LAC 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 (Bolivia), Carlos J. Pérez (Nicaragua), Dalva Maria Da Mota (Brazil), Tirso Gonzáles (Peru), Jahi Michael Chappell (USA), Michelle Chauvet (Mexico), Eric Holt Jiménez (USA), Clara Cruzalegui (Peru), Ericka Prentice-Pierre (Trinidad and Tobago), Luis Fernando Chávez (Venezuela), Amanda Gálvez (Mexico), and Rosa Luz González (Mexico)

CONTENT

1.6 Recent Evolution and Current Situation of Agriculture in LAC

1.6.1 Importance of agriculture to Latin America and the Caribbean

1.6.2 Characteristics and trends in production in Latin America and the Caribbean

1.6.2.1 Available resources

1.6.2.1.1 Natural resources

1.6.2.1.2 Economic resources

1.6.2.1.3 Technological resources

1.7.2.1.4 Labor

1.7.2.1.5 Market Trends

1.6.2.2 Regional trends in production

1.6.2.2.1 Transgenic crops

1.6.2.2.2 Nanotechnology

1.6.2.2.3 Agrofuels (bioenergy crops)

1.6.2.3 Food chains

1.6.2.4 Sociocultural characteristics

1.6.2.5 Knowledge

1.6.2.5.1 Knowledge, culture, and agricultural development

1.6.2.6 Gender aspects

1.7 Performance of Production Systems

1.7.1 Productivity

1.7.2 Sustainability

1.7.2.1 Traditional/Indigenous System

1.7.2.2 Conventional/Productivist System

1.7.2.3 Agroecological system

1.7.3 Quality and food safety

1.7.4 Impacts of the Production Systems

1.7.4.1 Environmental impacts

1.7.4.1.1 Agriculture general impacts

Key Messages

1) 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.

2) 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 and includes the peasant systems. The conventional system has a market-based approach, is focused on intensive production practices and tends towards monoculture and the use of external inputs. The agroecological/organic system is based on the combination of agroecology and traditional knowledge, and favors the use of organic inputs and the integration of natural processes.

3) The environmental and social vulnerability of Latin American agriculture is one of the results of implementing the development models prevalent in the last 50 years. The development models of the last 50 years have accorded priority to capital- and technology-intensive production systems that consume large quantities of fuels from non-renewable sources, are oriented to the external market, with limited social benefits. In the traditional/indigenous production systems the effects of those models are expressed mainly in their displacement towards the agricultural frontier causing deforestation, erosion of resources, and loss of biodiversity. The agroecological/organic systems, in the context of the predominant models, are geared to market segments with high purchasing power, which excludes large social sectors from their benefits.

4) Agricultural productivity has increased in the last 50 years; nonetheless, this has not resulted in a 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, factors such as the lack of access to and distribution of foods, and the low purchasing power of a large sector of the population, 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 hunger and malnutrition in the region. To the contrary, one of the main problems in the rural sector has the importing of foods from other countries where production is subsidized.

This supply 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.

5) LAC 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 percent of the world's arable land, and 28.5 percent 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 percent 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 percent of available lands. Moreover, there is a steady loss of soil and diversity due to problems of erosion, urbanization, pollution, and expansion of agriculture.

6) Most of the region's rural population has lost or experienced a diminution of their access to and control over the use and conservation 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, and to other countries. 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.

7) While the policies favoring the opening up of trade have created market opportunities for the countries of the region, they have increased the vulnerability of small and medium producers in the region, benefiting almost exclusively the large producers. The free trade agreements and structural adjustment programs fostered by the international financial institutions and adopted by the national governments 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, the producers have reacted by forming cooperatives and developing alternative markets, in particular the fair trade market and the market for organic produce. Many large producers have successfully inserted themselves in the international market.

8) In LAC, approximately 25 percent of the inhabitants live on less than US$ 2 a day. These levels of poverty have persisted despite economic growth in the region. Per capita GDP in Latin America and the Caribbean declined 0.7 percent in the 1980s and increased 1.5 percent in the 1990s, without poverty levels changing significantly.

9) Malnutrition and hunger have a detrimental impact on the potential for development of the countries of the region and increase susceptibility to disease. In percentage terms, the undernourished population in Latin America and the Caribbean fell from 13 to 10 percent from 1992 to 2003. Nonetheless, the region continues to have a population of 54 million persons who are undernourished, with stark regional differences. For example, in Mesoamerica undernourishment increased from 22 to 25 percent during that same period. This under of undernourished inhabitants means vulnerability to disease, the impossibility of having a normal educational performance, and therefore the inability to participate efficiently and productively in development processes.

10) In LAC, food dependency has been exacerbated as a result of neoliberal globalization. The importation of subsidized food products has dismantled local production systems, creating 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. This has resulted in the loss of food sovereignty, especially in the most vulnerable sectors of the region.

11) The performance of the agricultural systems is mixed in terms of production and sustainability, as well as environmental impacts. The traditional/indigenous system stands out the diversity of species and ways of life, with variable levels of production (from high to very low). 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. The agroecological system stands out for its high productivity and sustainability, and growing access to a market niche for certified organic products, yet this system 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.

12) 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 also connectivity between fragments of natural habitats.

13) In LAC, emigration is on the increase as is the vulnerability of the rural population. This is due to the substitution of a large part of the agricultural labor force by machinery and technologies, provoking a reduction in the number of farms due to the concentration of landholdings; the loss of land tenure by peasants and indigenous communities; rural violence; and population increase.

14) In LAC, cultural diversity, local/traditional knowledge, and agrobiodiversity are being lost. 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 selected with scant participation of the peasant and indigenous communities. This process of cultural and technological erosion has been casting aside an ancestral rural cultural heritage, with local content, adapted to their surroundings, yielding to external, more uniform knowledge and cultures.

15) The health of rural communities in LAC has been detrimentally impacted by problems of acute and chronic intoxications in the countryside due to the indiscriminate use of agrochemicals. For example, in Central America, the Plagsalud program of PAHO/WHO estimated 400,000 acute intoxications per year; underregistration is estimated at 98 percent. The problems of intoxication are worse in rural areas because no occupational health programs have been put in place for farmers, nor are there health services specifically geared to treating intoxications due to exposure to pesticides, causing several chronic diseases that reduce the capacity to generate income. Children, the elderly, the infirm, and the malnourished are the most vulnerable, compromising the right to life and human dignity.

16) 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 and the Caribbean, in general, as the participation of men in agriculture diminishes, the role of women 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."

17) Transgenic crops 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. Transgenic crops are used in commercial production, especially of cotton, soybean, maize, and canola. The social and environmental repercussions are differentiated for each of these crops and by countries of the region. The technology has been adopted quickly by the producers of the conventional/productivist system, increasing profitability, but in some regions it has also accentuated the above-mentioned social and environmental deterioration. Biosafety policies are recommended that impede the consumption and cultivation or transgenic organisms in countries that are the centers of origin of those crops, so as to avoid contamination and preserve genetic diversity. In regions that are not centers of origin, regulatory arrangements should be guided by the precautionary principle. The possibility of genetic contamination in some species has been demonstrated, and it should be an essential part of biosafety policies, which should also take into account transgenic edible crops used for the production of non-edible nutraceuticals, biopharmaceuticals, or industrial products.

18) Policies for alternative energy supply based on renewable resources, motivated by the worldwide energy crisis, presents opportunities and threats to the agricultural sector, thus their externalities should be carefully analyzed. Agricultural production for use in alternatives to fossil fuels has increased quickly in recent years in LAC, benefiting some economic sectors and providing alternative markets to the agroindustrial sector. Although the development of these crops offers an opportunity for rural revitalization, there are risks of negative environmental and social impacts. In LAC the expansion of crops for biofuels based on just a few species, such as sugar cane, oil palm, soybean, and timber species, is diminishing food the production by substitution or displacement, with a negative impact on food security in some regions, and with a detrimental impact mainly on small producers, indigenous populations, and other traditional communities. The use of byproducts or animal and plant waste is another source of biofuels, whose use attenuates environmental problems.

19) The structures of agricultural regulation in LAC are not institutionally adequate, resulting in regional weaknesses such as low competitiveness and the vulnerability of the endemic natural patrimonies. There are some 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. The understanding of these agreements by countries 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 Objectives and Conceptual Framework

Latin America and the Caribbean (LAC) has a population of 569 million persons, 209 million of whom are poor, and 81 million of whom suffer extreme poverty, most of whom live in rural areas (ECLAC 2006; FAO, 2006b; UNDP 2005b). The region has great biodiversity and an abundance of natural resources, which contributes to the production of 36 percent of the cultivated foods and industrial species worldwide. Nonetheless, these resources are rapidly degrading (UNEP, 2006). 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, Ferranti et al., 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.

The document, The Millennium Development Goals: A Latin American and Caribbean Perspective (UNDP, 2005a), concludes that the region produces sufficient food to meet the nutritional needs of all its inhabitants. Though this is not uniform across the region, all the countries, including those with a high rate of malnutrition, have a food energy supply of more than 2,000 kilocalories per person per day, which exceeds the minimum recommended for an adult (1,815 kilocalories) (Figure 1.1). In all, the region produces three times the quantity of food it consumes (UNDP, 2005a). These data suggest that hunger and malnutrition in the region 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.

[Insert Figure 1.1: Support of food energy of the countries of Latin America and the Caribbean)

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

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).

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, in particular an evaluation of the performance and impacts of the three main systems of production in the region: the indigenous/traditional, the conventional/productivist, and the emerging agroecological system. The conceptual framework, context, and current situation (Chapter 1), 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.

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 and poverty reduction.

The conceptual framework (Figure 1.2), taken as a reference for developing the content of this report, seeks to understand and analyze the interrelations of the agricultural knowledge, science, and technology systems (hereinafter AKST systems), the agricultural production systems, and the contextual factors and variables as a basis for retrospective and prospective analysis of their contribution to the attainment of the objectives of development and sustainability. The 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. The AKST systems aim to improve the performance indicators of agricultural production systems through processes of technological innovation.

(Insert Figure 1.2: Conceptual Framework)

In the conventional approaches to systems, the vulnerability of agricultural production systems is conceived of based on the world view of the outside expert who acts under his or her universal conception of reality on the local views and interests and reproduces a division of labor in the process of generating, accessing, and using knowledge that transforms producers in mere receptacles of values, concepts, and paradigms generated far from their context, and without any commitment to their needs, demands, or aspirations. This linear mode of intervention, in which just a few generate, others transfer, and the thousands of producers adopt the technological innovations, has prevailed in the last 50 years. To the contrary, in the Agricultural Information and Knowledge Systems approach, the systems are considered to be a social construct in which the actors who constitute it perceive their interdependence, come to agreement on the present and future systematic vision, negotiate principles, premises, objectives, strategies, and courses of action, and systematize their experiences and lessons through semi-structured processes of interpretation and intervention negotiated through the integrated management of knowledge and innovation. The integrated management of knowledge and innovation suggests identifying the world view – conception of reality – that conditions the ways of thinking and acting of those who interact to transform their reality, and therefore is centered on the changing web of relationships and meanings that influence perceptions, decisions, and actions in human initiatives. Accordingly, this mode of intervention considers the actors of the social context in which the new technologies are generated and applied as being co-responsible at every stage of the process of generating, validating, and using the relevant information and technologies for innovation in agriculture.

Agricultural production systems include all the activities for producing food, fibers, energy, biomass, and environmental services such as landscape management and carbon sequestration. These productive and services activities entail the social and economic organization of the labor force, rural resources, and information (direct drivers) with different performances in light of indicators such as efficiency, productivity, competitiveness, equity, quality, and environmental sustainability.

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 (indirect drivers), including social, economic, institutional, cultural, political, and environmental. The critical external factors are capable of bringing to bear strong influences on agricultural production systems, determining internal obsolescences, shortcomings of capacities and resources, and flaws in their relationship with the external environment.

In Latin America and the Caribbean, the progress made to attain the millennium development goals does not show significant progress so as to indicate with certainty that poverty will have been cut in half by 2015 (UNDP, 2005a). Progress in the region, in this regard, measured based on the index of purchasing power parity of individuals and progress in fighting malnutrition and hunger, indicates that the region has a trend towards impoverishment and that the number of malnourished persons in the region has diminished very slowly. In particular, in LAC in the last 10 years the number of poor, and inequality, has increased (Cardoso and Helwege, 1992; Rosenthal, 1996; Berry, 1998; O'Donnell and Tockman 1998; Portes and Hoffman, 2003; Hoffman and Centeno, 2003; ECLAC, 2004; Ferranti et al., 2004).

Notwithstanding the great biodiversity and availability of natural resources, the rate of degradation of those resources is the highest in the world, largely because of the type of agricultural development (industrial productivist model) pursued over the last 50 years. From 1970 to 2000, on average six hectares were deforested daily, only 60 percent of which was incorporated to agricultural production; the remaining 40 percent were abandoned due to problems of degradation and speculation (UNEP, 2002). 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 social learning (Bhouraskar, 2005), through human interaction (Röling, 2003), negotiated to create consensus-based actions that transcend particular private interests. 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, this evaluation is done based on the premise 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. Therefore, it is urgent to undertake a critical analysis of the factors that gave rise to the present-day situation of poverty, hunger, inequality, and environmental degradation so as to avoid falling once again into the same trap, and to be able to propose options with real possibilities of change.

The schema for generating knowledge, the process of social learning, and the innovation in agriculture which, it is hoped, will produce the conditions for and viability of human development is characterized and influenced by a dynamic context in which development processes are the result of policies formulated and applied based on the objectives and promises of the socioeconomic development models. In order for the AKST system to have a positive impact on the changes, leading to improvements in the standards of living and quality of life, the system has to be sensitive to stimuli and indicators that point to the degrees and nature of the changes demanded for attaining the development and sustainability objectives, taking into account alternative future scenarios.

Constructing scenarios is a methodology used to support the understanding of the future, and, accordingly, decision-making on current policies and strategies. The scenarios offer a likely vision, distant in time, of the nature of complex phenomena and as to how one reaches that expression based on the present-day situation and a model of how different sorts of phenomena will evolve (social, economic, environmental, technological), and interact. The use of scenarios makes it possible to manage the uncertainty that necessarily characterizes the future, depending on premises on decisions of the social actors in relation to various macro variables.

Accordingly, applying the conceptual framework proposed entails, first, characterizing the global and regional context in which both the AKST systems and the agricultural production systems are found, and analyzing the recent history and current situation of Latin American agriculture with special emphasis on the performance of production systems. This assessment, along with an assessment of the AKST systems (Chapter 2) and an elaboration of plausible future scenarios (Chapter 3) will be an input for proposing a series of realistic options that may contribute to attaining the goals of reducing poverty, hunger, and inequity, as well as attaining environmentally sustainable development (Chapters 4 and 5).

1.2 Latin American and Caribbean 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 (includes peasant),
2. Conventional/Productivist;
3. Agroecological.

The importance of each of these systems varies not only among subregions, but also within each subregion and even within each country. Table 1.1 presents a description of the principal characteristics of these three agricultural systems (the performance and impacts of these three systems are presented in section 1.7).

