment feed, spawn, and develop.

Destruction of beneficial organisms and resistance in pests – The repeated application of pesticides destroys populations of enemies of pests, such as predators, parasitoids, and antagonists, at the same time as it fosters the selection of individual pests that can tolerate higher doses than those required to kill most. Resistance has been growing since 1947.

The development of resistance in undesired organisms induces farmers to increase the dose or to use mixes of highly toxic products in some sites called "bombs" ("*bombas*") thereby increasing their risks and consequences.

Particularly worrisome at present is the increase of arvenses plants (improperly called weeds) resistant to herbicides, mainly glyphosate, due to the establishment of transgenic varieties resistant to or tolerant of herbicides, such as Roundup Ready (RR) soy from Monsanto. From 2000 to 2005, the number of biotypes of herbicide-resistant weeds increased from 235 to 296, and to 178 species. At present, it is one of the most serious problems in Argentina. The development of resistance in pests has made the use of mixes of extremely and highly toxic formulations common. As rural workers are exposed to more than one pesticide, in most cases of intoxication it is hard to know which pesticide is causing the problem.

Increase in pests and diseases – On planting genetically uniform varieties in large areas, in monoculture conditions, the Green Revolution increased the pressure of diseases and pest populations. As soon as a pathogen or pest has adapted to the defenses of a plant, the defensive barriers of all neighboring, genetically uniform plants succumb to its action. Pests or diseases may infest crops that have the same genetic structure with the speed of an epidemic.

1.9.2. Social

According to FAO (1986), the technological changes in agriculture over the last 50 years, such as the package of improved seeds, growing technologies, better irrigation, and chemical fertilizers were very successful in attaining the essential objective of increasing agricultural production, crop yields, and aggregate food supplies. Nonetheless, the swift modernization of agriculture and the introduction of new technologies, characteristic of the Green Revolution, had a differential impact on rural populations, depending on class and gender. The effects of modern agriculture were differentiated, depending on whether you were paid workers, growers, or consumers, from households with or without land, rich or poor, male-headed or female-headed. Moreover, there were two general trends: the rich benefited more than the poor from that technological change, and men benefited more than women.

In Latin America, the modernization of agriculture entailed the transformation from traditional production to modern production, along with the accompanying social changes. Yet the process was carried out conservatively in the region, if we compare it with what happened in Europe, which has implied a large debt to the external banking system and the exclusion of most of the population. Agriculture saw improvements in production, exports, and incomes, although poverty and rural marginality expanded, especially for thousands of small producers (Becker, B., 1995).

However, the productive accomplishments of modern agriculture cannot be ignored; year after year millions of tons of food are produced, yet this is not enough to alleviate hunger and achieve food security in the region, since the poor don't have access to the food, and agrarian policies have not undertaken to resolve the social issue of access to the benefits of technology, therefore there is a growing accumulation and concentration of the wealth generated by agriculture (Rosset P., Collins J., and Moore F., 2000).

In addition, FAO (2000) indicates that one of the important social effects of modern agriculture has been demographic change, due to the substitution of a considerable part of the agricultural labor force by machinery, the increase in the area per worker, and the consequent reduction in the number of farms, which has unleashed an intense rural exodus, also driven by the reduction in related activities (the trade in primary products, processed goods, and crafts, as well as public services). This decline in the rural population has made it difficult to maintain the services (mail, schools, stores, physicians, and pharmacies) and social life.

Indeed, it is argued that industrial and modern agriculture, outside of the social impact produced by poverty and inequality, has traded technologies for peasants, expelling thousands of families from rural communities, and devaluing everything that farmers represent for the social, economic, and environmental life of the rural world. At the same time, it has generated a major increase in inequality and the continuing dismemberment and disappearance of peasant communities, and with that the major loss of cultural diversity (Riechmann J., 2003).

At the same time, industrial or modern agriculture has significantly upset the land tenure of peasants and indigenous communities, since those who cannot become incorporated into this type of agriculture and are unable to compete are forced to sell their lands and seek jobs as wage workers or emigrate to the cities, which means that the concentration of landholdings in just a few hands produces greater stratification, and therefore greater inequality and economic and social insecurity.

The technological changes in agriculture have resulted in a diminution of the number of small producers and an increase in the number of agricultural workers. The workers who have come to be employed by the agricultural enterprises have suffered the deterioration of their social and working conditions, mainly low wages, unstable employment, the lack of social security, and exploitation at work (Ahumada M., 2000).