(Insert Table 1.1 Description of agricultural systems)

The *traditional/indigenous* system is a family agricultural system, primarily involving family consumption, under which one can distinguish the ethnic systems constituted by indigenous and Afro-descendant communities linked to the territory, and the peasant systems. It is based on local/ancestral knowledge, and is hardly articulated to the market for inputs and products, though today many peasants market part of their production. 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, 2007). 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. (For the example of the Andean world view, see Figure 1.3). This system 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 (David et al., 2001; Deere, 2005). 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 (see Section 1.6.2.5).

(Insert Figure 1.3: Andean Cosmovision)

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 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 (see Section 1.7).

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. This system is characterized by the search for sustainability in social, economic, cultural, and environmental terms; scant articulation in productive chains; and a strong link to the market for differentiated products, especially organic products.

The systems described are expressed in the subregions with differentiated nuances and through mixed forms or particular combinations.

1.3 Regionalization

Latin America and the Caribbean is a very extensive and varied geographic region. It extends from Baja California (32 1/2^0 N) to Tierra del Fuego (55^o S) and has a total of 2.050 billion hectares (including internal bodies of water) in 45 countries with 569 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). 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)

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 types of production associated with these zones. Table 1.3 shows the agroecological zones of the region as well as the principal types of agriculture in these zones.

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

1.4 Global Context: Main Trends

To perform a critical evaluation of the AKST systems and of agriculture in Latin America and the Caribbean, one must know the context in which these systems operate. This section presents the main trends of the global context, and the next section presents the regional context that impact on the AKST systems.

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 in our region (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-Guerra, 2003; de Souza Silva et al., 2005). The main trends globally can be grouped in: (1) technological changes, (2) macroeconomic changes, especially globalization, (3) the emerging resistance movements with new outlooks, and (4) environmental/natural changes.

Among the main technological changes we see the emergence of an immaterial economy dependent mainly on an intangible factor — *information* — and on the communications infrastructure. From this technology is emerging a digital hemisphere whose dynamic is dependent on virtual networks of power through which flow capital, decisions, and information. The rise of the network concept, supported by new possibilities of digital technology and communications infrastructure, has implications for the management of interdisciplinary, inter-institutional, and international projects. Also worthy of special note are 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 nations.

Globalization has seen the acceleration of 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. This model has led to 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. Under this new model one notes, among other things, the end of the social contract between capital and labor under the notion of "labor flexibility," and the construction of transnational productive chains outside the control of nation-states and local actors through technological convergence and productive decentralization, as well as a process of homogenization that has led to the very fast erosion of cultural diversity.

The process of globalization has not been accepted passively by the governments and peoples of the region. The last decade has seen the formation of regional and subregional economic blocs for internal integration (economic, technological, and political) and to counter external competition, as well as a struggle to establish a *global civil society* dependent on *participatory democracy* networks and emergence and proliferation of social movements to vindicate and uphold the importance of the interdependence among human, social, and ecological considerations. These trends towards participatory democracy through social movements include the struggle for sustainable development mediated by the creation of a global civil society to monitor the excesses of transnational corporate capitalism; 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 struggle for indigenous rights; and the struggle to control (and in general contest) the products of science and even the process of doing science (anti-GMO groups, anti-human cloning groups, and groups to stop animal suffering, among others).

Finally, the environmental changes, particularly the loss of biodiversity and global warming, have assumed a central role in the different forms of international discourse. Climate change, for example, has been included as an item for discussion at the United Nations Security Council, even though not all the members of the Security Council approve its inclusion. There are also multiple international agreements related to biodiversity and agriculture, which are crucial in an agricultural development agenda for the region, mainly when knowledge, science, and technology are thought of as instruments for propelling such development. The most important initiatives for harmonizing regulatory frameworks in agriculture include (a) the Cartagena Protocol on Biosafety, which seeks to protect biodiversity in light of the risks associated with genetically modified organisms (transgenics); (b) the International Plant Protection Convention (IPPC), which seeks to prevent the dissemination and introduction of pests that affect plants and plant products, and to promote appropriate measures for combating them; (c) Codex Alimentarius, created in 1963 by the FAO and WHO to development food standards, regulations, and other related texts, such as codes of practices under the Joint FAO/WHO Food Standards Program; (e) the World Intellectual Property Organization (WIPO). to foster the protection and effective use of intellectual property worldwide through cooperation with the member states and other interested parties, and among them; (f) the International Union for the Protection of New Varieties of Plants (UPOV), an intergovernmental organization for the protection of new plant varieties; and (g) the International Treaty on Phytogenetic Resources for Food and Agriculture.

There are other agreements related to controls on international trade and the use of potentially toxic substances, which largely have to do with agriculture because they include chemical pesticides that pose a high risk to the environment and human and animal health, such as: (a) the Basel Convention on the Transboundary Transport of Toxic Substances; (b) the FAO Code of Conduct on the Distribution and Use of Pesticides; (c) the Montreal Protocol for Substances that Deplete the Ozone Layer; (d) the Rotterdam Convention, which established the prior informed consent (PIC) procedure for trade in prohibited or severely restricted substances; and (e) the Stockholm Convention on Persistent Organic Pollutants (POPs), which includes more than a dozen organochlorinated pesticides, including DDT (Bejarano, 2004; UNEP, 2001).

As a result of these global changes, 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. For example, 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, and by 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. 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 (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).

Countering these trends one finds the rise of very strong rural social movements and indigenous movements that propose alternatives for autonomy, food sovereignty, agroecology, and peasant networks (Vía Campesina, MST, and the World Social Forum, among others), as well as the growing include of consumers who demand local, organic, socially fair, diverse, nutritional, and safe foods (Slow Food Movement and consumers' associations).

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 review 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.

1.5 Regional Context

1.5.1 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 that promoted and continue to promote development models that impact 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. Consequently, 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, 2003). 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, 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 percent, yet during the same period hunger in the region increased 19 percent (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 (IDB, 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, Glaeser, 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 LAC. 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 and Caribbean economies in the 1980s led the Inter-American Development Bank to name 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 LAC 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, 2003), in particular, policies to (1) ensure fiscal discipline (putting finances in order, fiscal responsibility, cutting public spending, and voluntary retirement plans, among others); (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 and the Caribbean 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 had mixed effects (Gratius and Stiftung, 2002; Lederman et al., 2003; Gallagher, 2004). NAFTA, the free trade agreement among the United States, Canada, and Mexico, exemplifies the mixed effects of these treaties. For example, a study by the World Bank concluded that due to NAFTA Mexico has come closer to the levels of development of the United States and Canada (Lederman et al., 2003). The study estimates that without NAFTA, the levels of exports and foreign investment would have been 25 percent and 40 percent (respectively) less than what was obtained with NAFTA. On the other hand, the study concludes that the environmental cost of economic growth in Mexico in the years in which NAFTA has been in force have been 10 percent of annual GDP, or US$ 50 billion annually in damages (Gallagher, 2004). In addition, it is argued that under NAFTA the government of Mexico has lost the capacity to protect the environment and human rights, and that its citizens are losing the right to participate democratically in determining the course and priorities of their development (Gratius and Stiftung, 2002).

Following the neoliberal 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 (Ferranti et al., 2004).

In summary, the development models that have guided the economic policies, and, therefore, agrarian 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.

1.5.2 Social context

1.5.2.1 General situation of poverty in Latin America and the Caribbean

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 (such as food, housing, education, health care, drinking water), resources (productive resources, employment, income), and sociopolitical conditions (human rights, economic, social and cultural rights, political rights) 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.

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.

In 2005, Latin America and the Caribbean had a total population of 569 million persons, 77.6 percent of whom are urban and 22.4 percent rural (ECLAC, 2006). At the same time, the region has a population of 209 million poor persons, 81 million of whom are living in extreme poverty (ECLAC, 2006). Of the poor, children and youth are hardest hit, as they account for approximately 60 percent of the poor as of 2002 (Dirven, 2004; ECLAC, 2003).

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 (2006), the number of poor diminished in relative terms only 8.5 percent from 1990 to 2005, from 43.3 percent to 39.8 percent of the total population, whereas the number of persons living in extreme poverty diminished, in the same period, from 22.5 percent to 15.4 percent. In the rural areas the downward trend is similar, yet poverty only declined in real terms from 65.4 percent to 58.8 percent of the rural population.

According to almost all indicators, LAC 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 Centeno, 2003; ECLAC, 2004; Ferranti et al., 2004). The Gini coefficient[2] for the region is 0.52, whereas for 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.

[2] The **Gini coefficient** is a measure of inequality developed by Italian statistician Corrado Gini. Normally it is used to measure income inequality, but it can also be used to measure any form of unequal distribution. The Gini coefficient is a number between 0 and 1, where 0 corresponds to perfect equality (everyone has the same income) and 1 corresponds to perfect inequality (one person has all the income and everyone else has none). The **Gini index** is the Gini coefficient expressed as a percentage, and is equal to the Gini coefficient multiplied by 100.

The worst cases are Bolivia, Brazil, Honduras, Colombia, Nicaragua, Dominican Republic, Chile, Guatemala, Paraguay, Mexico, and Argentina (Table 1.4).

(Insert Table 1.4: Gini index 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). Nonetheless, the impact of poverty in LAC continues to be greater among rural residents, especially among women. Economic globalization and neoliberal policies have impacted the characteristics of the contemporary rural labor market, reducing to a minimum or eliminating government protection for workers, increasing unemployment and underemployment, and displacing small producers (Valdés, 2005). Nonetheless, there have been areas in which non-traditional export crops have expanded opportunities for rural employment, especially among women, though these jobs are often seasonal, poorly paid, and under precarious conditions involving mistreatment and discrimination (Deere, 2005) (see section 1.6.2.6).

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) does not reflect the complexities of the situation. First, it should be noted that four large and relatively urbanized countries – Brazil, Mexico, Colombia, and Argentina – dominate regional statistics. Second, surprisingly little is known of the degree of rural poverty in the region, since the estimates of poverty 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 is information in the region that clearly illustrates the rural situation. For example, 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 at least five countries (Colombia, Brazil, Venezuela, Mexico, and Panama) poverty is disproportionately distributed in rural areas. Finally, 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 (2006), 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 (see section 1.6.2.6).

In terms of the levels of education, the illiterate population 15 years and over, accounts for 9.5 percent of the total population in this age group in LAC (ECLAC, 2004). Illiteracy is 10.3 percent among women and 8.8 percent among men. The drop-out rate is 37 percent 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 (UNDP, 2005a). 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, for most of the countries, those rates are considerably greater in rural than in urban areas (ECLAC, 2006). 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), reports that chronic malnutrition in the region affects 15 percent of children under five years. In most of the countries of the region, children in rural areas, where food is produced, have the highest levels of malnutrition (Dirven, 2004). In addition, an inverse relationship has been noted between malnutrition and agricultural output. Group I countries, with malnutrition of 0 to 10 percent, have 400 percent greater per capita food production than group II countries (malnutrition of 10 to 20 percent), and have 320 percent greater per capita food production than group III countries (malnutrition of 20 to 65 percent).

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) (see section 1.5.3).

1.5.2.2. 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 hectares (UNEP, 2002), equivalent to 30 percent of the arable land in the world, and 28.5 percent of the total land in the region (2.018 billion ha). Nonetheless, the region has the greatest inequality in land distribution in the world (Figure 1.4; Ferranti et al., 2004). Historically, the land tenure systems in LAC 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.

(Insert Figure 1.4: Inequality in land distribution in different regions of the world)

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, 1997). The reforms were limited in terms of the redistribution of land, and allocation of land was not accompanied by supplemental measures (such as technical assistance, loans, and market access) 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 (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 (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 (Gunter, 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 seasonal 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, several analysts 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 (Thiesenhusen, 1996; Rosset et al., 2006). Indeed, 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, LAC is the region with the most unequal land distribution in the world. 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 hectares 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 (CLADEHL, 2002).

As a result of the great inequity in the distribution of land, the region is the home to many social movements that advocate the rights of the landless. These include the Movimento dos Trabalhadores Sem Terra (MST) in Brazil, which is considered the largest social movement in the region, bringing together approximately 1.5 million landless persons in 23 of Brazil’s 27 states (Wolford, 2003) (see Box 1.1).

(Insert Box 1.1. Land distribution in Brazil and the role of the MST)

1.5.2.3 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).

There are many different definitions of food security. In 1996 Maxwell drew up a list of 32 possible definitions (Runge et al., 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 various perspectives that are part of 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). Based on this concept of food security, the city of Belo

Horizonte in Brazil developed a food security program that has been recognized internationally (see Box 1.2).

(Insert Box 1.2 Belo Horizonte's food security program)

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)[3] was begun (FAO, 2006b). In 1996, more than 180 nations participated in *World Food Summit* and 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.

Within the free-market paradigm of the WTO, food security has been given a different definition, and went from meaning the growing capacity of the developing countries to produce food for their own consumption, to meaning merely access to cheap food, supplied by the developed countries or by the agroindustrial sector (Glipo, 2003).

By way of contrast, the concept of food sovereignty was developed by Vía Campesina[4] as an alternative to neoliberal policies, and was brought into the public debate at the World Food Summit in 1996. Since then, that concept has become a major topic of the international agrarian debate, including in the United Nations bodies. Food sovereignty was the main topic of the NGO

---

[3] 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, http://www.fao.org/SPFS/index_es.asp). 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.

[4] Vía Campesina is a global movement that brings together organizations of peasants, small and medium producers, rural women, agricultural workers, and indigenous communities in Asia, Africa, the Americas, and Europe.

forum held parallel to the FAO's World Food Summit in June 2002 (Vía Campesina, 1996; Desmarais, 2002).

Vía Campesina defines food sovereignty as the right of the peoples, their countries, or unions of states to define their own agrarian and food policy, without dumping with respect to third countries.

The concept includes: Prioritizing local agricultural production to feed the population and 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 equitably and sustainably (Vía Campesina, 2003). The concept of food sovereignty has come about as a reaction to the definition of food security, which promotes the notion that everyone should have food, but doesn't specify where it will come from, or who will produce it, and with that, this concept allows for control of food by the large multinational companies and may contribute to creating more dependency, poverty, and marginalization. Vía Campesina also supports the concept of food as a right (see Box 1.3). The concept of 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; Niéleny, 2007).

(Insert Box 1.3: Food as a right, in the context of the United Nations)

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 often not those grown and consumed by the local populations (Grain, 2005). Food sovereignty has a broader dimension, since it 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 the concept of food sovereignty argue that to attain a world without hunger one must place the communities center stage (Grain, 2005).

The Pesticide Action Network-Latin America (RAP-AL, 2007) adds that food sovereignty also has to do with the agricultural production system, considering that agriculture that depends on imported and contaminating seed and chemical inputs does not allow for food sovereignty, which is why they support agroecological alternatives.

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 goals of sustainable development. For the developing countries, food sovereignty encompasses the demand that the

World Trade Organization (WTO) put an end to its control over food and agriculture. Food sovereignty basically recognizes that small farmers and landless peasants will never be able to compete in the entrepreneurial agricultural paradigm (Desmarais, 2002; Glipo, 2003; Rosset, 2006).

To the extent that food sovereignty incorporates fundamental aspects of economic equity, 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 (Glipo, 2003) and represents the paradigm that is an alternative to market fundamentalism.

1.5.3 Economic context

It is generally accepted that economic growth can contribute to fighting poverty (Adelman and Morris, 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 economic growth. On average, a 10 percent increase in poverty reduces annual growth 1 percentage point (World Bank, 2006).

As mentioned above, Latin America and the Caribbean is the region with the highest levels of inequality in the world (ECLAC, 2004; Ferranti et al., 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, some analysts argue that market-oriented reforms will eventually lead to economically sustainable growth, greater equity, and a better standard of living for the population (Lustig, 1995; Sadoulet and de Janvry, 1995; Lederman et al., 2003). Nonetheless, others argue that globalization is worsening the lives of millions of Latin Americans. The statistics show that although in the 1990s (the decade of structural adjustment programs and neoliberalization) there was moderate economic growth, the number of poor by the mid-1990s was 210 million, i.e. 50 million more than the average throughout the “lost decade” of the 1980s (ECLAC, 1997; Londoño and Szekeley, 1997). On the other hand, the modest increase in economic growth has not improved the levels of inequity in the region, which, for most countries, are still greater than the levels prior to the 1980s (Birdsall and Londoño, 1997; Korzeniewicz and Smith, 2000).

In addition, 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 (Aguirre Rojas, 2005; 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, 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; Rosset, 2006).

Finally, in the economic context one cannot ignore the role of family remittances. The flow of money in the form of remittances has become a major source of financing for many countries of LAC. In the last 10 years the growth in remittances has surpassed the growth of private capital investment and development assistance (Acosta et al., 2007). Although this is a trend worldwide, LAC is the region with the greatest volume of remittances in the world, with a flow of US$ 40 billion in 2004 and 27 percent of all remittances to non-industrialized countries (Acosta et al., 2007). In part, due to remittances many countries in Central America and the Caribbean have been transformed from agroexport economies to labor-exporting economies (Orozco, 2002). The volume of family remittances in LAC began to grow in the 1980s, and that trend continues and is even more accentuated today. For example, remittances received in Mexico increased from US$ 1 billion in 1980, to US$ 3 billion in 1990, to US$ 6 billion in 2000, and by 2004 reached US$ 18 billion (Orozco, 2002; Acosta et al., 2007). For Haiti, in 2004 family remittances accounted for more than 50 percent of GDP, and for Jamaica, Honduras, El Salvador, the Dominican Republic, Nicaragua, and Guatemala, the accounted for 15 to 20 percent of GDP (Figure 1.5; Acosta et al., 2007). In El Salvador, remittances occasionally exceed the total value of exports, and in Nicaragua and the Dominican Republic they represent more than half of the value of exports (Orozco, 2002). In some countries of LAC remittances have became a major source of support for the communities. Although very little is known about the impact of remittances on poverty, a recent study suggests that remittances contribute to economic growth of the region, and to diminishing inequalities (Acosta et al., 2007).

(Insert Figure 1.5: Remittances in Latin America and the Caribbean)

1.5.4 Political context

In LAC, the 1980s saw the fall of the last military dictatorships and a process of democratization unfolded which, albeit with many shortcomings, provided a political opening to the most excluded sectors. In addition, in the region (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 regimes (Aguirre Rojas, 2005). 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 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 advocating internal changes that are important in the context of this evaluation, although they do not yet have the political strength that would enable them to bring about substantial changes. 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) demands for agrarian reform, especially land redistribution; (3) demands relating to access to and control and sustainable management of natural resources, including mining and energy resources and water; and (4) the insertion of the concept of food sovereignty in the debate nationally and internationally.

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 (Kearney, 1996). 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. Nonetheless, as mentioned above, the indigenous movements have strengthened significantly, becoming an important political force in some of the countries with the largest indigenous populations, such as Bolivia, Peru, Mexico, Guatemala, and Ecuador (Varese, 1996; Warren and Jackson, 2003; Yashar, 2005).

1.5.5 Environmental context

1.5.5.1 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 et al., 2001); it has 40 percent 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 twelve countries with the highest number of globally threatened bird species are found in the region (UNEP, 2002). Unfortunately, there is little data to have an idea of the extent to which arthropod species are threatened.

The Latin American region possesses 28 percent of the world's forest area, almost a billion hectares in total (World Bank, 2005a); 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, and more recently soybean production has been one of the major driver for the region as a whole (Angelsen and Kaimowitz and Smith, 2001; Ledec, 1992). The overall annual deforestation rate from 2000 to 2005 in the region is estimated at 0.51 percent (World Bank, 2005a), 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. However, since 2004 deforestation in the Brazilian Amazon fell by 60 percent due to stepped up enforcement efforts (Presidencia da República [Brazil], 2007) and lower commodity prices, namely beef and soybean, and the strong Brazilian currency, which has lowered the level of land speculation (Butler, 2007). However, the growing demand for corn ethanol means that less soybean is being planted in the United States and Brazil, the biggest producer of soybean in the world, is making up the shortfall by clearing new land for soybean cultivation. Whether it will result in an increase in deforestation rates in the Brazilian Amazon or the *cerrado* remains to be seen (Butler, 2007). Soybean expansion has also impacted forests in Argentina, where the rates of deforestation have increased dramatically in the last decade (Grau et al., 2005). 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 were 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).

1.5.5.2 Climate change and agriculture in Latin America and the Caribbean

LAC 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.

The Intergovernmental Panel on Climate Change (IPCC, 2007), in its latest report, forecasts a change in temperature of up to 5.8 degrees for this century. This climate change has the potential to create local and regional conditions that include deficits and surpluses of water, sometimes seasonal in the same geographic locations (Table 1.7). The potentially grave impacts that can be expected, according to the IPCC, are a considerable increase in heat waves, storms, floods, landslides, and avalanches unleashed by the forecast increases in the intensity of precipitation and the rising sea level. There may be health problems in human beings, livestock, and crops due to the greater incidence of pests and insects that are vectors of disease.

(Insert Table 1.7: Climate change in some countries of LAC)

In addition, an increase is predicted in the sea level of up to 88 centimeters in this century, affecting (due to the intrusion of sea water in the soils subjacent to arable lands, and also due to temporary and permanent flooding) approximately 30 percent of the agricultural regions worldwide. It is believe, in particular, that riparian and coastal settlements are at risk, but urban floods may also be a serious problem for water supply and for waste management systems that have not been designed with sufficient or modern capacity so as to keep their capacity from being overtaken, and to prevent the spread of tropical diseases. The IPCC (1997, 2001) had already identified 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 LAC 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 LAC have the potential to alter 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, 2001a). 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 these regions, 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, soybean, and wheat), even taking into consideration fertilization with carbon dioxide and moderate adaptations by producers (IPCC, 2001a).

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). Box 1.4 illustrates the relationship between changes in agriculture (which are often governed by climate changes) and the emergence of infectious diseases.

(Insert Box 1.4: Emergence of infectious diseases and agriculture)

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 (2001b) concludes that the alterations resulting from climate change have a high potential to impact negatively on the ways 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 reduce the emissions of gasses the contribute to climate change, or to implement risk management strategies and promote 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 1.5).

(Insert Box 1.5: Resistance of agroecological systems to the impacts of Hurricane Mitch)

1.5.6 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 and Afrodescendant cultures.

The indigenous population of LAC accounts for about 10 percent of the total (IDB, 2004; Hall and Patrinos, 2005). 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, 2007), 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). 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 percent of the region's protected areas (Colchester and Gray, 1998). In Central

America the percentage increases to 85 percent (Oviedo, 1999). Toledo (2003), for his part, notes that nearly 60 percent 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, 2007). 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.

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). 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, 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.

1.6 Recent Evolution and Current Situation of Agriculture in LAC

1.6.1 Importance of agriculture to Latin America and the Caribbean

Agriculture is much more than simply the production of economically important goods. As a source of food for human beings and animals, fiber, materials for construction and for crafts, oil, and fuel, agriculture is vital for the cultures and communities that produce them, and plays a critical role for the goals of sustainable development and reducing poverty and inequality. Recently special emphasis has also been placed on the role of agriculture in providing environmental services such as mitigation of the effects of climate change, regulation of the water cycle, erosion control, maintenance of habitats for wildlife, and preservation of landscapes and places of religious importance. In this sense, agriculture is a multifunctional activity (Chaparro, 2000; Cahill, 2001; Dobbs and Pretty, 2004; Brunstad et al., 2005). This doesn't mean that agriculture can simultaneously satisfy all these functions, since that depends on specific contextual characteristics. Nonetheless, these multiple functions of agriculture should be taken into consideration, especially in the context of the goals of the IAASTD.

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 percent of GDP in 1998 in Latin America overall (Dixon et al., Gulliver 2001), in Central America in 2000 agriculture contributed from a low of 7 percent of GDP (in Panama) to a high of 36 percent (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 percent of total exports of goods in Costa Rica, to a high in Belize of 69.4 percent 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 (IPCC, 1996).

Recent research has shown exhaustively that agricultural activities are diminishing in rural areas from the standpoint of the number of persons involved, and the income generated, while non-agricultural activities are on the rise, in particular those linked to the provision of services. For these reasons, the families that live in areas defined as rural are increasingly abandoning exclusively agricultural activities, to seek out other opportunities (Da Silva, 2004; Dirven, 2004). These phenomena are responsible in part for the migrations from the countryside to the cities, but are not the sole cause. The expansion of the large transgenic monocultures in the countries of the Southern Cone is transforming the agrarian structure, increasing the concentration of land

and the migration of peasants (Fearnside, 2001a, b; Pengue, 2005). In addition, violence due to territorial interests are causing massive forced displacement, as in Colombia and Ecuador.

Parallel to this difficult context fishing is also developing; it continues to be one of the key components of certain local economies in many places in Latin America, especially the Amazon region, both in terms of the value of production and in terms of employment. Bernal and Agudelo (2006) cite figures from the FAO according to which there are more than 38 million people directly engaged in fishing and fish farming, one a full-day or part-day basis; and the developing countries now provide 70 percent of the fish for human consumption. Marine fishing is also an important economic activity in LAC, generating employment and incomes; most of the fish offloaded is accounted for by the Southern Cone countries.

The current status of agriculture in LAC, 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. The heterogeneity in levels of agricultural knowledge is due in part to the 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 (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.

1.6.2 Characteristics and trends in production in Latin America and the Caribbean

1.6.2.1 Available resources

1.6.2.1.1 Natural resources

Agriculture produces unprocessed agro-food products using natural resources (land, water, biodiversity) 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 with abundant resources in terms of land, water, and biodiversity (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 is the region with the largest reserves of arable lands in the world. It is estimated that 30 percent of the territory in LAC has agricultural potential (Gómez and Gallopin, 1995). 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 et al., 2001). Nonetheless, due to the mismanagement of the soils and to the use of marginal areas for agriculture, the region has approximately 300 million hectares of degraded agricultural area (FAO, 1998), while another 80 million hectares of arid lands are threatened with desertification due to overgrazing, overexploitation of the vegetation for domestic uses, deforestation, and the use of inappropriate irrigation methods. This represents more than 50 percent of the total agricultural area (including grazing areas) affected by degradation. Erosion, acidification, loss of organic matter, compaction, impoverishment of nutrients, salinization, and soil contamination are a result 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 (see section 1.7) (UNEP, 2006).

Erosion is the main cause of degradation of land in LAC, and affects 14 percent of the territory in South America and 26 percent in Mesoamerica (UNEP, 1999). This problem is especially serious in steep areas such as the Andean region (central and northern), as well as the maize and bean zone of Mesoamerica. In these areas erosion is causing low levels of production and is impacting on the migration of small producers to the cities or the agricultural frontier in forested areas, contributing to soil degradation there (FAO, 1998). This process is also taking place in other steep areas 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 due to the use of synthetic fertilizers. In South America nutrient attrition affects at least 68 million hectares (Scherr and Yadav, 1997). Nutrient attrition may also be a consequence of deforestation in moist tropical zones. The conversion of forest to cropland in these areas has brought about the loss of organic matter and has accelerated erosion and the increase in the sediment load in rivers and lakes (FAO, 1998).

Chemical contamination of the soil and water also derives from the technologies of intensive agriculture, while have been increasing in the last 30 years. Nitrification of the soil and water is directly related to the use of chemical fertilizers (UNEP, 2006), 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).

Water – In terms of water, 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 percent 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 in 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 et al., 2001).

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 - 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 percent 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).

Potato (*Solanum tuberosum*) was domesticated 7,000 years ago around Lake Titicaca in the Andes (Spooner et al., 2005). Potato is the most important crop for the cultures in the Andes, where over 100 varieties can be found growing within a single valley (Brush, 1992).

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 (Heiser, 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.

1.6.2.1.2 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 (Da Silva, 2004).

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; Deere, 2005).

According to several sources compiled by David et al. (2001), 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.

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).

1.6.2.1.3 Technological resources

Agriculture today 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); 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 percent 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. The models of rural development in LAC have emphasized technological resources, which are capital intensive. Historically this has been one of the problems that has plagued the Green Revolution. Nonetheless, not all technological resources have to be capital intensive (Chaparro, 2000).

The second scientific and technological area includes the proposals for alternative forms of agriculture, with proposals for ecological agriculture, or agroecological 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).

Agroecology emphasizes technology that is knowledge-intensive, low cost, and easily adaptable by small producers.

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; Farah and Pérez, 2004).

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 percent 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,b).

The non-traditional agricultural export sector, favored by neoliberalism, has opened up salaried employment opportunities mainly for women in the rural sector. Nonetheless, these jobs are often seasonal, poorly paid, and performed in precarious conditions (Deere, 2005). 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 percent of the flower workers are women, and they generally earn the minimum wage, which covers only 45 percent 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 percent 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.

1.7.2.1.5 Market Trends

Over the last 30 years, with the accelerated pace at which the markets for Latin American products, and markets worldwide, have been changing, the commercial formats of quotas and preferences have increasingly become a thing of the past. As a result, markets are fully engaged in a process of transformation in the trade arrangements between countries and between regions, and a collapse in tariffs and import duties has accompanied the elimination of quotas and preferences, pointing towards more competitive global markets with a prevalence of value-added, comparative advantages, quality goods and services, as well as safe foods, traceability, and biosafety.

This transformation in the region, with tariff barriers having been replaced by technical barriers, accords less importance to the volume of production in relation to factors such as efficiency and productivity. This process of abrupt change in markets has resulted not only from geopolitical changes that have produced an international dynamic in which the market approach prevails, even among countries and regions that are not on the same wavelength politically, but also from consumers themselves imposing conditions and requirements. There is a growing trend among consumers in the region towards a more conscientious, intelligent, and differentiated culture of consumption with respect to the foods, cosmetics, and medicinal products they consume, as well as the services they demand.