Giberti H. (2002) suggests that the impoverishment and unemployment of many agricultural producers that has been caused by the development of modern agriculture favored the hiring of workers in abusive conditions, often disguised in pseudo-associative forms, as often happens with horticulture around the large cities. This rural worker is more unprotected today than 50 years ago; he or she practically lacks medical coverage and the possibility of retirement, as indicated by the tiny numbers who attain this benefit.

Another sociocultural effect has been on local knowledge and how it is disseminated. FAO (2000) suggests that as the design of the new means of production happens away from the farms and the immediate surrounding area, at research and development centers and relatively concentrated industrial and services enterprises, training for farmers and agricultural workers no longer happens on the farm, but rather in public and private institutions, and through technical and economic information services. In a broader perspective, the rural cultural patrimony of the past, locally developed and managed, has given way to a relatively uniform culture disseminated by the educational system and the media.

In addition, Green Revolution agriculture has meant, for rural producers, scant participation in the choice of the technologies that have been applied, since the approach has almost always been imposed vertically, resulting in barriers to the acceptance of technology. As a result, cultural integration, specifically of local or traditional customs and knowledge, has been scant or nonexistent (Altieri M, 1992).

Modern agriculture has impoverished and deteriorated the cultural aspects of how we feed ourselves. First, food customs and diversity have been lost, since numerous traditional foods have disappeared from the markets and from the rural kitchen, having been replaced by those produced by industrial agriculture and food imports. In addition, due to the whole social transformation that has taken place in the homes of peasant families, the kitchen has disappeared as the central space of the home, and with it a culture whose values were quality food, sociability (*convivencia*), associated with the fact of obtaining nutrition, and enjoyment of variety (Riechmann J., 2003).

1.9.3. Health

The Latin American market is a target for sales of pesticides and transgenics. A dramatic increase of 30% from 2003 to 2004 drove sales up to US$ 5.4 billion, and this could reach US$ 7.5 billion by 2009 (according to analyst Gautam Sirup). The growth is expected to result from the expansion of crop areas, increased planting of transgenics, and the expansion of specialized crops. Brazil is the largest market in Latin America, responsible for 63% of sales. Three companies, Bayer, Syngenta, and BASF, account for 61% of the Latin American market. Many of the oldest and most hazardous products are responsible for a large share of sales in the region, including 2-4,D, paraquat, metamidophos, methomyl, endosulfan, and chlorpyrifos. More than

one-third of the active ingredients present in the Latin American markets are not licensed for sale in the United States.

While climbing sales benefit the agrochemical industry, this is bad news for farmers in Latin America. One factor driving the sales of pesticides is the explosion of a disease affecting the soy crop in Asia (*Phakopsora pachyrhizi*). The disease first appeared in Paraguay in 2001, and has developed quickly, now affecting almost all the soy grown in Brazil, where farmers are applying pesticides up to two times per season, increasing the use of fungicides up to sixfold from 2003 to 2004.

Poisoning and deaths - Pesticides account for more poisonings than any other cause worldwide. The World Health Organization (WHO) estimated in the late 1970s that there would be more than three million poisonings annually, with likely mortality of 1%. In the 1990s, it was estimated that there were 25 million cases of poisoning in the world, taking the lives of some 220,000 persons; 99% of these deaths occur in the countries of the South, i.e. Latin America, Africa, and Asia. According to other estimates, one in seven workers is poisoned due to the use of pesticides. These data are more alarming if one considers that in Latin America, where the use of pesticides has risen the most in recent years, and with it cases of poisoning, a large number of women of reproductive age and children work in agriculture, exposed to pesticides in very dangerous conditions.

In a research project on the impact of acute intoxications due to pesticides in six Central American countries, carried out since 2000 by PAHO, WHO, Danida, and the ministries of health, in the project called PlagSalud, it was estimated that in a population of 29 million, 55% are exposed, whatever the cause (agriculture, domestic, or intentional), to chemical pesticides. A survey of more than 32,000 persons found that 1.9% of the general population and 4.9% of the exposed population may have suffered a slight, moderate, or serious episode of intoxication in a one-year period. Adjusting for age and sex, nearly 400,000 episodes of intoxication may have occurred in the six countries studied, in which underregistration is estimated at 98%.

Epidemiological surveillance in Nicaragua in 2002 revealed the major social and environmental problem, on estimating a national morbidity rate of 25.3 per 100,000 population, and mortality of 3.1 per 100,000 population, three times greater than average mortality estimated by the WHO. The average number of days lost per event was 9.4, which represents high costs for the those affected who are not being compensated.