This change in the functional structure of markets has resulted in a series of challenges and opportunities for Latin American agriculture. Among these opportunities, mention can be made of the emergence of new market niches such as the organic, ecologically-sound, ethnic, and functional markets, as well markets based on ethical-social considerations (for example, the fair trade market). This range of products may be produced by the small and medium producers of the region, since the volumes are not necessarily very high, and what is most important is the type and denomination of origin of products. It is for that reason that many small and medium producers from countries such as Guatemala, Nicaragua, El Salvador, the Dominican Republic, Peru, and Colombia have been able to become international suppliers and position themselves in markets as demanding as those of Europe, Japan, and the United States. Relevant cases include coffee, cacao, banana, oriental vegetables, fruits, and aromatic herbs (Salas-Casasola et al., 2006). Box 1.6 illustrates the example of medicinal herbs and plants in the Caribbean.

(Insert Box 1.6: Medicinal herbs and plants in the Caribbean)

The challenges posed by the markets' new structure include competitiveness, regulations, and marketing strategies and structures, even in those niche markets. A large number of countries in the region are trying to access the niche markets, for example for oriental vegetables in the east coast of the United States, or for organic fruits in Europe and throughout the United States and Canada. This means that as quotas and tariff barriers have disappeared, the scenario offers, in the best of cases, equal conditions, and, therefore, those countries that meet the technical requirements (quality, certification, traceability, biosafety, social and environmental responsibility) will have the best opportunity to gain access to, position themselves in, and stay in those markets.

LAC has a high ceiling for growing and tapping unsatisfied markets for organic and functional foods which by the year 2006 came to approximately US$ 40 billion. In the specific case of organic and ecologically-sound foods, the challenge is that organic agriculture requires more specialized management and the certifications are expensive for small producers. This has limited the participation of the region's small producers in the global organic market, but has also stimulated the formation of cooperative producers' organizations, which bring other secondary benefits (Bray et al., 2005) (see section 1.7.1).

As for the challenge of regulations, Latin American producers and exporters have to comply not only with good agricultural and generic manufacturing practices established by Codex Alimentarius, but in addition the markets themselves have defined their protocols and quality and safety standards such as EurepGAP for the European market, and USA-GAP and HACCP for the U.S. and Asian markets. These standards impose the challenge on Latin American and Caribbean agricultural producers and exporters of having to make adjustments in their production processes and physical production facilities so as to be able to comply with the markets' quality standards. Nowadays the producers in LAC who want to become inserted in the international markets are forced to adopt a culture of quality production based on continuous improvement and evolution of their products based strictly on market requirements. This process entails higher production costs and requires use of optimal methods, which at times wipes out the actual potential of many producers in the region, especially small producers.

1.6.2.2 Regional trends in production

The region has a total of 2.018 billion hectares, of which approximately 726 million (i.e. 36 percent) are under agricultural production, including seasonal crops (7.1 percent), permanent crops (about 1 percent), and pastureland (about 30 percent). 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, although in the last decade, with the collapse of coffee prices, the area planted in coffee diminished in almost the entire region (Calo and Wise, 2005).

The change in land use varied by region (Table 1.8). Figure 1.6 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 percent. Although the rate of increase has diminished, since 1990 there was a 6 percent increase in the region; Brazil, French Guiana, and Paraguay are the countries that saw the largest percentage increases. Suriname, Uruguay, and Guyana have experienced almost no change since the 1990s, while Chile suffered a decline of almost 6 percent in the total area in agriculture.

(Insert Table 1.8: Land use by region)

(Insert Figure 1.6 Change in land use in the four geographic regions)

The main change in land use in the Southern Cone has been due to the increased production of soybean (Figure 1.7), especially in Brazil and Argentina; the total area planted in soybean was almost 47 million hectares 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 soybean has occurred at the expense of natural vegetation and more recently of the tropical forest in the Amazon (Fearnside, 2001b), while in Argentina the increase in soybean has been at the expense of the production of milk, maize, wheat, and fruit crops, as well as areas of natural vegetation such as the Yungas rain forest and the dry forest of the Chaco (Jordan, 2001; Jason, 2004; Grau et al., 2005; Pengue, 2005). Due to the expansion of soybean in Argentina, the rate of conversion of forest to agriculture is three to six times the global average (Jason, 2004). 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, 2001a) (see Box.1.7).

(Insert Figure 1.7: Area planted in soybean)

(Insert Box 1.7: Transgenic soybean in Argentina)

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 percent increase) and today has 269 million animals (Figure 1.8). 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 1.8: Cattle, Southern Cone)

The total agricultural area in Mesoamerica increased almost 9 percent from 1961 to 1990, but only 4 percent since 1990 (Figure 1.6). 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 20^{th} 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 1.6), 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 percent), 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 two to five 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 percent). One of the main trends in the English-speaking Caribbean has been the conversion of agricultural lands to urban centers and activities for tourism. Box 1.8 discusses this situation in several countries of this region.

(Insert Box 1.8: Land conversion from agriculture to tourism in the English-speaking Caribbean)

The four subregions of LAC also differ in terms of the percentage of land that is under different uses (for example, permanent crops and pasturelands, among others). As reflected in Table 1.8, Mesoamerica (including Mexico) 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. 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 percent). 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 percent respectively).

In terms of products or specific groups of categories of products, there have been changes depending on the markets' demands. In some products, growth has been 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 (mainly soybean and African palm), fruits, vegetables, and sugarcane.[5]

Recently sugarcane has taken on great importance given its potential for the production of ethanol. Sugarcane has the advantage of being quite efficient in the production of biomass, and is a crop that can produce year-round. In the region, only Brazil has begun to make significant use of sugarcane a raw material in the ethanol industry (Dias de Oliveira et al., 2005; Licht, 2005). It is argued that Brazil has the potential to produce enough ethanol to respond to the domestic demand for fuel if it earmarks all of its cane production to the production of ethanol, or if the area given over to this crop is doubled (in other words, if the area increases to 5.6 million ha) (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).

In addition to soybean, another oil-bearing crop that has expanded considerably in the region has been African palm, which has undergone expansion mainly in Central America, Ecuador, and

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

Colombia (Carrere, 2001; Buitrón, 2001; Donald, 2004). As in the case of soybean, the expansion of this crop, which is produced on large expanses as a monoculture, is threatening unique ecosystems such as the tropical forest of the Chocó in Ecuador and Colombia (Fearnside, 2001b; Donald, 2004; Grau et al., 2005). In Colombia, there have also been cases of violent displacements of Afrodescendant communities to grow African palm (Diocese of Quibdó, 2001).

The production of cereal grains (beans, lentils, pigeon peas, and others) and root crops and tubers has remained stable in recent years, but inn some cases there have been drops in production. LAC exported a total of 18.8 million metric tons of cereal grains (18 percent of world exports) (USDA, 2005), but almost all of this was produced 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 LAC, 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.

LAC is one of the most important regions in the world in livestock production. Nonetheless, beef exports are dominated by just two countries, Argentina and Brazil. Of total world beef exports, estimated at 5.72 million tons (USDA, 2005), Argentina and Brazil together account for 37 percent, with 2.14 million 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 percent increase in demand for beef with respect to 2005 imports (USDA, 2005).

As for hog production, of a total of 4.2 million tons sold in the international market, only 11 percent is produced by LAC. Once again, two countries alone account for the lion's share of these figures: Argentina (48 MT) and Mexico (440 MT).

Milk production in LAC is far below expectations, taking into account the proportion of arable land and pastureland in the region. The region produces only 8.96 percent of the milk produced in the world (FAPRI, 2006). The production of milk 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.

The wealth of LAC's marine biomass has not been properly taken into account, as evidenced by the low levels of production of this resource. The fish supply internationally is 100.2 million metric tons, only 3.1 million tons of which is produced in Latin America and the Caribbean (this figure does not include Mexico) (FAO 2003).

The area in forests 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 hectares of tropical forest and some 130 million hectares of other types of forest, accounting for 48 percent of the total. This forest cover is not evenly distributed, for Argentina, Brazil, Bolivia, Colombia, Mexico, Peru, and Venezuela account for 56 percent of the total. There are other countries, however, with serious forest problems, such as Haiti, less than 3 percent 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 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.

In summary, among the main trends in the region in recent years, special mention can be made of the production of oil-bearing crops, particularly soybean, which increased considerably in Argentina, Brazil, Bolivia, and Paraguay, as well as African palm in Honduras, Guatemala, Costa Rica, Ecuador, and Colombia. In addition, there was an increase in the cultivation of fruits and vegetables for export, mainly in Mexico, Chile, Argentina, Brazil, and Costa Rica. Another trend during the 1990s was the increase in forest products in Chile, Argentina, Uruguay, and Honduras, and the increase in stock-raising in Brazil, Mexico, and Chile. In the English-speaking Caribbean there has been a transformation of agricultural lands to urban development and tourism, increasing dependence on imported foods. In many countries of the region, the increase in exports has occurred at the expense of food production for the domestic market, which has led to an increase in imports of agricultural goods (including fish and forest products, as well as agroindustrial products).

According to an extensive study by ECLAC cited by David et al. (2001), from 1979 to 2001, the region imported two times more agricultural products than it exported. Nonetheless, FAO data show that the deficit in the exports of grains and legumes is much greater for the countries of Mesoamerica and the Caribbean than for South America, although the data for South America are highly influenced by the exports of countries such as Brazil and Argentina (see Figure 1.9). This emphasis on export products also has repercussions on the food sovereignty of the countries of the region. For example, among the products with a market deficit are products essential for food in the region, such as maize, beans, rice, cereal grains, milk, and other dairy products (David et al., 2001). Finally, these trends have also impacted the agrarian structure of several countries in the region, since the increase in exports has taken place mainly in the most capitalized sector of agriculture (the large producers tied to agroindustry and the export market), and have resulted in the displacement of small producers. The ECLAC study concludes that the neoliberal reforms responsible for the changes described have accentuated the differences between those who have access to capital and market and those who do not (David et al., 2001)

(Insert Figure 1.9: Imports and exports of cereal grains and legumes)

1.6.2.2.1 Transgenic crops

Despite the controversy concerning around transgenic crops, gradually they have been 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 transgenic crops, with almost 32 million hectares planted in 2006 (Argentina, 18; Brazil, 11.5; Paraguay, 2; Uruguay, 0.4). Mexico, Colombia, Honduras, and more recently Bolivia are also producing transgenic crops, but have less than 0.1 million hectares each (James, 2006). Today, LAC produces just over one-third of the transgenic crops in the world. Most are accounted for by just three crops: herbicide-resistant soybean (Argentina, Brazil, Paraguay, Uruguay, Bolivia, and Mexico), Bt maize (Argentina, Uruguay, and Honduras), and Bt cotton (Argentina, Brazil, Mexico, and Colombia) (Table.1.9) (James, 2006).

(Insert Table 1.9: Production of transgenic crops in Latin America and the Caribbean)

Transgenic crops have been an economic success story in some countries of Latin America, in particular Argentina; nonetheless, thus far these benefits have been monopolized mainly by the large producers and agroindustries (see Box 1.7: Transgenic Soybean in Argentina). Internationally, 90 percent of the producers who grow transgenics, i.e. 9.3 million, are small producers, but they are almost all in China (6.8 million) and India (2.3 million) (Brookes and Barfoot, 2006; James, 2006). In LAC, most producer of transgenics plant large tracts in monoculture.

Although the promoters of transgenic crops argue that this technology benefits small producers, and that it is a sound tool for fighting poverty and hunger in the world (Pray et al., 2002; James, 2006), there are very few empirical studies that verify these assertions for LAC. In a recent study of Roundup-resistant soybean in Argentina, Qaim and Traxler (2005) concluded that transgenic soybean was more profitable than conventional soybean, and that small producers benefited the most. A second study on the adoption of Bt cotton by producers in Coahuila, Mexico reached a similar conclusion (Traxler and Godoy-Avila, 2004). Both cases represent special situations since in Argentina the producers do not pay for the “intellectual property rights” for the transgenic seed.

Moreover, in this study the classification of “small” includes producers of up to 100 hectares with access to capital. In the case of Mexico, the producers pay intellectual property rights to the company Monsanto/D&PL, but they receive credit from the government to purchase the transgenic seed. In this case the benefit accrued largely due to the financial and technical support provided by the government and by the implementation of other plant health programs (Traxler and Godoy-Avila, 2004).

The technology of transgenics has brought about major transformations in the environment and society in some countries of LAC. The economic benefits have been accompanied by social changes such as the displacement of small producers and the consequent migration to the cities (Pengue, 2000), the concentration of lands and agribusinesses (Verner, 2005; Altieri and Pengue 2006), and the loss of food sovereignty (Jordan, 2001; Teubal and Rodríguez, 2001; Souza, 2004; Altieri and Pengue, 2005; Verner, 2005). Moreover, environmental benefits have been reported mainly related to the increase in area planted with zero labor or reduced labor, and to a reduction in the use of pesticides associated with Bt crops. For example, in Argentina, where more than half of the transgenic soybean in the region is grown, 80 percent of the area requires zero tillage, contributing to a reduction in the rate of soil erosion (Trigo and Cap, 2003; Qaim and Traxler, 2005). In the state of Coahuila, Mexico, where 96 percent of the area in cotton is planted with Bt cotton, an 80 percent reduction was reported in the number of applications of insecticides, although the authors recognize that not all of the reduction can be attributed to the transgenic cotton because the region also has a strong program to eradicate the boll weevil and an effective integrated pest management program (Traxler and Godoy-Avila, 2004). In general, adopting transgenic cotton appears to be highly determined by the presence of a particular pest, and in many regions producers have opted to continue using the conventional seed (Traxler and Godoy-Avila, 2004; Qaim et al., 2003).

These environmental benefits of transgenics are overshadowed by other negative environmental impacts. Many scientists have expressed concern over the use of transgenic crops on a large scale considering the environmental risks, which may threaten the sustainability of agriculture (Goldberg, 1992; Paoletti and Pimentel, 1996; Snow and Moran, 1997; Rissler and Mellon, 1996; Kendall et al., 1997; Royal Society, 1998; Altieri and Rosset, 1999). For example, the widespread adoption of homogeneous transgenic varieties inevitably leads to genetic erosion and the loss of local varieties developed and used traditionally by thousands of peasants (Robinson, 1996). In the case of transgenic soybean, a dramatic increase has been reported in the use of herbicides, especially glyphosate (Trigo et al., 2002; Qaim and Traxler, 2005); the evolution of resistance to glyphosate has already been reported in some weeds, limiting the possible benefit of the technology (Holt and Le Baron, 1990; Papa, 2000). The massive use of Bt crops affects other organisms and some ecological processes, and can lead to resistance. For example, it has been shown that the Bt toxin may affect beneficial insects that feed on pests that eat the Bt crop

(Hilbeck et al., 1998). There is also evidence that the pollen from Bt crops that is deposited on the leaves of wild plants around the areas planted in Bt crops may kill other lepidopterans that are not pests, such as the Monarch butterfly (Losey et al., 1999). There is also evidence that the Bt toxin adheres to soil colloids and lasts up to three months, having a negative impact on the populations of invertebrates that help in the decomposition of organic matter (Donnegan et al., 1995; Palm et al., 1996). In addition, the intensive use of Bt varieties increases the pressure of selection and generates resistance, threatening not only the future utility of these crops, but also annulling one of the most useful tools available to the organic producers for fighting pests (Pimentel et al., 1989; Mallet and Porter, 1992; Gould, 1994; Alstad and Andow, 1995).