It is important to note that intoxications are not the only risk posed by pesticides. In addition are other dangers to human and animal health, such as chronic diseases, genetic mutations, cancer, congenital malformations (teratogenesis), endocrine or hormonal changes, reproductive problems, and compromised immune systems as the result of occupational exposure or exposure to residues in

water, air, and contaminated food. Therefore, 100% of the rural and urban population is exposed to the risks of the poisons.

The problems caused by pesticides may be brought on by the active ingredients, solvents, inactive or inert ingredients, or a combination of these. Among the pesticides that have caused the most cases of poisoning and death are organophosphate insecticides such as paration (which caused the death of 24 children in Taucamarca, Peru, in 1999); the organochlorine insecticide endosulfan (Thiodan, Thionil), prohibited in Colombia but sold illegally in the coffee growing zone, where it continues to cause intoxications; and the herbicide paraquat (Gramoxone), the main cause of occupational and accidental deaths in Central America, which can have a seriously harmful and irreversible impact on the respiratory system, and for which there is no antidote.

Chronic intoxications - Persons subject to high levels of exposure because of their occupation may be poisoned without manifesting symptoms, which means they are not warned of the high risk they run of suffering severe intoxication and dying from a small additional exposure, which in normal conditions would not cause a critical intoxication. Among the main chronic effects, mention is made of cerebral lesions and lesions of the nervous system in general, such as peripheral polyneuropathies and Parkinson's disease; cardiovascular diseases; kidney and liver disorders; cancer, genetic mutations, teratogenesis (congenital functional malformations or abnormalities); endocrine or hormonal problems, reproductive problems (sterility, impotence, abortions, stillborn children, development problems in offspring) and suppression of the immune system. All pesticides produce chronic effects, particularly those known as persistent organic contaminants, or POCs, which are targeted for control by the Stockholm Convention.

Hormonal or endocrine effects – The greatest harm from exposure to pesticides occurs during pregnancy, when toxics with endocrine effects or xenohormones limit or block the delicate natural signals that the hormonal systems of the mother and fetus send the cells and organs to guide their development. The endocrine alteration in the womb during the stage of fetal development may result in cancer, endometriosis, learning disorders, behavioral disorders, immunological and neurological disorders, and other problems such as low sperm count, genital malformations, and infertility. These hormonal problems may originate in fetal exposure and not manifest until puberty.

Recent evidence has shown that the substances that provoke endocrine alterations may cause undesirable effects with levels of exposure far below those identified as the "no observed effect level" (NOEL). This means that the rule in traditional toxicology that says that "toxic action depends on dose" does not apply to endocrine effects. This scientific evidence takes on particular importance in the case of pesticide residues in the environment and food, because the maximum limits allowed also cease to be valid. And if one cannot determine a "safe dose,"

evaluating risk based on the low doses is inadequate, because there will not be an "acceptable risk" in the handling of this class of chemicals.

If there is no "safe dose" the reasonable decision is to withdraw from the markets those pesticides that have hormonal or endocrine action, which is what the governments have accepted to do with the Stockholm Convention, which entered into force in May 2006.

According to the *Second National Report on Human Exposure to Environmental Chemicals* of January 2003, by the Government of the United States, based on studies of almost 10,000 persons, women have greater concentrations of organochlorine insecticides that were withdrawn from use in the United States many years ago. These are persistent organic contaminants, which will take many years to disappear, therefore they are one of the worst threats to future generations.

Teratogenesis **–** birth defects: Several studies suggest a relationship between exposure to pesticides in pregnant women and birth defects. Many of the agrotoxics used in agriculture have caused birth defects in laboratory animals. These same agrotoxics can enter the human body by aspiration, through the skin, or through the digestive tract, and pass through the membrane of the placenta with the risk of affecting the development of the embryo or the fetus, where they can cause physical deformities or physiological or functional anomalies that are manifested at birth. Chile reports the highest indices of malformations in newborns, mainly in the areas where fruit is produced for export, and in forestry areas that use high levels of chemical inputs.