Transgenic crops have also had a negative impact on biodiversity due to the conversion of forest areas and natural savannahs to transgenic plantations, in particular of soybean. In Brazil and Argentina the expansion of transgenic soybean has impacted directly and indirectly on the deforestation of unique ecosystems such as the tropical forest of the Amazon region and the Cerrado in Brazil, and the Yungas forest in Argentina (Fearnside, 2001b; Montenegro et al., 2003; Pengue, 2005).

As LAC is important as a center of origin of crops of global importance, such as maize, potato, and tomato, there is concern over genetic contamination should transgenic crops be introduced in the centers of origin, for example transgenic potato in Bolivia, or transgenic maize in Mexico. Indeed, there is already evidence of genetic contamination of local varieties of maize in Mexico (Chapela and Quist, 2001), although it is argued that this contamination may have been temporary (Ortiz-García et al., 2005). Also worrisome is the possible contamination by transgenics of edible crops that are given non-food uses, for example the production of nutraceuticals and biopharmaceuticals or non-edible industrial products that impede use of the crop for food (see Box 1.9).

(Insert Box1.9: Pharmaceutical crops in centers of origin)

On balance, despite the economic success of some transgenic crops and their swift adoption by large and medium agricultural producers in some regions, thus far transgenic crops in LAC have not contributed adequately to satisfying the goals of sustainability, poverty reduction, and equity. Leading social movements in Latin America and the Caribbean have openly stated their opposition to transgenic crops and in particular to intellectual property rights and genetic use restriction technology (sterile seed technology) which, they argue, threaten the rights of local producers to keep and use genetic resources (Vía Campesina, 1996; Desmarais, 2002). Despite the opposing positions on transgenics, there does appear to be consensus in the region as to the pressing need to apply and adhere to precautionary regulations in the process of generating and adopting this technology. The Cartagena Protocol on Biosafety, adopted under the Convention on Biological Diversity, is the first international agreement for the control of modern biotechnology, and applies the precautionary principle to the use and transnational movement of transgenic crops (Eggers and Mackenzie, 2000). Of the countries in LAC that are growing transgenic crops, Argentina, Uruguay, and Honduras have not ratified the agreement.[6]

1.6.2.2.2 Nanotechnology

Another component of the new technology is nanotechnology. Nanotechnology refers to the manipulation of matter on a nanometric scale (one nanometer equals one one-millionth of a meter). In LAC, the use of nanotechnologies has not yet become widespread, nor are there government initiatives in the area of research and development to produce particular applications for the region.

Nanotechnology is thought to offer society opportunities. The possible applications in agriculture include integrated pest and disease management at the molecular level, as well as technologies that improve the capacity of plants to absorb nutrients. One can already find intelligent sensors and systems on the market for applying slow-releasing inputs at the molecular level used in agriculture to fight viroses and other pathogens. There are also the so-called nanostructured catalytic materials, which bolster the efficiency of pesticides, including herbicides, possibly contributing to reduced chemical use in agriculture. Nonetheless, nanotechnology also poses major environmental and possibly health risks, as well as social, economic, and ethical challenges (ETC, 2007). Nanoproducts could enter the human body or the environment and have unpredictable effects. Research studies into the impacts of nanoproducts are almost non-existent, such that very little is known of the possible consequences of releasing these products in the environment. As nanoproducts are still not widely dispersed in the environment, they present an excellent opportunity to implement the precautionary principle, so as to make it possible to assess possible impacts before the products are released into the environment.

1.6.2.2.3 Agrofuels (bioenergy crops)

Biofuels/Agrofuels: The global trend towards diminished world oil reserves plus the steadily increasing demand for fuels from non-renewable resources had induced a marked interest in the last decade (1996-2006) in identifying alternative fuel sources. In this context, major efforts have been made to optimize the use of plant biomass as an alternative renewable source for the production of bioenergy.

Traditional sources of biofuels have been used on a small scale with little technology, such as the direct fuel of firewood and manure for generating bioheat. The most widely used modern bioenergy has been microbial fermentation of manure to obtain biogas, which provides heat and

---

[6] http://www.biodiv.org/biosafety/signinglist.aspx?sts=rtf&ord=dt .Visited April 26, 2007.

electricity on rural properties. And more recently, on a larger scale are liquid biofuels, alcohol, and biodiesel (Global 3.2.2.2.5), obtained from crops such as sugarcane, soybean, castor-oil plant, oil palm, cassava, maize, and beets, among others, more specifically called agrofuels.

The possibility of producing biofuels holds out one of the great hopes in the world for reducing dependency on fossil fuels such as gasoline, gas oil, and kerosene.

The Americas have traditionally held a leading place in the production of sugarcane, which has been a leading crop in the bioconversion of biomass to fuel (IEA, 2004). In LAC, countries such as Argentina, Brazil, Mexico, Uruguay, and Colombia produce agrofuels mainly from sugarcane and oil palm. Brazil has produced fuel alcohol since 1975; it is the leading producer of sugarcane worldwide and produces 60 percent of the world total of ethanol from sugar, with three million hectares of sugarcane crops. In 2005, production reached a record 16.5 billion liters, two million of which were for export (Jason, 2004)

Among the advantages attributed to agrofuels as an alternative to fossil fuels that they mitigate climate change due to the reduction in gas emissions from the greenhouse effect, bring higher rural incomes for farmers, and contribute to greater rural development. In Colombia, moreover, the government (in 2007) considers them an alternative to illicit crops, and as a source of employment in rural areas.

While on the one hand most oil-dependent countries are engaged in the discussion of biofuels today, seeing in them a viable long-term solution to the problem of regional energy insufficiency, on the other hand researchers put forth concerns because they consider that large-scale production of monoculture crops for agrofuels – under the conventional/productivist system of production dependent on chemical inputs (pesticides and fertilizer) made using the fossil energy that is sought to be replaced – will have negative impacts.

The concerns are related to accelerated processes of deforestation, destruction of biodiversity, soil erosion and degradation, impacts on water, and a negative balance of greenhouse gas emissions. To this situation are added the possible effects of displacement of food crops and increases in food prices, which will directly affect the food security and food sovereignty of local communities, mainly in developing countries. In Mexico, the redirection of maize crops for export to the United States to manufacture ethanol brought on a disproportionate increase in the price of maize, an essential ingredient in the tortilla, which is the main source of food and nutrition for the Mexican population. The increase in food prices is also hitting the livestock and poultry industries (Bravo, 2006; Fearnside 2001a).

Energy inefficiency: The high demand for fossil fuels energy of the conventional/productivist system by way of the use of machinery and agrochemicals has been established (see Section 1.7 on performance and impacts of production systems). RALLT (2004) cites studies that show that producing one ton of cereals or vegetables using modern agriculture requires six to ten times more energy than using sustainable farming methods.

As regards the possible benefit in terms of climate change, the concerns also have to do with the conventional model of production, which depends on fossil fuels, and therefore contributes to the emission of greenhouse gasses. It is calculated that at present, it is responsible for 25 percent of carbon dioxide emissions worldwide, 60 percent of methane gas emissions, and 80 percent of nitrous oxide, all of which are powerful greenhouse gasses. The components of modern industrial agriculture that consume the most energy are the production of nitrogen fertilizers, agricultural machinery, and irrigation using pumps. These accounted for more than 90 percent of the energy used directly or indirectly in agriculture, and all are essential to it (RALLT, 2004). In addition, the elimination of carbon-sequestering forests to open the way to these crops will further increase CO_2 emissions (Bravo 2006, Donald 2004).

There is also a major debate on the energy balance for making ethanol or biodiesel from some bioenergy crops. The results of the research by David Pimentel and Tad Patzek at Cornell University in the United States (Pimentel and Patzek, 2005) support the notion that the energy balance of all the crops, with current processing methods, is such that more fossil energy is spent to produce biofuels than they provide. Thus, for each unit of energy expended on fossil fuel, the return is 0.778 units of methanol from maize; 0.688 units of ethanol from switchgrass; 0.636 units of ethanol from wood; and, in the worst of the cases examined, 0.534 units of biodiesel from soybean (RALLT, 2004; Bravo, 2006).

1.6.2.3 Food chains

We understand *agro-food chain* to refer to the whole set of different movements in the process of food production that take place before, within, and after agricultural production systems, linking all those involved, from the producer of inputs to the end consumer. The concept includes items whose end use is food as well as agricultural output sold to other industries. The set of all the agro-food chains, including support services, constitutes the *agribusiness* (Castro et al., 2001). The predominant model of development in the last 50 years, as already indicated, accorded priority to articulating the production systems and inputs, and offered incentives for developing agro-exports. The best-articulated agro-food chains in the region are for oil-bearing crops, beef, dairy products, and vegetables. The opening up of Latin American markets and the need for the markets of the developed countries to expand has accelerated the economic concentration of the components of agribusiness, especially the supply of inputs and seed, and marketing agro-food products, in which the multinational corporations are already the most powerful economic actors, influencing policy decisions that are restructuring agriculture generally, agro-food systems in particular, and the process of technological development and technological innovations for the agricultural sector (Friedland et al., 1991; Bonanno et al., 1994; McMichael, 1994).

Although the agricultural inputs sector was already dominated by large corporations before the 1990s, that decade saw a greater rate of concentration in this sector. For example, today only 10 corporations control 84 percent of pesticide sales in the world. The 10 largest corporations in the seed business control 50 percent of seed sales worldwide, and the 10 largest biotechnology companies control almost 75 percent of biotechnology sales, including seed for transgenic crops (ETC, 2005).

At the other end of the food chains one finds the processors, distributors, and supermarkets. The penetration of transnational corporations in this sector is also proceeding by leaps and bounds in the region, even in rural areas. For example, in Argentina only seven supermarket chains control 77.5 percent of supermarket sales in 1999 and of these, 80 percent belonged to multinational chains (Carrefour, Ahold, and Wal-Mart, among others). As of that date, only two national chains had survived (Gutman, 2002). In Costa Rica, supermarket chains control 50 percent of all food sales, and the seven largest companies control 98 percent of supermarket sales (Alvarado and Charmel, 2002). In Chile, four companies (two national and two foreign) control 50 percent of the market; the milk and dairy products sector is the most heavily dominated by the supermarket chains: the five largest companies account for 80 percent of sales (Faiguenbaum et al., 2002). The growing control of multinational chains in the sale of foods is taking place throughout the region. As of 2003 supermarket chains controlled from 50 to 60 percent of all food sales in LAC, an extraordinary increase, considering that just 10 years ago they controlled 10 to 20 percent. Five corporations control 65 percent of these sales (Reardon et al., 2003).

This rapid growth and consolidation of supermarkets has had important consequences for the structure of the markets (Gutman, 2002), for small producers (Ghezán et al.., 2002; Gutman, 2002; Reardon and Berdegué, 2002; Schwentesius and Gómez, 2002), and for consumers (Vorley, 2003). In Brazil, as new “retailers” with integrated operations and new rules of participation expand they are displacing small and medium rural enterprises, which were playing an important role generating employment and diversifying the ways one could make a living in the Brazilian countryside (Farina et al., 2004). In addition, the new rules imposed by the supermarkets in Brazil with respect to the beef market have ruined the small butcheries, merchants, and truck drivers who were involved in this market before (Farina et al., 2004). In Chile, the growth of the large supermarket chains has taken place at the expense of traditional food outlets. From 1991 to 1995, on average 22 percent of these traditional outlets were wiped out (Faiguenbaum et al., 2002). The same trend has been documented for Argentina, Costa Rica, and Mexico (Nielsen, 1999; Alvarado and Charmel, 2002; Gutman, 2002; Schwentesius and Gómez, 2002).

The effect on small producers has been equally devastating. The supermarkets are seeking a limited number of suppliers who can provide them with the volume and quantity of products they need. The supermarkets in LAC purchase 2.5 times more fresh produce (fruits and vegetables) from local producers than those which the region exports to the rest of the world (Reardon and Berdegué, 2002). With the rapid growth of supermarkets and the consolidation of that sector, local producers are increasingly subject to the rules established by a small group of transnational companies. It has been argued that for the fresh fruit and vegetables sector, the growing dominance of supermarkets may have a positive effect on producers and consumers, since the supermarkets demand a higher-quality producer (Belsevich et al., 2003). Nonetheless, these same authors conclude that the general trend is to disfavor the small and medium producers, who lack the capital and credit needed to accommodate to the new exigencies of the market. The negative impact on small and medium producers has been documented for several countries of the region (Alvarado and Charmel, 2002; Ghezán et al., 2002; Gutman, 2002; Schwentesius and Gómez, 2002; DFID, 2004).

It is argued that on balance the growth of supermarkets has had a positive overall impact for consumers, though there are not many studies on this (Rodríguez et al., 2002). It is assumed that supermarkets are more convenient, and provide greater diversity of products along with better-quality products at a lower price. Nonetheless, as supermarket chains consolidate and the competition diminishes, these benefits will deteriorate, as with milk in some regions of the United States (Hendrickson et al., 2001).

The debate continues over the impacts of the major concentration of corporations in the food sector. There is also a debate over whether the global dominance of supermarket chains is inevitable, and over the possible impacts of standards and direct contracts between supermarkets and producers. Nonetheless, most of the studies in Latin America and the Caribbean indicate that this concentration and dominance in the food sales sector will have negative repercussions for small and medium producers, and eventually for consumers. Although these predictions are still tentative, the evidence for this proposition was continuing to accumulate.

The transnational corporations continue their process of vertical and horizontal integration, and continue penetrating food chains in the region. Throughout the food chain the inequality in power is greatest as between small producers and the transnational corporations. To counter that inequality, some small producers have organized in associations to increase their bargaining power over conditions and prices (Berdegué, 2001; Vorley, 2003). Yet Berdegué (2001) argues that these associations can only be beneficial when transaction costs are high, as in the case of milk. But when transaction costs are low, as it is in the case of grains and potatoes, the benefit of producers' associations is called into question. In the context of a globalized economy, this kind of not-very-differentiated product makes all producers worldwide compete with one another for buyers. The development of cooperatives in the context of globalization and borders open to capital poses a major challenge to small producers, since transnational agribusinesses can buy their produce practically anywhere in the world.

The concentration and consolidation of these agribusiness chains have increased the gap between the prices received by food producers and the prices paid by consumers (Vorley, 2003; see Box 1.10 on soybean in Brazil). These impacts have repercussions throughout society, both rural and urban, and have effects beyond the economic effects related to the displacement of small producers, job losses, and consumers' ability to buy food. Food is one of the pillars of any culture; how it is produced, distributed, prepared, and shared with family and friends is part of what defines a culture, and that pillar is quickly eroding with the expansion and concentration of transnational supermarket chains.