Effects of transgenic foods on health and the environment **–** As for transgenic crops, there is steadily mounting evidence of the major impacts they may have on the environment and on the health of consumers; at the same time they yield less, use more chemicals, and are much more expensive than conventional crops (Silvia Ribeiro of the Grupo ETC, January 2006). According to statistics provided by the companies that produce transgenics, in 2005 these crops had expanded to more than 400 million ha worldwide, Argentina having the second largest area planted, after the United States, with 17 million ha. Among the top 11 countries are four more Latin American countries, including Uruguay, Paraguay, and Mexico.

The expansion of these crops has occurred with the concealment of real data on the proven effects in animals, such as allergic diseases and impairment of the immune system. To this is added the genetic contamination of native varieties, such as the contamination of maize in Mexico, with the grave threat this poses to biodiversity.

A scientific study published on January 8, 2006 by the British daily The Independent showed that more than half of the young born to laboratory rats whose mothers were fed with Monsanto's transgenic soy during pregnancy died in the first three weeks of life. This means an average six times greater than other rats who received normal food, and indicates the risk to humans. In

other studies, of rats fed with transgenic maize made by the same company, the animals suffered changes in their internal organs, indicating possible damages to the immune system.

The capacity of the governments of Latin America to exercise controls on the market for GMOs may be minimal or nonexistent. For example, in January 2006 Nature revealed that the Bt10 maize sold by Syngenta without authorization in the United States, in contrast to the Bt11, has marker genes, resistant to antibiotics, which means that it has the potential to recombine with bacteria from the digestive tract of those who ingest it, be they animals or humans, conferring resistance to the antibiotic ampicillin, one of the most widely used to fight common bacterial infections. It means that if one needs the antibiotic, it is likely it will not have any effect, but that won't be known until one is sick and the medicine isn't working. This case made clear the inability of regulatory agencies and society to control transnational companies. The European Union, for example, had to acknowledge that it did not have the equipment needed to detect the difference between the approved Bt11 maize and the unapproved Bt10. It goes without saying that in Latin America the capacities to apply the so-called "biosafety" law and the precautionary principle are certainly much more rudimentary than in the EU. In addition, confidentiality clauses guarantee companies that they can keep secret the details of transgenic designs to protect themselves from their competitors, therefore, when it comes to risk assessments of applications filed, the "experts" will not have adequate information.

1.9.4. Economic

It is very difficult to evaluate the social and environmental costs of agriculture based on the use of agrotoxics because it is not easy to assign many values when ethical considerations come into play. For example, what value should be assigned to human life? Nonetheless, efforts have been made to try to evaluate these environmental and health costs, such as those of David Pimentel and his team of researchers at Cornell University in the United States, who have valued the costs of the public health impact of intoxications and deaths, contamination of domestic animals and cattle, loss of natural enemies, and costs due to resistance to pesticides, losses of honeybees and pollination of crops, losses in fishing, crops, wild birds, and contamination of groundwater.

Based on Pimentel's studies, in 2004 RAP-AL made an initial effort to calculate social and environmental costs in Latin America, for its paper presented at the 'Tribunal on Food Sovereignty: The World Bank and the IDB on Trial for the policies that have given rise to a Historical, Social, and Ecological debt of the North to the South.' The same methodology and data applied in the United States were used, yet considering that in Latin America many costs may be greater, due for example to the environmental costs stemming from the destruction of biodiversity, as the region includes some of the most biodiversity-rich countries in the world.

To evaluate the health impacts, general approaches of the World Health Organization were used that indicate that 15% of the population of Latin America lives in rural areas, with 5% poisoned,

2% hospitalized, and 1% mortality (Table 1.8). With respect to the cost of human life, the 3.7 million dollar figure used by the United States Environmental Protection Agency (EPA) was used, based on the notion that the life of a Latin American is no less valuable than the life of a person from the United States. In this initial calculation it was estimated that there is a social and ecological debt of US$ 130 billion annually; as in the case of the U.S. study, the impacts on soil, loss of fertility, hormonal effects, sterility, malformations, and others have yet to be calculated. In addition, the calculations are for one year, but the debt has accumulated for more than 50 years of Green Revolution-type agriculture, therefore economic projections remain to be done to come up with the amount owed to us.

(Insert Box 1.8: Estimated health costs due to pesticide use)

In the case of cancer, in the United States it was estimated that there have been 10,000 cases due to pesticides (0.003% of the total population) (Pimentel, 2004). In Latin America it was estimated that 0.02% of the total population has suffered cancer due to pesticide use, for a study of Latin America workers in the United States indicated an incidence 5.5 to 8.3 times higher than the U.S. average; and in Latin America, the conditions include greater exposure and more carcinogenic pesticides on the market (0.003x6=0.018 Approx. 0.02%).

Historically, agriculture has been one of the largest and most important sectors receiving World Bank loans. The trend has been to capital-intensive agriculture, with growing use of chemical inputs, and now genetic engineering, for export, that may initially seem "efficient" but which has a detrimental effect on the health, quality of life, and food security of farmers and local consumers, and results in pollution, erosion, and loss of biodiversity.

The aggressive promotion of structural adjustment policies and rural development by the Bank favoring agricultural intensification and production for export, at the cost of smaller-scale agricultural with fewer external inputs, is the main barrier to the significant adoption of pest management plans and ecological and cultural production systems, which are called for by the Bank's new policies.

In response to the demands of civil society organizations, in December 1998 the World Bank adopted an operational policy on pesticides and pest management that requires Bank-supported projects to reduce farmers' reliance on pesticides and promote alternative integrated pest-management methods that have a sound ecological foundation. It also prohibits the use of Bank funds for the purchase of hazardous pesticides.

PAN North America (Pesticide Action Network) analyzed the impact on pesticide use in 107 Bank projects approved from 1999 to 2003. It showed that the Bank's policy is just on paper, because

more than 90% of those projects continue to promote the use of pesticides; although they don't mention them directly, they invoke them using a different vocabulary. The Bank considers the private sector a key ally in global development, yet this collaboration tends to benefit the large corporations more than poor farmers. For example, the Bank financed more than US$ 250 million in pesticide sales from 1988 to 1995; from 1993 to 1995 all the contracts signed went directly to the largest pesticide companies in France, Germany, the United Kingdom, the United States, and Japan. While the farmers who participated in these projects suffered the negative health effects and detrimental impact on the ecological stability of their production systems that result from pesticide use, the Bank recognized that only 1% of the projects had a complete environmental evaluation.

1.9.5. On food (NOT DONE)

1.10. Conclusions

Since the 1960s, the transfer and development of knowledge, science, and technology in LAC were aimed at increasing the production of food and fibers accorded priority by the dominant western culture. The "Green Revolution" was a veritable success in terms of increasing food production, nonetheless it was a failure in terms of the objectives of improving the living conditions of the rural population in LAC (Evenson and Gollin, 2003). The technological packages developed in the research centers and implemented by the national and international rural development agencies contributed to the concentration of land in a few hands, and helped widen the gap between small and large producers who, because they had access to capital, were able to exploit these new technologies (Escobar, 1995). These technologies also had a disproportional impact on women and children (Jeggins, 1986; FAO, 1997), and led to the loss of jobs in rural areas. Recently, the Millennium Goals document (UN, 2005a) identifies the lack of jobs and their poor quality as one of the main problems facing the region. Input- and capital-intensive technologies (pesticides, fertilizer, and machinery, among others) have also resulted in environmental degradation, the erosion of genetic diversity, the loss of biodiversity, water pollution, and the contamination and homogenization of food (National Research Council, 1989; Pimentel et al., 1995; Pimentel, 1996; Matson et al., 1997; Tilman, 1999; Beman et al., 2004; Pretty, 2005; Ralyela, 2005).

This degradation of conditions in the countryside in LAC has been the main cause of stepped-up migration from rural areas to the cities, creating mega-cities with areas steeped in extreme poverty and a larger and in many cases impossible-to-satisfy demand for services in the largest cities of LAC (Davis, 2005). The structural adjustment programs promoted and imposed by the International Monetary Fund, in combination with economic liberalization, have provoked a massive rural exodus (Bryceson et al., 2000). In the first half of the 1980s alone, urban poverty in Latin America increased 50% (Potts, 1997). By the end of the 1980s most of the poor in LAC (115

million of 199 million) lived in the vast urban shantytowns called *barriadas*, *colonias* and *favelas*, among other names (UN, 1999). Today, 75% of the population of LAC is urban (UNDP, 2005) and the region has the five largest mega-shantytowns in the world, which bring together more than 11 million people (Davis, 2005).

Since the 1960s, international development agencies and the national governments of LAC have emphasized the need to increase the gross national product in the region, and in particular to boost agricultural production, since agriculture is the largest economic sector in low-income countries. The assumption behind this development program is that economic growth will eventually benefit all sectors of society. Nonetheless, economic growth during the 1960s and 1970s did not reduce poverty (Figure 1.1). The increase in the gross national product and the increase in agricultural production in LAC over the last five decades has not improved living conditions for millions of indigents in the region. The result has been greater inequality in the distribution of wealth, and in some countries poverty expanded. LAC has the distinction of being the most unequal region in the world in terms of income distribution, with a Gini coefficient greater than 0.50 (UN, 2005b). These inequalities are not only economic, but also social, and include territorial imbalances and inequalities based on ethnic group, gender, and age (Justino et al., 2003; UN, 2005a).