(Insert Box 1.10: Integration in the food chain for soybean in Latin America)

This imbalance in power has led the global organization of small producers, Vía Campesina, to begin a campaign to remove agriculture from the WTO based on the argument that food is different (Rosset, 2006). Consumers are playing an important role by demanding fair trade products, although they still represent an insignificant percentage of food purchases in the world. Another recent development is self-regulation in the corporate sector. Some corporations, in search of a competitive margin over their competitors, are beginning self-regulation programs with respect to social responsibility. Nonetheless, despite all the publicity, very few corporations have adopted the social responsibility agenda (Oxfam, 2004). Finally, another possible way to control the impacts of the concentration of markets is to attack it directly. Considering the rapidity with which the concentration of capital is taking place, monitoring the transnational corporations should be an urgent task (Vorley, 2003). Part of this work was done by the now-defunct United Nations Center on Transnational Corporations. In addition, the civil society sector is working on this through organizations such as Corporate Watch. Vorley (2003) argues that economic globalization makes it necessary to improve global governance on matters of monopoly and competition. Nowadays, there are no international standards for competition to regulate the activities of corporations from one continent to another. The law on competition within the WTO moves away from regulating monopolies, towards simplifying regulations across national borders to facilitate transnational trade and access to the industrialized countries' markets for goods and services (Vorley, 2003).

1.6.2.4 Sociocultural characteristics

The agricultural sector in Latin America and the Caribbean is made up of different systems of production (traditional/indigenous, conventional/productivist, and agroecological) 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). For example, in family agriculture, the family lives on its farm, is at the core of all the activity, and makes the decisions in the productive system, and how its production is geared to meeting the needs of the family and the market; it is producer and consumer. In addition, the family is the source of labor for itself and for third persons.

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, and families share traditions and customs that are determinant in their lives in terms of relationships and production. In this sociocultural setting tradition is the dominant institution in relationships and exchanges. In that rural milieu there is a close relationship between the degree of isolation and 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, and Bolivia, among others), 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, 1971), phenomena that are generally more intense when the peasants belong to ethnic groups with a history of domination by others (Durston, 2002).

Moreover, peasant families have been diversifying their sources of subsistence, since scarcity of land, economic crisis, and neoliberal policies have led to a situation in which this sector can no longer support itself solely from agricultural production. The response has been to seek employment off the farm (both men and women), and to migrate to the cities or industrialized countries (Deere, 2005), disarticulating rural communities and eroding the sociocultural cohesion of the rural milieu.

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, 2000).

1.6.2.5 Knowledge

A retrospective evaluation and analysis of the current situation of the role of agricultural knowledge, science, and technology in the sustainable development of Latin America and the Caribbean must acknowledge that there is a wealth in the region beyond scientific knowledge as such.

One must, therefore, reconstruct the historical-cultural diversity and diversity of ways of knowing in the region, and their influences on the evolution of science, as a preamble to an approach to the role, for example, of colonialism and neocolonialism, 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. In this context, it is evident that the region is broken into complexities, different bodies, memories, languages, histories, diversities, and world views (Leff and Carabias, 1993; Possey, 1999; Maffi, 2001; Toledo, 2001, 2003; Toledo et al., 2001). This fragmentation, 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 importance of historical-cultural diversity 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. Colonialism in its diversity of nature and time intrinsically exists in the region, not only as a territorial phenomenon, imposed and invasive, but also as a legacy, reflected in a colonial and neocolonial attitude that predominates in many Latin American countries. This colonial mentality is one of the reasons why Latin America invests less than the world average today in research and development, and does not value the rich traditional/indigenous and local knowledge.

Colonialism has to date resulted in the suppression of local knowledge and wisdom for almost half a century, and its legacy permeates the AKST system, restricting its creative and proactive use. The dominant AKST system has operated under the premise that the 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 (2004, 2006) suggests the contrary effect of that colonial mentality of rejecting western 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 neocolonial world. As he sees it, this rejection fosters parochial trends which, given global interactions, is not only counterproductive, but can cause non-western societies to place limits on themselves, and may even torpedo the valuable resources that their own cultures and wisdom represent. It should be noted that for the indigenous peoples globalization (understood as the Euro-American colonial expansion and domination) is not new. Several studies by Quijano (2000), Lander (2000), Lumbreras (1991), and Grillo (1998) illustrate how the indigenous peoples of LAC engaged in a dialogue with and digestion of the colonial world.

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 world views, knowledge, wisdom, and cultures has not taken advantage of the synergies that could be derived from the interaction between scientific knowledge and traditional/local knowledge and wisdom. This challenge puts forth, to the AKST system, another type of paradigm, as an alternative to the current dominant one, in addition to considering other structural (for example, land tenure), cultural, and intercultural factors.

In terms of exclusively scientific 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 percent of gross domestic product, whereas the rest of the world invests 0.5 percent. 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.

1.6.2.5.1 Knowledge, culture, and agricultural development

In LAC, the “other ecologies” (Toledo and Castillo, 1999:164) and their respective systems of agricultural knowledge are as diverse as the rich and diverse cultures of the region (Deruyttere, 1997; Altieri, 1999). For example, the indigenous population is made up of more than 400 ethnic groups (Deruyttere, 1997), or 800 cultural groups (Toledo, 2007).

In general, agricultural knowledge in the region is associated with the three types of agricultural production systems described in this document: the conventional/productivist system, the agroecological system, and the traditional/indigenous system (including peasant agriculture). Historically, indigenous forms of agriculture (hunting, fishing, gathering, domestication and cultivation of plants and animals) not only precede the other two, but are the result of an intimate and sophisticated interaction and co-evolution with nature in general, and in particular with a significant number of plants and animals (Fowler and Mooney, 1990; Valladolid 1998, 2001; Altieri, 1999; Barkin, 2005, Narby, 2007). These interactions gave way to what today are known as centers of origin of native crops (Diversity, 1991). Traditional/indigenous knowledge is very valuable for the peoples of the region for three reasons: First, it contributes to the cultural affirmation of the indigenous peoples and is useful for learning about nature and its resources, including sources of food, medicines, forage, building materials, and tools, among other things (Toledo, 2005). For example, the Tzeltal of Mexico can recognize more than 1,200 plant species, whereas the P’urepecha recognize more than 900 species, and the Maya of the Yucatan approximately 500 species (Toledo et al., 1985). Second, this knowledge results from the experience accumulated and shared by many men and women over thousands of years. And third, knowledge is also wisdom, as it is closely linked to the identity, values, beliefs, traditions, and ideals of individuals and communities. Nonetheless, it is also important to recognize that traditional knowledge and local knowledge have weaknesses. For example, often this knowledge and wisdom is not found in books and may be lost if not transmitted from generation to generation. Traditional knowledge is also limited to a locality or region, and is not easily transferable to other regions with different conditions. Finally, many natural phenomena cannot be perceived through feelings without the help of technologies, for example, microorganisms, biochemical processes, and the DNA molecule (Toledo, 2005). Moreover, from the standpoint of indigenous experience, traditional/indigenous knowledge and wisdom are not necessarily limited by what one can see, hear, touch or feel. For example, anthropologist Jeremy Narby (2007) notes that a good part of the extraordinary knowledge of Amazonian plant life comes through supra-conscious/extrasensory states during ceremonies and rituals, such as those performed by the shamans of the Amazonian indigenous peoples. In his view, a process of affirmation, cultural regeneration, and intercultural exchange could help recover the potential of combining the physical and the metaphysical (Narby, 2007; Narby and Huxley, 2004).

Colonial and neocolonial agriculture in the region is based on (1) the exploitation of the plants, animals, peoples and indigenous knowledge and wisdom native to the region, (2) the usurpation and violent or non-violent expropriation of lands and territories that belonged to the hundreds of indigenous peoples, and (3) the exclusion of the local peasant-indigenous and agroecological knowledge and AKST systems (Crosby, 1991, 2004; Lumbreras, 1991). One might suggest that parallel to the growth of modern homogenizing agriculture, peasant-indigenous and local forms of agriculture have tended to diminish. This is summarized, for the region, in the growth of the space in the face of the reduction of place, i.e. of the local world (see Table 1.10). "Place" – which is where the local, peasant-indigenous languages, cultures, rituals, knowledge and wisdom, and AKST systems are, with all of life, for the last 60 years, in particular – has been eroding significantly due to the policies that accord priority to the growth of the homogenizing space related to modern single-crop agriculture (Blazer, 2004; González, 2007).

(Insert Box 1.10: The reduction/disappearance of place)

In the last 60 years modern agriculture, and as a result the system of agricultural education, research, and extension work was strongly emphasized by agricultural development policies. This conventional/productivist agriculture is based on the mechanistic scientific outlook that arose in western Europe (Figure 1.10). Eurocentrism[7], in formal education generally and in agricultural education in particular, has contributed crucially to the dissemination and growing dominance of the mechanistic outlook (Rengifo, 1998; Bowers, 2002). Basic scientific knowledge on and for manipulating agriculture has been and is being generated mainly at the dominant centers that generate knowledge (international/regional research centers/institutes, universities) around the world. These centers have embraced and worked to sustain and promote the mechanistic models, theories, paradigms, and world view associated with the reductionist system of conventional/productivist agricultural research and production (de Souza Silva, 2007). This world view and corresponding paradigms are still a key component of a transnational network made up of academic centers (Wallerstein, 1997; Farid, 2005; Progler, 2005; Smith, 2002; Bowers, 2002; Pimbert, 2006), representatives of governments, think tanks, the business sector, international organizations, and development financing agencies (Escobar, 1999; González, 2007) (Figure 1.10).

(Insert Figure 1.10: Conventional/productivist approach to agriculture and conservation)

---

[7] Eurocentrism "is the imaginative and institutional context that informs contemporary scholarship, opinion, and law. As a theory, it postulates the superiority of Europeans over non-Europeans. It is constructed on a set of assumptions and beliefs generally accepted without prejudices by educated Europeans and North Americans who commonly accept them as the truth, as supported by 'the facts' or as 'reality.'"
"A key concept behind Eurocentrism is the idea of diffusionism. Diffusionism is based on two assumptions: (1) most communities are hardly inventive, and (2) a few human communities (or places, or cultures) are inventive and are, accordingly, the permanent centers of cultural change or "progress". On a global scale, this results in a world with a single center – Europe – and a periphery that surrounds it. " (Battiste and Youngblood Henderson 2000:21). For further thoughts, see Quijano (2000), Lander (2000),

The political leadership, policy makers, and civil society generally have also been permeated by the knowledge produced by the mechanistic western paradigm/world view and have become its practitioners.

A well-articulated and well-financed transnational network of scientific institutions has generated, fed into, and provided feedback to the conventional/productivist system for the production of agricultural knowledge. The environmental and sustainability problems associated with the system are derived from this reductionist knowledge base (Barrer, 2007) (Figure 1.11).

(Insert Figure 1.11: Two contemporary world views)

The agro-industrial project that emerges from the dominant AKST system proposes that the indigenous/peasant communities should modernize and progress by means of technology, machines, and scientific knowledge, as well as by entering the market. This agro-industrial proposal seeks to have the agro-ecosystem simplified and specialized to increase labor efficiency (Toledo, 2005).

Agroecology proposes modernization by way of path different from that of agroindustry. It proposes a form of development based on respect for the environment (the Mother Earth, for the indigenous peoples), as well as the traditions, culture, and history of the people. The agroecological proposal recognizes the need for scientific and technological research, yet unlike the agroindustrial proposal, it suggests a dialogue of different ways of knowing based on a respectful exchange among the researchers or technical personnel and the peasant and indigenous communities (Toledo, 2005). Ishizawa (2006) and Machaca (1996, 1998) propose a dialogue of ways of knowing from a perspective of cultural affirmation and decolonization, while at the same time suggesting the challenge posed by the world views for the dialogue.

The dominant society in general, and the dominant policies and AKST system in particular, have contributed to the marginalization or exclusion of the cultures, world views, systems of knowledge, and ways of knowing and being linked to the peasant-indigenous and agroecological production systems. Several studies conclude that these two systems have a potential that has yet to be tapped or fully recognized (Altieri, 1987, 1996; Chamba and Chamba, 1995; Machaca 1996, 1998; Rosset 1999; Toledo, 2005), or integrated to the region's AKST system. Nonetheless, agricultural movements proposing alternatives to conventional/productivist agriculture and/or decolonization and cultural affirmation suggest the potential of such alternative ways of knowing and AKST systems for making a significant contribution to attaining sustainable development objectives (Altieri, 1987, 1996; Grillo, 1998; Rengifo, 1998; Valladolid, 1998, 2001; Delgado and Ponce, 1999; Huizer, 1999; Rist et al., 1999; Toledo 2001, 2003; Toledo et al., 2001; Funes et al., 2002; Barkin, 2005; Ishizawa, 2006; Badgley et al., 2007). This situation creates an opportunity in the region for a new, inclusive AKST policy, one which incorporates, on its own terms, the peasant-indigenous and agroecological systems of knowledge and wisdom (Leff and Carabias, 1993).

1.6.2.6 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, both as producers and as wage workers in the agricultural sector (Deere, 2005). 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 and Craske, 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 fresh vegetables (e.g. in Mexico, Guatemala, and Brazil) for export to North America (Deere, 2005). In addition, a large proportion of women and their children (50 percent) 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). 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. 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 LAC, especially in the indigenous/peasant 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/peasant 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 indigenous/peasant 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 in LAC 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).

1.7 Performance of Production Systems

This section presents an evaluation of the three main systems of production in the region: traditional/indigenous, conventional/productivist, and agroecological. This evaluation includes an assessment of the performance of these systems in terms of several indicators, such as productivity, sustainability, and quality of food. In addition, this section includes an assessment of the environmental, social, economic, and health impacts of the three systems.

1.7.1 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 and the Caribbean, 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, and medicinal plants, among others. 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, consists of several traditional systems that predominate in many rural areas of Latin America and the Caribbean (Ortega 1986), but which 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/productivist system (Altieri, 1999). For example, in the 1950s Sanders (1957) estimated that maize production in the *chinampas*, a traditional system in Mexico, yielded 3.5 to 6.3 tons per hectare. That same year, the yield of maize in the United States was 2.6 tons per hectare, and it was not until 1965 that it reached 4 tons per hectares (USDA, 1972, as cited in Altieri, 1999). In the 1990s the average yield of maize in LAC was only 2.56 tons per hectare, and the countries with the highest yields were Argentina and Chile, with 4.35 and 8.49 tons per hectare respectively (Morris and López-Pereira, 1999). 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).

One characteristic of the traditional systems is their high agrobiodiversity (Toledo, 2007). 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 hectares 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).

Often, small producers who practice this type of agriculture have multiple survival strategies and combine subsistence agriculture with commercial activities and wage labor (Ewell and Merrill-Sands, 1987; Deere, 2005; Barrera-Bassols and Toledo, 2005). Despite the trends towards intensification of agriculture in LAC, traditional/indigenous agriculture is still practiced by millions of producers. As of 1980 such systems of production were found in 16 million productive units and used 160 million hectares, involving some 75 million people, i.e. almost two-thirds of the rural population of LAC (Ortega, 1986). In the 1980s this sector produced 41 percent of the food for domestic consumption and was responsible for productive 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 weakened, and it is possible that today it accounts for a lower percentage of domestic food production (David et al., 2001).

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 hectare, with a rate of energy efficiency (unit output per unit input) of 10:1 (Pimentel and Pimentel, 1979; Altieri, 1999). 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) (Figure 1.12).

(Insert Figure 1.12: Comparison of energy balance of different systems of production)

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. 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 hectare, 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 hybrid varieties in their systems.

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 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., 2007).

Based strictly on measures of yield (production per unit of area of a single crop), many economists and agronomists conclude that the conventional/productivist system has greater productivity. Nonetheless, many small producers plant several crops on the same land, such that a comparison of productivity as between large and small farms should use total output on a given unit of land, not just that of one crop. Taking this into consideration, analyst Peter Rosset (1999), analyzing data from several countries, concluded that the small properties almost always produce more per unit of area than large ones. Indeed, this relationship, known as "the inverse relationship between farm size and productivity," is widely accepted by agricultural economists, though there is a major debate over the causal mechanism of that relationship (Yotopoulos and Lau, 1971; Bardhan, 1973; Sen, 1975; Berry and Cline, 1979; de Janvry, 1981; Carter, 1984; Feder, 1984; Assunção and Ghatak, 2003).

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, and in most cases than the agroecological/organic system (Figure 1.12).

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. For the purpose of this evaluation we are including the organic systems in this category. Nonetheless, most agroecologists argue that organic systems are not necessarily agroecological. For example, the production of organic bananas in some parts of Central America and Ecuador, which consists of large expanses of monoculture, and which obtain organic certification because they don't use agrochemicals, are not agroecological systems. In addition, many small producers in LAC are adopting agroecological practices, but either because their production is not for the market or due to lack of resources to pay the certifying authorities, do not certify their production. In the last 20 years the agroecology movement has grown enormously worldwide, and particularly in LAC (Altieri and Masera, 1993). A recent study reports results from 286 projects with agroecological interventions that includes 12.6 million producers on approximately 37 million hectares, or the equivalent of three percent of the land in non-industrialized countries (Pretty et al., 2006). IFOAM estimates that almost 20 percent of all land and 28 percent of all farms with organic certification worldwide are in LAC (Willer and Jussefi, 2007) (Box 1.11), though this is largely due to the organic extensive livestock systems, especially in Argentina, which has three million hectares certified organic. Mexico is the country with the largest number of organic farms in the world, with more than 85,000 farms in organic management. It is estimated that in LAC there are some 5.8 million hectares certified organic, with an annual value of US$ 100 million (Lernoud, 2007). Cuba is the only country in the world that is carrying out a massive conversion to organic agriculture, by promoting agroecological practices in both rural and urban areas (Box 1.12). In contrast to the other countries in LAC, where organic production is for the export market, in Cuba organic production, with some exceptions, is not certified and is for domestic consumption.

(Insert Box 1.11: Trends in organic agriculture in Latin America and the Caribbean)

(Insert Box 1.12: Organic agriculture in Cuba)

It is frequently stated that organic agriculture, because of its lower yields, will not be able to supply enough food to feed the world. To address this question a study from the University of Michigan compiled results from almost 300 studies worldwide comparing yields of organic and conventional systems (Badgley et al., 2007). Based on the evidence the authors concluded that organic agriculture could produce enough food, on a per capita basis, to provide 2,640 to 4,380 kilocalories/per person/per day depending on the model used (Figure 1.13). They also found that in developing countries, where organic systems were compared to the commonly practiced agriculture, organic farms outperformed conventional practices by 57 percent, demonstrating that intensification using organic methods is possible.

(Insert Figure 1.13: Estimates of organic and conventional output)

Another study, by the University of Essex in England, carried out a census of 286 projects in 57 countries, including 45 in Latin America and the Caribbean (Pretty et al., 2003, Pretty et al., 2006). 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. 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 percent had farms with less than two hectares. 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. (2006) estimated an increase in food production of 79 percent per hectare. These results have been confirmed by other recent studies (see for example Parrott and Marsden, 2002; Pimentel et al., 2005; Halberg et al., 2006; FAO, 2007a; Kilcher, 2007).

Recent studies suggest 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 percent less energy, less water, and no agrochemicals (Pretty, 2002; Halberg et al., 2005; Pimentel, 2005; Badgley et al., 2007). Yet even more important for the purposes 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 evidence of the potential of ecological agriculture to pull peasants out of poverty, strengthen social relations, eliminate dependency on outside inputs and knowledge, and strengthen the connection with their environment. A recent report by the FAO (El-Hage Scialabba and Hattam, 2007) that came out of the FAO-sponsored conference Organic Agriculture and Food Security in 2007, concludes that organic systems have a great potential to increase food access, reduce risk, and build long-term investment that increase food security, all of which directly address the IAASTD goals. It also states that when total household yield and nutritional and environmental impacts are measured along with the cost-effectiveness of production, as well as energy efficiency, organic systems are superior to conventional systems.

Since the early 1990s, organic agriculture has experienced a leap in demand, which has induced a spectacular increase, representing one the areas of agriculture with the greatest commercial potential (Box 11).

1.7.2 Sustainability

1.7.2.1 Traditional/Indigenous System

The sustainability of an agricultural system has to do with obtaining the best possible result without compromising the resource base looking to the future. The concept of sustainable agriculture integrates goals such as protecting the environment, profitability or productivity, and maintenance of rural communities (Altieri, 1995). For a long time, anthropologists and ecologists have recognized the sustainability features of indigenous/traditional systems, and these systems have been the basis of knowledge for the development of modern agroecology (Steward 1955; Netting, 1974; Altieri, 1995). Several specific aspects of traditional and indigenous agricultural systems tend to make them more sustainable and 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 (Altieri, 1995; 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 also cause less pollution.

Although these traditional systems maintained and still maintain hundreds of generations of farmers, some (such as the *chinampas* in Mexico and the *camellones elevados* in Lake Titicaca in Peru and Bolivia) were not able to survive, and others are in the process of disappearing due to social, economic, and political pressures (Denevan 1980; Turner and Harrison, 1983; Wilken, 1987). As the crisis of rural livelihoods advances, these systems gradually disappear, and with them the genetic resources and knowledge and wisdom that evolved over millennia.

1.7.2.2 Conventional/Productivist System

The greatest criticism of the conventional/productivist system is that it is not environmentally sustainable. The advent of high-input agriculture has led to a simplification and homogenization of the system, which results in the loss of planned biodiversity (in other words, the diversity of crops and other productive organisms such as honey bees, fish for food, and others). The reduction of planned diversity results in a diminution of the associated diversity (that is, all the other organisms that live in that agroecosystem). The loss of biodiversity has negative consequences for the sustainability of the agroecosystem, as it has a direct impact on ecological processes as well as on the environmental services provided by ecosystems (Naeem et al., 1994; Altieri, 1995; Tilman et al., 1996; Matson et al., 1997; Yachi and Loreau, 1999; Reganold et al., 2001). Some of the ecosystem services that are degraded by modern production practices 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). Production practices used in the conventional/productivist system, which are dependent on chemical inputs and mechanical manipulation of soils, can have devastating effects on these important but little-understood ecosystems. Erosion caused by tillage and other production practices, such as leaving bare soil exposed between planting seasons, has also gravely impacted soil fertility (Buck et al., 2004).

Pollination is another key ecosystem service that can be seriously degraded in intensive agricultural landscapes. Studies in Costa Rica, Brazil, 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 and Marcelo, 2006; De Marco and Monteiro Coelho, 2004; Ricketts et al., 2004). Also systems that are more diverse and harbor high levels of bee species increase pollination services (Klein et al., 2003; Steffan-Dewenter et al., 2005). Finally, 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 pesticides in conventional/productivist agriculture has also had a negative impact on the other beneficial fauna, such as natural enemies (predators, parasitoids, and others), stimulating the evolution of resistance in pests, the resurgence of primary pests, and outbreaks of secondary pests (Nicholls and Altieri, 1997). This so-called "vicious cycle of pesticides" has caused a continuous increase in the use of pesticides in the region. The phenomenon is well-established in the scientific literature and is responsible for crop losses due to pests and diseases, which have increased notably despite the ever greater use of pesticides (Pimentel et al., 1978).

Particularly worrisome at present is the increase in weeds resistant to herbicides, mainly glyphosate, due to the establishment of herbicide-resistant or -tolerant varieties, such as Roundup-Ready soybean from Monsanto (Box 1.7). From 2000 to 2005, the number of biotypes of herbicide-resistant weeds climbed from 235 to 296, and to 178 species.

All these factors combine with the vast expanses of single-crop agriculture characteristic of the conventional/productivist production system to create conditions that are unsustainable in the long run (Matson et al., 1997).

1.7.2.3 Agroecological system

The agroecological systems have emerged in response to the lack of sustainability and the environmental and health impacts of the conventional/productivist system. One of the pillars of the agroecological systems is the elimination or reduction in the use of pesticides and synthetic fertilizers; the other pillar is biodiversity. A recent study of 286 agroecological projects with small producers in 57 countries of Africa, Asia, and Latin America and the Caribbean found that while the average yield increased 79 percent, there were also increases in the efficiency of water use and the potential for carbon sequestration. Also contributing to the increase in the sustainability of the systems, the study found that 77 percent of the producers reported a 71-percent reduction in the use of pesticides. This study is significant because it covers an area of 37 million hectares, which represents three percent of the area planted in the non-industrialized countries (Pretty et al., 2006). One of the strategies for managing agroecological systems is to increase biodiversity, both planned and associated (Vandermeer, 1995). The increase in biodiversity is accompanied by the restoration of ecological processes such as pollination and the depredation of herbivores by natural enemies (Nicholls and Altieri, 1997). Alongside these benefits, agroecological practices may also increase the system's resistance to catastrophes, thereby bolstering its sustainability. Recently a participatory study by the Movimiento Campesino a Campesino showed that farms managed with agroecological practices were more resistant to the impacts of Hurricane Mitch in Nicaragua (Holt-Giménez, 2001) (Box 1.5).

1.7.3 Quality and food safety

Food quality and safety is understood as the guarantee that a food will not cause harm to the consumer, or in other words that it won't cause disease. The modern concept incorporates factors such as agricultural practices, genetic manipulation, the inclusion of hormones or other drugs in animals' diets (Campos, 2000), and post-harvest handling such as storage conditions and the use of unauthorized additives. The Codex Alimentarius Commission, established by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), prepares risk-based food safety standards that are used as a reference in international trade and give the countries a model for national laws (FAO, 2007).

The concept of food quality has to do with nutritional value, organoleptic properties such as appearance, color, texture, and flavor, and functional properties. Quality is related to characteristics that determine value or acceptability by consumers, and compliance with standards that ensure that a product is safe for consumers, not contaminated, adulterated, or bearing a fraudulent presentation. Safety therefore has to do with risks associated with production and subsequent handling, processing and packaging, such as contamination with agrochemicals (pesticides and fertilizers), veterinary drugs, or unauthorized food additives; microbiological risks posed by bacteria, protozoa, parasites, viruses, and fungi or their toxins (mycotoxins, aflatoxins); natural toxins present in the environment (zinc, arsenic, cyanide) or in foods themselves (solanine and histamine); and toxic industrial chemicals or radioactive waste (arsenic, cadmium, copper, lead, mercury, and polychlorinated biphenyls) (FAO, 2000). Exposure to pesticide waste or other contaminants in the diet has adverse effects on the production and reproduction of animals and in human populations (Singh et al., 2007).

Although until a few years ago authorities and researchers from several countries affirmed that foods produced organically did not differ significantly in terms of food safety and nutrition from conventionally grown foods, there is more and more evidence and official recognition that organic foods contain lower amounts of residue of additives and colors, pesticides, veterinary drugs, and in many cases more nitrates and other vitamins, minerals, essential fatty acids, and beneficial antioxidants; and they appear to have the potential to lower the incidence of cancer, coronary heart disease, allergies, and hyperactivity in children (FAO, 2000; Haward and Green, 2003; Green, 2004; Cleeton, 2004; Soil Association, 2005 and 2007). Baker et al. (2002) performed a statistical analysis of data on pesticide residues in 94,000 food samples to describe and quantify differences between fresh fruits and vegetables from three different modes of production: conventional, integrated pest management, and organic. A comparison was done of data from three programs: the Pesticide Data Program of the US Department of Agriculture; the Marketplace Surveillance Program of the California Department of Pesticide Regulation; and tests performed by Consumers Union, an independent organization. It was found that concentrations of pesticide residues in organic samples were consistently lower than in the other two categories, and the greatest concentrations were found in the conventional samples, which also contain multiple pesticide residues in greater proportions.

According to Barg and Queirós (2007), in 2004 a study was carried out in Uruguay on the quality of fruits and vegetables and levels of contamination by agrochemicals, with 200 samples. Residues were detected in 72 percent of them; in 7 percent of the cases the maximum residue limits or MRLs – established by Codex Alimentarius for individual products – were exceeded, but it was considered that in many samples residues of several pesticides were detected, which add up. Combinations of low levels of insecticides, herbicides, and nitrates have proven to be toxic at levels at which the chemicals individually considered are not (Cleeton, 2004). Barg and Queirós (2007) added that the MRLs allowed are set based on the technologies available and the current economic and commercial interests, and that the limits allowed today may be different in the future, and from what they were in the past, thus they are not established in relation to the harm they cause to health, but have more to do with the technological packages currently available and the companies involved.

According to FAO (2000) sensory analysis studies have been performed to determine differences in the organoleptic properties of fruits and vegetables such as apples, tomatoes, and carrots, in which the persons interviewed have recognized better flavor and color in organic as compared to conventional produce. In addition, it has been recognized that there are fewer losses due to fungi attacks during the storage of organic produce.

It is recognized that many developing countries have deficient food safety systems due to weak public infrastructure and incomplete or obsolete legislation that is not in line with international standards; there are even shortcomings in the developed world, when primary production is not covered. In addition, the responsibilities related to food safety and food control tend to be dispersed among several institutions, and the laboratories lack the equipment and basic supplies they need, all of which is aggravated by climatic conditions. The shortcomings of the food safety systems may result in an increase in food problems and food diseases. Diarrheal diseases, for example, provoked mainly by the consumption of unhealthy food and water, take the lives of 1.8 million children each year (FAO, 2007).

Almost all chemical pesticides authorized in conventional food production are prohibited in organic production; therefore contamination may be very low in organic products. More than 500 additives are authorized in conventional foods, but only 30 additives are authorized in organic foods. It has been concluded that a predominantly organic diet reduces the amount of toxic chemicals ingested, avoids transgenics, reduces the quantity of food additives and coloring; increases the consumption of vitamins, minerals, essential fatty acids, and beneficial antioxidants; and appears to have the potential to lower the incidence of cancer, coronary heart disease, allergies, and hyperactivity in children (Cleeton, 2004).

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 (Consumers International, 2004).

Although organic or agroecological foods are of significantly better quality than conventional ones, it cannot be said that they are totally safe. For example, one may find detectable levels of persistent organic pollutants (POPs) in organic or agroecological foods, such as DDT and other organochlorine insecticides that are no longer used because they accumulated in the soil for years.[8] Agroecological produce may also contain residues of other chemical pesticides that

---

[8] These persistent contaminants are called organic because they contain carbon in their molecule since they are manufactured from fossil fuels, but their use if prohibited in organic agriculture.

reach it by drift, with rain, or with contaminated waters, but also less frequently and in lower concentrations than in conventional produce (FAO, 2000; Bordeleau, 2002).