The paradigm of economic growth persists today, even though it has become clear that the development agenda in the last five decades has worsened inequality and has not improved the conditions of the poorest sectors in the region. This reality has become so evident that the World Bank, in its "World Development Report 2006," highlights the importance of equity for the development process. According to this report, economic growth has not reached the poorest persons on the planet. The situation is further aggravated if one considers that the poorest are the ones who suffer disproportionately the negative environmental consequences of such growth (Simms et al., 2004). Given this outlook, the economic development paradigm that the international development agencies have been promoting in the countries of LAC should be re-examined. Working from this development paradigm, the governments have favored and emphasized western science and technologies, ignoring the rich diversity of knowledge, cultures, and agri-cultures of the pre-colonial ethnic groups, as well as the concept of sustainability to be found in the cosmovisions of the indigenous peoples.

Although food production has overtaken population growth worldwide and in LAC, it is forecast that the region's population will continue to grow, albeit at a slower pace, and that changes in consumption patterns will increase the demand for food in the region (UN, 2005a). In the past, both intensive agriculture and large-scale commercial agriculture were justified as the only alternatives for being able to feed a growing population (FAO, 2004). More recently the industry and international research centers have been promoting transgenic crops as the "new Green

Revolution" which, it is argued, will enable us to increase production and ward off famine (Borlaug, 2000; Smil, 2000; Huang et al., 2002; Trewavas, 2002). Nonetheless, today it is being shown and accepted that it is possible to double and even triple food production with organic or agroecological agriculture (without agrochemicals or transgenic crops) (FAO, 2002; Pretty et al., 2003; IFAD, 2003, 2005; Badgley et al., in press). In addition, it is recognized that small producers not only are more productive and more efficient than large producers, (Cornia, 1985; Tomish et al., 1995; Gilligan, 1998; USDA, 1998; Rosset, 1999), but that they also contribute more to local economic development (Goldschmidt, 1978; Durrenberger and Thu, 1996; Langevin and Rosset, 1999) and to natural resource conservation (Altieri, 1995; Pretty, 1995; Netting, 1993) than large producers. This has led agencies like the World Bank and its leading economists to acknowledge that land redistribution and agrarian reform are needed to increase production, eliminate hunger and poverty, and improve the living conditions of the rural population (Bisnwanger et al., 1995; Stiglitz, 1998; Deininger, 1999; World Bank, 2006).

Despite the poverty, hunger, and sharp inequality besetting the region, there are positive aspects. The region has made considerable strides with respect to gender equity in education, improvements in access to drinking water, and a decline in infant morality (UN, 2005b). In the political arena there have also been improvements. The era of the dictatorships has been left behind, and most of the countries of the region have democratic processes under way, and have vibrant and broad local, national, and transnational social movements and grassroots movements (Gallicchio, 2004). These movements are experimenting with alternative models and forms based on the redistribution of wealth, democratic participation, and natural resource conservation and environmental protection (Escobar and Alvarez, 1992; Alvarez et al., 1998; Fals-Borda, 1997) and are building bridges to global movements through organizations and movements such as Vía Campesina and the World Social Forum (Fals-Borda, 2003).

Today, Latin America and the Caribbean finds itself at a crossroads. The region can either follow the same paradigmatic path of "trickle-down economics," with the hope that in a more globalized world economic growth will result in improved conditions for the majority, or it can face up to the weight of the evidence and choose other paths. This evaluation offers elements to help make informed decisions on the possible consequences of different development strategies and on the type of agricultural science, knowledge, and technologies needed to improve the conditions of the rural population, and therefore of the urban population, in LAC.

The role that agricultural knowledge, science, and technology have played in this economic development process has been crucial yet ineffective for eliminating poverty and hunger in the region. In addition, it has resulted in environmental degradation at unsustainable levels. For that reason, it is necessary to reassess agricultural knowledge, science, and technology in the context of sustainable development in Latin America and the Caribbean, and seek options, looking to the

future, that make possible the full realization of the aspirations of the Latin American peoples, without degradation of the natural resource base and the environment.

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