Animal manure and other organic waste such as biosolids or sludge from wastewater treatment plants, which may be used as fertilizer in ecological agriculture, may pose risks of contamination by pathogenic microorganisms that survive inadequate composting conditions (FAO, 2000).

It might be thought that organic foods pose risks of contamination with aflatoxins, a by-product of the contamination of foods with certain fungi in conditions favorable for them, given that they occur without the use of chemical fungicides. Nonetheless, it has been shown that such is not the case. Aflatoxins, which may induce cancer of the liver at very low dosages if ingested over a prolonged period of time, may be avoided by good practices in farming, post-harvest handling, and storage. Studies have been reported that found that the levels of aflatoxin in organic milk was lower than in conventional milk (FAO, 2000).

With regard to post-harvest handling, the vitamin C content and the dry matter are, on average, greater in organic crops and the percentage of water less, therefore they keep better than products handled with chemicals, since they are more resistant to diseases and pests (Barg and Queirós, 2007).

1.7.4 Impacts of the Production Systems

1.7.4.1 Environmental impacts

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, 2005b; McNeely and Scherr, 2003; Heywood and Watson, 1995; Goudie, 1990). 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.

1.7.4.1.1 Agriculture general impacts

The annual expansion in cultivated area in Latin America from 1961 to 1997 was 1.26 percent per year, far greater than any other region (Dixon et al., 2001). Since 1961, cultivated land has expanded by 47 percent, while cropping intensity has only increased by 1 percent (Dixon et al., 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 using traditional production methods, 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; Vandermeer and Perfecto, 2005). 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 percent 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 et al., 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 land tenure, 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 intensification 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 percent of the world's land area, but represents around 7 percent 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 percent 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, generally using extensive systems with low levels of inputs. 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 percent 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).

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, a third 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).

Export-oriented production of commodities using conventional production systems has led to extensive clearing of native vegetation outside the rain forest in many parts of Latin America, as exemplified by the recent expansion of soybean cultivation throughout the Brazilian cerrado and the forests of Argentina. 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 percent of which is endemic (Klink and Machado, 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 soybean, 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 et al., 2000; Klink and Machado, 2005). As a result, by 2002 more than half the original vegetation of the cerrado had been cleared for human use (Klink and Machado, 2005), with more than 70 percent of the farmed area dedicated to cattle production, generally of low intensity (Wood et al., 2000). Most of the rest is dedicated to large-scale, mechanized soybean production, oriented towards the export market. Likewise, due to the expansion of soybean, Argentina now has rates of deforestation that are 3 to 6 times the world averages (Jason, 2004) (Box 1.7).

1.7.4.1.2 Declines in on-farm 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. 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 (Perfecto et al., 1996; Perfecto and Armbrecht, 2003; 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. In his global analysis, Donald (2004) found that the increase in production of the five major commodities in the world (soybean, rice, cacao, coffee, and oil palm) were achieved through an increase in the area planted as well as an increase in yield per area, both of which led to environmental degradation and a massive loss of biodiversity. These negative environmental impacts were a consequence of both habitat loss and environmental contamination due to the use of agrochemicals. Similarly, Robinson and Sutherland (2002) documented the reduction of biodiversity due to agriculture in post-war Britain. They also present evidence that the loss of biodiversity was due to both habitat loss and habitat degradation (i.e. contamination with pesticides and other agrochemicals as well as the homogenization of the farm habitat).

1.7.4.1.3. Impacts on freshwater ecosystems

Freshwater ecosystems are very poorly understood, but it is clear that they are highly threatened worldwide (Millennium Ecosystem Assessment, 2005b; Abell, 2001; Olson and Dinerstein, 2002). 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 percent of freshwater biodiversity in the region is seriously threatened (Olson and Dinerstein, 2002).

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 are 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 (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 and Laikre, 2003).

1.7.4.1.4. Contamination and degradation of aquatic and terrestrial ecosystems

Agriculture also impacts biodiversity beyond the conversion of natural habitat. In particular, the use of agrochemicals in the conventional/productivist system results in contamination and degradation of ecosystems. Agrochemicals can harm species that utilize agricultural landscapes or nearby areas, and they have a major impact on aquatic and marine biodiversity. Pesticides persist in the environment and many disperse globally as a result of drift, soil volatilization, and evaporation (Kurtz, 1990). Pesticides have caused extensive contamination of the soil (Kammerbauer and Moncada, 1998), surface water and groundwater (Dalvie et al., 2003), marine and estuary sediments (Bhattacharya et al., 2003), fog (Steinheimer et al., 2004), rain

(Quaghebeur et al., 2004), polar snow (Barrie et al., 1992), mammals (WWF Arctic, 2006), and even tree bark (Simonich and Hites, 1995).

Certain persistent pesticides even accumulate in human tissues and are concentrated as they pass through the links in the food chains. They are implicated in massive deaths of marine mammals (Colborn et al., 1996) and of many bird species (Goldstein et al., 1999). As a result of hormonal or endocrinal alteration, which many can cause, they are responsible for serious population losses and for the feminization of male amphibians (Hayes, 2005) and alligators (Colborn et al., 1996; Crain et al., 1997). Some halogenated pesticides, particularly methyl bromide, contribute to the destruction of the ozone layer, which protects the earth (Miller, 1996; UNEP, 1999).

The impact of fertilizers and pesticides on the soil has been the subject of little research in LAC, 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 and Caribbean countries, such as the northern coast of Colombia. Given that the Stockholm Convention on POPs entered into force in May 2004, in several countries of LAC inventories are being taken of obsolete (prohibited or expired) pesticides, which include POPs (UNEP, 2001)

The conventional/productivist system 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.

1.7.4.1.5. 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 is 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).

1.7.4.2 Social impacts

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 and the Caribbean, the intensification of agriculture entailed the transformation from traditional production to production using external inputs, 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, 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. At the same time, agrarian policies have not been able to resolve the social right to access the benefits of technology, therefore there is a growing accumulation and concentration of the wealth generated by agriculture (Rosset et al., 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. The document The Millennium Development Goals: A Latin American and Caribbean Perspective identifies the lack of jobs as one of the main problems in the region (UNDP, 2005a).

Indeed, it is argued that conventional/productivist agriculture, apart from the social impacts produced by poverty and inequality, has exchanged 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, 2003).

At the same time, industrial/conventional/productivist 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 (2002) suggests that the impoverishment and unemployment of many agricultural producers that has been caused by the development of industrial agriculture favored the hiring of workers in unjust conditions, often disguised in pseudo-associative forms, as often happens with horticulture around large cities. This rural worker is extremely vulnerable: he or she practically lacks medical coverage and the possibility of retirement, as indicated by the tiny numbers who attain such benefits.

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 directly in the countryside, 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, conventional/productivist 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, 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, 2003).

1.7.4.3 Impacts on health and nutrition

1.7.4.3.1 Health effects of diminished biodiversity

Biodiversity is essential for nutrition and food safety and offers alternatives for improving the standard of living of communities, thus improving the overall health of human beings. Today certain communities continue using some 200 or more species in their diet, but the world trend is towards simplification, with negative consequences for health, nutritional equilibrium, and food safety. Biodiversity plays a crucial role mitigating the effects of micronutrient deficiencies (iron, zinc, copper, magnesium, and calcium), which weaken hundreds of millions of persons. A more diverse diet is crucial for diminishing the trend towards malnutrition and for living a healthier life (Barg and Queirós, 2007).

The loss of traditional varieties, soil degradation and contamination, the loss of biodiversity due to the establishment of large, genetically uniform expanses of single-crop agriculture, and the elimination of their organic management all resulted in deficiencies in essential micronutrients and vitamins in conventional food crops. Our foods are nutritionally unbalanced, since they are fertilized generally with one to three elements (nitrogen, phosphorus, and potassium), yet it is known that plants need 42 to 45 minerals to grow healthy, and with this type of reductionist agriculture very few nutrients are provided to the plant (Barg and Queirós, 2007).

Statistics from the governments of the United Kingdom and the United States indicate that the levels of minerals in fruits and vegetables fell up to 76 percent from 1940 to 1991. By way of contrast, there is mounting evidence that organic fruits and vegetables may have a greater vitamin and mineral content (Cleeton, 2004), from 40 to 60 percent more (Barg and Queirós, 2007), although some recommend that additional research be done (Table 1.11) (Soil Association, 2005).

(Insert Table 1.11: Levels of minerals in organically- and conventionally-grown foods)

1.7.4.3.2. Acute and chronic toxicity due to agrochemicals

Poisonings and deaths - Pesticides account for more poisonings than any other cause worldwide. In 1990 the World Health Organization (WHO) estimated that each year three million severe cases of poisoning occur, with likely mortality of 1 percent (WHO, 1990), whereas Jeyaratnam (1990) calculated 25 million poisonings that same year, estimating that an average of 3 percent of workers were intoxicated that year. Such figures reflect only the most severe cases and significantly underestimate unintentional poisonings due to pesticides, because they are based primarily on hospital records. Most of the rural poor do not have access to hospitals, and physicians and workers in the health sector often fail to recognize and report cases of poisoning (Murray et al., 2002). In a research study on the incidence of acute intoxications due to pesticides in six Central American countries, done in the early years of this decade by PAHO, WHO, DANIDA, and the ministries of health, within the project known as PlagSalud, 98 percent underregistration of intoxications was estimated (Murray et al., 2002; PAHO, 2003).

It is estimated that 99 percent of the deaths occur in the countries of the South, i.e. Latin America, Africa, and Asia (WHO, 1990). 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 conditions that are very dangerous in which they are highly susceptible (Nivia, 2000).

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. According to the most recent documentary research by PAN International (Pesticide Action Network), contained in its position paper on the elimination of pesticides (PAN, 2007), the main chronic effects caused by chemical pesticides include cerebral lesions and lesions of the nervous system in general, such as peripheral polyneuropathies and Parkinson's disease (Semchuk and Love, 1992; McConnell et al., 1993; Baldi, 2003; PAN Germany, 2003; Isenring, 2006); cardiovascular diseases; kidney and liver disorders; cancer (Brody and Rudel, 2003; Flower, 2004); genetic mutations; teratogenesis (congenital functional malformations or abnormalities) (Levario et al., 2003); endocrine or hormonal problems; reproductive problems (sterility, impotence, abortions, stillborn children, development problems in offspring) (Colborn et al., 1996; Figà-Talamanca, 2006; Bretveld et al., 2007); and suppression of the immune system. All pesticides produce chronic effects, particularly those known as persistent organic pollutants (POPs), which include DDT and other organochlorinated insecticides, which are targeted for control by the Stockholm Convention approved at the United Nations in 2001, and which entered into force in May 2004 (UNEP, 2001; UNEP, 2007).

1.7.4.3.3. Health effects of contamination of the environment and foods

There are growing concerns not only about the presence of pesticide residues in foods and their health effects, but also about the "cocktail effect" of multiple pesticide residues, along with food additives, hormones, and antibiotics used in breeding livestock and poultry, and due to the use of chemical fertilizers. Chemical fertilization in conventional agriculture results in higher levels of nitrates, which can have negative effects on health, because in certain conditions they can be converted to nitrosamines, which are carcinogenic. They may also reduce the ability of the blood to transport oxygen, and pose a risk of methemoglobinemia (FAO, 2000). An effort has begun to look for multiple pesticide residues and nitrates in food samples, because the evidence suggests that when they act in combination in foods, the harmful effects may be compounded. Combinations of low levels of insecticides, herbicides, and nitrates have proven toxic at levels at which the chemicals individually are not (Cleeton, 2004).

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 (Colborn et al, 1996; Figà-Talamanca, 2006; Bretveld et al., 2007). In addition, it is suggested that they may contribute to higher rates of hormone-dependent cancers such as breast and prostate cancer, in women and men occupationally exposed to pesticides. It is likely that women with breast cancer will have five to nine times more pesticide residue in their blood than those not afflicted with the disease (Bejarano, 2004; Cleeton, 2004).

Children may be particularly susceptible to pesticide residues because they consume more food and water per unit of body weight than adults, and their relatively immature organs may have a limited ability to detoxify these substances. In a comparative study with children ages 2 to 4 years in Seattle, six times more pesticide residue was found in children fed conventional foods than those fed organic foods. In another comparative study in Sweden with 295 children ages 5 to 13 years from schools with different approaches to education and food, it was found that in the school with alternative approaches, in which preference is giving to organic food, there was a lesser prevalence of allergies (Cleeton, 2004).

1.7.4.3.4 Risks due to transgenic foods

There are many concerns about the possible effects of transgenic foods, which are prohibited in organic or agroecological foods. The potential health effects of GMOs on humans are unknown, but there are ever greater concerns because more than half of the studies that do not find negative effects on organs of laboratory animals have been done in collaboration with the industry. Other studies, done independently, relate health risks mainly in the intestinal walls, due to the transfer of transgenes to intestinal bacteria; the scientists suggest that until they are adequately researched it is best not to consume them (Cleeton, 2004).

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 (Riveiro, 2006). According to statistics provided by the transgenics industry, in 2006 these crops (herbicide-tolerant and insect-resistant) were planted on 100.8 million hectares (249.1 million acres), 12 percent more than in 2005 (90 million hectares); global sales of these seeds reached US$ 6.050 billion (a 14 percent increase with respect to the previous year) (CropLife, 2007). Argentina was in second place in area planted after the United States, followed by Brazil in third place. Another five Latin American countries are among the 22 countries that planted transgenics in 2006, according to CropLife (2007): Paraguay (7^{th} place), Uruguay (9^{th}), México (13^{th}), Colombia (15th), and Honduras (18th). The top eight countries saw growth of more than one million hectares each from 2005 to 2006; geographic expansion occurred mainly in Latin America and Asia.

Participation by crop in the transgenic seed market in 2006 was as follows: soybean 43.9 percent; maize 41 percent; cotton 11.9 percent; canola 3 percent; and others, 0.2 percent (CropLife, 2007). The expansion of these groups has taken place with the concealment of real data on the proven effects in animals, such as allergic diseases and diminished performance of the immunological system (Riveiro, 2006).

1.7.4.4. Economic Impacts

It is very difficult to evaluate the social and environmental costs of conventional/productivist agriculture 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 (2004), in 2004 the Pesticide Action Network – Latin America (RAP-AL) made an initial approximation of the social and environmental costs in LAC. The RAP-AL study used same methodology and data applied in the United States, 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 (Nivia, 2005).

To evaluate the health impacts, general approaches of the World Health Organization were used that indicate that 15 percent of the population of Latin America and the Caribbean lives in rural areas, with 5 percent poisoned, 2 percent hospitalized, and 1 percent mortality (Table 1.12). 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, although the calculations are for one year, the impact has accumulated for more than 50 years of industrial/productivist agriculture, therefore adequate economic projections remain to be done to estimate the cumulative economic impact of this type of agriculture in the region.

(Insert Box 1.12: Estimated health costs due to pesticide use)

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. 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.

The Pesticide Action Network (North America) 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 percent 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 percent of the projects had a complete environmental evaluation (Karen, 2004).